VOLUME IV

ENVIRONMENTAL IMPACT ASSESSMENT

sn power

MIDDLE YEYWA HYDROPOWER PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT

FINAL REPORT

AUGUST 2018

Multiconsult

SN POWER

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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

FINAL REPORT

AUGUST 2018

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အကျဉ်းချုပ်

မြန်မာနိုင်ငံ၊ ရှမ်းပြည်နယ်(တောင်ပိုင်း) ရှိ မြစ်ငယ်(နမ္မတူ) မြစ်ပေါ်တွင် တည်ဆောက်မည့် အလယ်ရဲရွာ ရေအားလျှပ်စစ်စီမံကိန်း အတွက် ပတ်ဝန်းကျင်ထိခိုက်မှု ဆန်းစစ်ခြင်း အစီရင်ခံစာ တင်ပြနိုင်ရန် ပြည်တွင်း၊ ပြည်ပ ပညာရှင်များပါဝင်သော အဖွဲ့များသည် SN Power ကုမ္ပဏီ၏ ကိုယ်စား ကွင်းဆင်းလေ့လာမှုများကို ၂၀၁၅ ခုနှစ်မှ ၂၀၁၈ ခုနှစ် အထိ လုပ်ဆောင်ခဲ့ကြပါသည်။

စီမံကိန်းလုပ်ဆောင်မည့် သတ်မှတ်ထားသော နေရာသည် ရှမ်းကုန်းမြေမြင့်ဒေသဖြစ်ပြီး နက်ရှိုင်းသော ကမ်းပါးစောက်များရှိကာ ကမ်းပါးစောက်၏ အထက်ဘက်မြစ်ကမ်းနား နေရာများတွင် သစ်တောများ ကျန်ရှိနေပြီး အထက်ပိုင်းတွင် စိုက်ပျိုးမြေများကိုတွေ့ရှိရပါသည်။ နက်ရှိုင်းသော ကမ်းပါးစောက်များမှ အောက်ခြေအထိ သစ်တောများ ဖုံးလွှမ်းထားသည်ကိုတွေ့ရပါသည်။ အလယ်ရဲရွာ ရေလှောင်တမံ တည်ဆောက်မှုသည် (၇၀) ကီလိုမီတာ ရှည်လျားမည်ဖြစ်ပြီး ကျဉ်းမြောင်းသော ရေလှောင်ကန် ပုံစံရှိ၍ မြစ်ကမ်းပါးစောက်သဖြင့် အောက်ခြေသစ်တောများသာ ရေနစ်မြုပ်မည် ဖြစ်ပါသည်။

သွယ်ဝိုက်ထိခိုက်နိုင်သောနယ်မြေတွင် ကျေးရွာများစွာ တည်ရှိနေကြပါသည်။ အဆိုပါ ရွာသားများ၏ အဓိကအသက်မွေးဝမ်းကျောင်းလုပ်ငန်းမှာ စိုက်ပျိုးရေးဖြစ်ပြီး ကြံစိုက်ပျိုးခြင်းနှင့် ပြောင်းစိုက်ပျိုးခြင်း တို့ သည် အဓိကဝင်ငွေရရှိသော စိုက်ပျိုးသီးနှံများ ဖြစ်ပါသည်။ မြစ်၏ညာဘက်ခြမ်းရှိ ကျေးရွာများသည် ကောင်းမွန်သော လမ်းပန်းဆက်သွယ်ရေးစနစ် ရှိပြီး၊ ဘယ်ဘက်ခြမ်းရှိ ကျေးရွာများ၏ လမ်းပန်းဆက်သွယ်ရေးစနစ်မှာ အလွန်ခက်ခဲ နိမ့်ကျလျက်ရှိနေပါသေးသည်။ သွယ်ဝိုက်ထိခိုက်နယ်မြေရှိ ကျေးရွာအားလုံးသည် လျှပ်စစ်ဓာတ်အားဖြန့်ဖြူးရေးစနစ်နှင့် ဆက်သွယ်ထားခြင်း မရှိပါ။ အဆိုပါ ရွာသားတို့၏ ဝင်ငွေပမာဏသည် မြန်မာနိုင်ငံအတွက် ကမ္ဘာ့ဘဏ်မှ သတ်မှတ်ထားသော ဝင်ငွေအဆင့်ထက် အနည်းငယ် မြင့်မားနေပါသည်။

စီမံကိန်း တည်ဆောက်ရေးကာလတွင် အဓိကထိခိုက်နိုင်သော အချက်များမှာ ကုန်းမြေပေါ်တွင် နေထိုင်သော သတ္တဝါများနှင့် ရေနေဂေဟ စနစ်များ ဖြစ်ပါသည်။ အဆိုပါထိခိုက်မှုများကို လျော့ပါးအောင် မပြုလုပ်နိုင်ပါက ဖေါ်ပြပါ ပတ်ဝန်းကျင်ထိခိုက်မှု နှစ်မျိုးသည် အသင့်အတင့် (အလယ်အလတ်အဆင့်) ထိခိုက် နိုင်ပါသည်။

လူများအတွက် သက်ရောက်နိုင်သော ထိခိုက်မှုများတွင် နေရာဒေသစီးပွားရေးကို မူတည်ဆုံးဖြတ်ရာ၌ အသွင်အပြင် အပြောင်းအလဲများ၊ စီးပွားရေးလုပ်ငန်းပြောင်းရွှေ့မှုများ ကြောင့် အနည်းငယ်မှ အလယ်အလတ် အဆင့် ထိခိုက်မှုများ ရှိနိုင်ပါသည်။ စီမံကိန်း တည်ဆောက်မှုကြောင့် လူအများအပြား ပြောင်းရွှေ့လာကြ၍ လူမှုဘဝလုံခြုံမှုများကို အလယ်အလတ်အဆင့် ထိခိုက်နိုင်ပါသည်။ နောက်ဆုံးအနေနှင့် ဒေသခံများ၏ သစ်တောသုံးစွဲနိုင်မှုများ၊ မြစ်ချောင်း အရင်းအမြစ်သုံးစွဲမှုများအပေါ် ထိခိုက်နိုင်မှုမှာ အနိမ့်ဆုံးအဆင့် ထိခိုက်နိုင်မှုမှ အလယ်အလတ်အဆင့် ထိခိုက်မှုများအထိ ရှိနိုင်ပါသည်။

စီမံကိန်းလည်ပတ်မှုအဆင့်တွင် ဖြစ်ပေါ်နိုင်သည့် ရေအရည်အသွေး၊ ကုန်းနေသတ္တဝါများ၊ ရေနေဂေဟစနစ်များတို့အပေါ် သက်ရောက်ထိခိုက်မှုများမှာလည်း လုံလောက်သော လျော့ပါးသက်သာစေမည့်အစီအမံများ မပြုခဲ့လျှင် အလယ်အလတ်အဆင့်ထိခိုက်မှုများ အထိ ရှိနိုင်ပါသည်။

လူသားများအတွက် ထိခိုက်မှုများတွင် စီမံကိန်းလည်ပတ်မှု အဆင့်၌ သိသာထင်ရှားစွာ မှန်းဆမှု မပြုနိုင်သော်လည်း မြစ်ချောင်းအရင်းအမြစ် သုံးစွဲမှုတွင် အနိမ့်ဆုံးအဆင့်ထိခိုက်နိုင်ပြီး၊ ဒေသခံစီးပွားရေး အခြေအနေတွင် အနည်းငယ်ကောင်းမွန်သော သက်ရောက်မှုများရှိလာနိုင်ပါသည်။

ထိခိုက်နိုင်မှုများကို လျော့ပါးစေရန် သုံးသပ်ခြင်း ကောင်းမွန်သော သက်ရောက်မှုများကို မှန်းဆခြင်း လုပ်ဆောင်ချက်များ၊ စီမံချက်များကို ချမှတ်သွားမည် ဖြစ်ပါသည်။

အဓိက ပတ်ဝန်းကျင်ထိခိုက်မှုလျော့ပါးစေရန် လုပ်ဆောင်ချက်တွင် ဒေသအစုအဖွဲ့ပိုင်သစ်တောများ ထူထောင်ခြင်း ရေနေဂေဟစနစ်နှင့် ငါးများထိန်းသိမ်းရေး အစီအစဉ်၊ ဇီဝဗေဒစနစ် ထိန်းသိမ်းရေးနှင့် ကာကွယ်စောင့်ရှောက်ခြင်း အစီအစဉ်၊ ရေလှောင်ကန်ရှင်းလင်းခြင်းနှင့် ပြန်လည်ဖြည့် တင်းခြင်း အစီအစဉ်များ ပါဝင်မည် ဖြစ်ပါသည်။

လူမှုဘဝဖူလုံရေးတွင် အကျိုးအမြတ် ခွဲဝေမှုနှင့် ထိရောက်သော လူမှုဘဝဖူလုံရေး အထောက်အပံ့များအတွက် သွယ်ဝိုက်ထိခိုက်နယ်မြေအတွင်းရှိ ကျေးရွာချင်းဆက်လမ်းများ ပိုမိုကောင်းမွန်အောင် အဆင့်မြှင့်တင်ပေးခြင်း၊ ဆက်သွယ်နိုင်သောရွာများနှင့် လမ်းများ ကောင်းမွန်အောင်ပြုပြင်ပေးခြင်းအားဖြင့် လျှပ်စစ်ဓာတ်အားဖြန့်ဖြူးရေး ကွန်ယက်နှင့် ချိတ်ဆက်ပေးနိုင်ရန် တင်ပြထားပြီး ဖြစ်ပါသည်။

တိုက်ရိုက်ထိခိုက်ခံရသူများအတွက်လည်း ပြောင်းရွှေ့ရမည်ဆိုပါက အဆောက်အဦများ ပြန်လည်တည်ဆောက်ပေးရေး၊ ဆုံးရှုံးသွားသောစိုက်ပျိုးမြေများ၊ စီးပွားရေးအတွက် အသုံးချမြေများကို လက်ရှိပေါက်ဈေး (အချက်အလက်များ ကောက်ယူနေစဉ်ကာလ) တွက်ချက် သတ်မှတ် လျော်ကြေးပေးသွားမည် ဖြစ်ပါ သည်။

ဆန်းစစ်လေ့လာမှုများပေါ်အခြေခံပြီး ခြုံငုံသုံးသပ်ရမည်ဆိုလျှင် အလယ်ရဲရွာ ရေအားလျှပ်စစ်စီမံကိန်း တည်ဆောက်ရေး လုပ်ငန်းစဉ်သည် ပတ်ဝန်းကျင်နှင့် လူမှုဘဝထိခိုက်မှုများအပေါ် အလယ်အလတ်အဆင့်ထိခိုက်နိုင်ချေရှိသည်ကို တွေ့ရပြီး အဆိုပါထိခိုက်မှုများလျှော့ချနိုင်သည်ကိုလည်း လေ့လာတွေ့ရှိရပါသည်။ လူမှုဘဝထိခိုက်မှုပိုင်းတွင် အချိန်နှင့် တစ်ပြေးညီ ထိခိုက်မှုလျှော့ချနိုင်သည့် လုပ်ဆောင်ချက်များကို လေ့လာတွေ့ရှိသော အချက်အလက်နှင့် လိုအပ်မည့်လုပ်ငန်းစဉ်များအရ အကောင်အထည်ဖော် လုပ်ဆောင်နိုင်မည် ဖြစ်ပါသည်။

၁။ နိဒါန်း

၁.၁. အခြေခံအကြောင်း

SN Power ကုမ္ပဏီသည် ၂၀၁၄ ခုနှစ် ဇူလိုင် ၂ ရက်နေ့တွင် ပြည်ထောင်စုသမ္မတမြန်မာနိုင်ငံ၊ လျှပ်စစ်စွမ်းအား ဝန်ကြီးဌာနနှင့် နားလည်မှုစာချွန်လွှာ ရေးထိုးခဲ့ပြီး အလယ်ရဲရွာ ရေအားလျှပ်စစ်

တည်ဆောက်ရေး စီမံကိန်းအကောင်အထည်ဖော်မည့် နေရာဖြစ်သော ရှမ်းပြည်နယ် (တောင်ပိုင်း) ရှိ မြစ်ငယ်မြစ်(နမ့်တူမြစ်) တွင် လေ့လာမှုများကို စတင်လုပ်ဆောင်ခဲ့ပါသည်။

အဆိုပြု စီမံကိန်းသည် လည်ပတ်နေပြီဖြစ်သော မြစ်အောက်ဖက်ရှိ ရဲရွာ ရေလှောင်တမံ နှင့် တည်ဆောက်ဆဲ အထက်ရဲရွာ စီမံကိန်းများ၏ကြားတွင် တည်ရှိပါသည်။ လေ့လာသုံးသပ်ခဲ့သည့် အဆိုပြု လျာထားတမံနေရာ(၇)နေရာများအနက်မှ ရေလှောင်တမံ အမြင့် (၁၆၀) မီတာ တည်ဆောက်ပြီး၊ ရေလှောင်ကန်အရှည် (၇၀)ကီလိုမီတာရှည်သော ဆည်ကို တည်ဆောက် ရန် ဆုံးဖြတ်ခဲ့ပါသည်။

ဖြစ်မြောက်နိုင်စွမ်း ကြိုတင်လေ့လာခြင်းကို ၂၀၁၅ ခုနှစ် ဩဂုတ်လတွင် အကြိုစူးစမ်းလေ့လာမှုများနင့် အကြိုအင်ဂျင်နီယာနည်းပညာပိုင်းဆိုင်ရာ တွက်ချက်လေ့လာမှုပုံစံများကို အခြေခံပြီး အဆုံးသတ်ခဲ့ပါသည်။ SN Power သည် နောက်ပိုင်းတွင် အသေးစိတ် အင်ဂျင်နီယာနည်းပညာပိုင်းဆိုင်ရာ စူးစမ်းလေ့လာမှုများ နှင့် ပတ်ဝန်းကျင်ထိခိုက်ဆန်းစစ်ချက် လေ့လာမှုကို လုပ်ဆောင်ရန်ဆုံးဖြတ်ခဲ့ ပါသည်။

၁.၂. စီမံကိန်းအကောင်အထည်ဖော်သူ

SN Power သည် နော်ဝေနိုင်ငံအခြေစိုက် အပြည်ပြည်ဆိုင်ရာ ပြန်လည်ပြည့်ဖြိုးမြဲ စွမ်းအင်ကုမ္ပဏီ အဖြစ် ဈေးကွက်လိုအပ်ချက်အရ ထွက်ပေါ်လာပါသည်။ စီးပွားရေးချိုင့်သုံးသပ်ချက်အရ ဖွံ့ဖြိုးရန်၊ တည်ဆောက်ရန်၊ ဆည်းပူးရန် ပိုင်ဆိုင်လုပ်ဆောင်ရန် စဉ်ဆက်မပြတ် ဖွံ့ဖြိုးတိုးတက်သော ပြန်လည် ပြည့်ဖြိုးမြဲစွမ်းအင်စီမံကိန်းများ၊ အဓိကအားဖြင့် ရေအားလျှပ်စစ်လုပ်ငန်းများ ကို ဆာဟာရတောင်ပိုင်းဒေသများ၊ အာဖရိက၊ အမေရိကအလယ်ပိုင်းနှင့် အရှေ့တောင်အာရှ ဒေသများတွင် လုပ်ဆောင်နေပါသည်။

၂။ ပတ်ဝန်းကျင်ထိခိုက်မှုဆန်းစစ်ခြင်းလေ့လာမှု

ပတ်ဝန်းကျင်နှင့် လူမှုဘဝ အချက်အလက်များ လေ့လာခြင်းလုပ်ငန်းကို ၂၀၁၅ ခုနှစ် မှ ၂၀၁၈ ခုနှစ် အထိ လုပ်ဆောင်ခဲ့ပါသည်။ ဖြစ်နိုင်ခြေလေ့လာခြင်း အဆင့် ၂၀၁၅ တွင် SN Power သည် MIID (မြန်မာနိုင်ငံ ဘက်စုံဖွံ့ဖြိုးရေး သုတေသနအဖွဲ့)၊ NEPS (ပြည်တွင်း အင်ဂျင်နီယာနှင့် စီမံကိန်းများ လုပ်ဆောင်မှုအဖွဲ့) များနှင့် အတွေ့အကြုံ ရင့်ကျက်သော အပြည်ပြည်ဆိုင်ရာ အကြံပေး (၂) ဦးနှင့်အတူ ပူးပေါင်း လုပ်ဆောင်ခဲ့ ပါသည်။

၂၀၁၇ ခုနှစ် မတ်လတွင် SN Power သည် နော်ဝေအခြေစိုက် Multiconsult အဖွဲ့နှင့် စာချုပ်ချုပ်ဆိုပြီး ပတ်ဝန်းကျင် ထိခိုက်မှု ဆန်းစစ်ခြင်း အသေးစိတ်လုပ်ငန်းများ ကို အလယ်ရဲရွာစီမံကိန်းဧရိယာတွင် လုပ်ဆောင်ခဲ့ပါသည်။ Multiconsult အဖွဲ့သည် ရှေးဦး စီမံကိန်းနေရာ လေ့လာခြင်းကို ၂၀၁၇ ခုနှစ် ဧပြီလတွင် လုပ်ဆောင်၍ အစီရင်ခံတင်ပြချက် (report) ကို ၂၀၁၇ အောက်တိုဘာလတွင် တင်ပြခဲ့ပြီး အချို့အချက်အလက်များကို နိုင်ငံတွင်းနှင့် အပြည်ပြည်ဆိုင်ရာ လိုအပ်ချက်များနှင့် အညီ တင်ပြခဲ့ပါသည်။ ထပ်မံလိုအပ်ချက်အရ လေ့လာရေး လုပ်ငန်းစဉ်ကို

Multiconsult နှင့် MIID တို့ ပူးပေါင်း၍ ၂၀၁၇ ခုနှစ် အောက်တိုဘာတွင် လုပ်ဆောင်ခဲ့ ပါသည်။ (လူမှုဘ၀လေ့လာရေးကို အဓိက လက်ဝဲဘက်ခြမ်းရွာများ) ၂၀၁၇ ခုနှစ် ဒီဇင်ဘာတွင် ကင်မရာ ထောင်ချောက်များ တပ်ဆင်ခြင်း၊ လိုအပ်သော သဘာဝပေါက်ပင် နေရာများ လေ့လာခြင်း၊ သဘာဝတောတောင်များ၊ ရေနေသတ္တဝါများကို စမ်းသပ်လေ့လာခြင်း လုပ်ငန်းများ လုပ်ဆောင်ခဲ့ပါသည်။

၃။ စီမံကိန်းရှင်းလင်းချက်

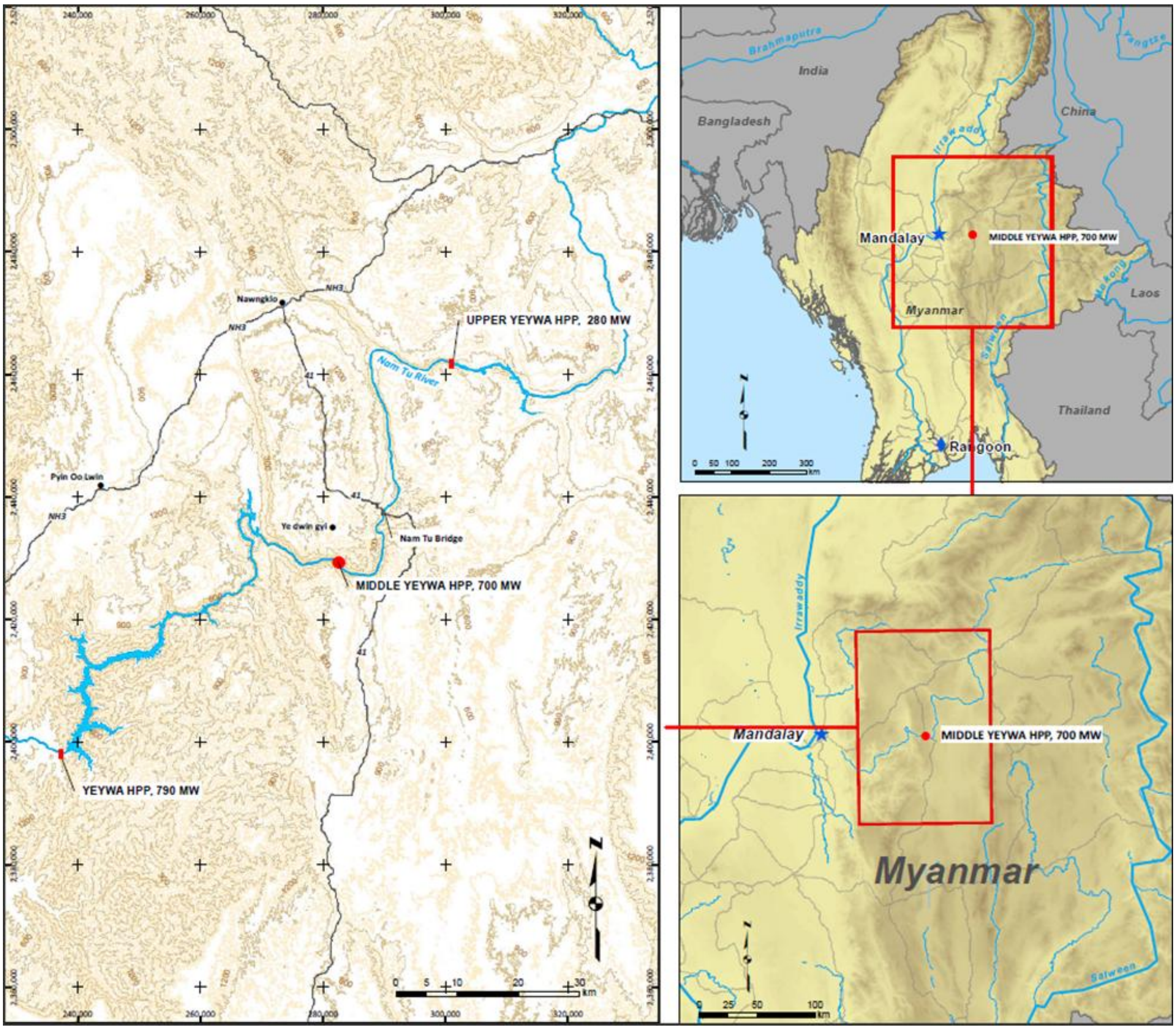
၃.၁. တည်နေရာ

စီမံကိန်းဒေသသည် ရှမ်းပြည်နယ်တွင် ရှိပြီး၊ မန္တလေးမြို့ အရှေ့ဘက် ၈၀ ကီလိုမီတာ၊ ပြင်ဦးလွင်မြို့ အရှေ့ဘက် ၅၅ ကီလိုမီတာဝေးကွာပြီး ဧရာဝတီ၏ မြစ်လက်တက် မြစ်ငယ်မြစ်ပေါ်တွင် တည်ရှိပါသည်။ (မြေပုံတွင် ကြည့်နိုင်ပါသည်)

မြစ်ငယ်မြစ်သည် အလွန်နက်ရှိုင်းစွာ ထိုးဖောက်၍ ပုံသဏ္ဍာန် ချောက်နက်ကြီးများကို ဖန်တီးပြီး မြင့်မား မတ်စောက်သော ကမ်းပါးစောင်းများရှိခြင်းကြောင့် ကျဉ်းမြောင်းသော ရေလှောင်ကန်နှင့် အလွန်အကျုံ နည်းပါးသော သက်ရှိ ဆုံးရှုံးမှုများသာ ဖြစ်နိုင်ပါသည်။ ရေလှောင်တမံနှင့် ဆက်စပ် အဆောက်အဦးများ၊ ဓာတ်အားထုတ်လုပ်ရေးစက်ရုံများ သည် နောင်ချို နှင့်ရပ်စောက်မြို့နယ်များတွင် တည်ရှိမည်ဖြစ်ပြီး၊ ၇၀ ကီလိုမီတာ ရှည်လျားသော ရေလှောင်ကန်သည် ကျောက်မဲမြို့နယ်တွင် တည်ဆောက်နေသော အထက်ရဲရွာ အခြေသို့ ရောက်ရှိမည် ဖြစ်ပါသည်။

၃.၂. ယေဘုယျဖွဲ့စည်းပုံ

စီမံကိန်းမှ အဓိက ရွေးချယ်ထားသည့် နေရာသည် အကောင်းဆုံးသော ရေလှောင်တမံ နေရာကို မူတည်ကာ လက်ရှိ ရဲရွာရေလှောင်ကန်ကန်ရေပြည့်အမှတ် (၁၈၅ မီတာ ပင်လယ်ရေမျက်နှာပြင် အထက်) နှင့် အထက်ရဲရွာ စီမံကိန်း (၃၂၃ မီတာ ပင်လယ်ရေမျက်နှာပြင် အထက်) (ရေရောက်ရှိမှု အဆုံးနေရာ) နေရာတွင် သတ်မှတ်ထားပါသည်။ ရေကာတာနေရာသည် မြစ်ငယ်မြစ်၏ အကျဉ်းဆုံး ရေတံခွန်ငယ်များ တည်ရှိရာ အခြေတွင် ရှိမှာဖြစ်ပြီး၊ လျှပ်စစ်ဓာတ်အားပေးစက်ရုံသည် မြေအောက်တွင်ရှိမှာမည်ဖြစ်၍ ရေလှောင်တမံ ၏ အောက်ဘက်ပိုင်း ၁၅၀ -၂၀၀ မီတာ အကွာခန့်တွင် တည်ရှိမည် ဖြစ်ပါသည်။



Project location (Source: Pöyry 2015). **(စီမံကိန်း တည်နေရာ)**

၃.၃ စီမံကိန်းအစိတ်အပိုင်းများ

၃.၃.၁ ရေလှောင်တမံ

ရေလှောင်တမံ ပုံစံသည် မျဥ်းကွေး ပုံစံဖြစ်မည်ဖြစ်ပြီး အမြင့်ဆုံး အခြေခံအမှတ်အားဖြင့် ၁၆၀ မီတာနှင့် ထိပ်ဖက် အကျယ် ၃၃၀ မီတာ အရှည်ရှိပါသည်။ သတ်မှတ်ထားသောရေလှောင်တမံမှာ အလယ်တွင် ရှိနေသော ထိပ်ပိုင်းရေပိုလွှဲ (၂) ခုနှင့် ဘယ်ဘက်ခြမ်း ရေပိုလွှဲ(၃) ခုပါ ရှိမည်ဖြစ်ပါသည်။ ရေပိုလွှဲမှ ထွက်ရှိလာမည့် ရေအားလုံးသည် ရေလွှဲလမ်းကြောင်းမှ တဆင့် ရေစုကန်သို့ ရောက်ရှိအဆုံးသတ်မည် ဖြစ်ပါသည်။

၃.၃.၂ လျှပ်စစ်ဓာတ်အားပေးစက်ရုံ

မြေအောက်လျှပ်စစ်ဓာတ်အားပေးစက်ရုံ ကွန်ရက်သည် ဓာတ်အားထုတ်လုပ်ရေး ရေယူလိုဏ်ခေါင်း နှင့် လျှပ်စစ်ထုတ်လုပ်ရေးအတွက်လိုအပ်သော ထရမ်စဖော်မာ လိုဏ်ဂူများ

ပါဝင်မည်ဖြစ်ပါသည်။ လိုအပ်သော ကားသွားလာနိုင်မည့်ပြွန်များ၊ ဆက်သွယ်ရေးပြွန်များ ပါရှိမည်ဖြစ်ပါသည်။ ပါဝါလှိုင်ဂူ (Power Tunnel) တွင် ၁၈၃.၇၅ MW ထုတ်သော ဒေါင်လိုက်ဝန်ရိုးပါ Francis တာဘိုင်စက် ၄ လုံးတပ်ဆင်မည်ဖြစ်ပြီး စုစုပေါင်း ၇၃၅ MW ရှိမည်ဖြစ်ပါသည်။

၃.၃.၃ ရေလှောင်ကန်

အလယ်ရဲရွာရေလှောင်တမံသည် ၇၀ ကီလိုမီတာ ရှည်လျားပြီး ကျဉ်းမြောင်းသော ရေလှောင်ကန် ဖြစ်ပေါ်စေမည်ဖြစ်၍ ၁၃၅-၁၄၅ မီတာ တမံ အထက်နားတွင်သာ ရေနက်မည်ဖြစ်ပြီး တဖြည်းဖြည်းရေတိမ်သွားကာ ရေလှောင်ကန် အဆုံးနေရာသို့ ရောက်ရှိမည် ဖြစ်ပါသည်။ ကန်ရေပြည့်မှတ်သည် (၃၁၇ မီတာ ပင်လယ်ရေမျက်နှာပြင် အထက်)ရှိပြီး၊ ရေလှောင်ထားသော ပမာဏမှာ ၁၁ စတုရန်းကီလိုမီတာရှိကာ စုစုပေါင်း volume ပမာဏမှာ ကုဗမီတာ သန်းပေါင်း ၄၀၀ ^၃ (400 million m^3) ရှိမည်ဖြစ်ပါသည်။

၃.၃.၄ ဆက်သွယ်ရေးလမ်းများ

လက်ရှိ မြေလမ်းများကို အဆင့်မြှင့်တင်ပြီး ၃.၈ ကီလိုမီတာ အရှည် ရှိသော လမ်းသစ်ဖောက်လုပ်၍ ချောက်နက်ထဲအထိ တမံအောက်ခြေသို့ အလျင်အမြန်ရောက်ရှိနိုင်ရန် အတွက် ဖောက်လုပ်မည် ဖြစ်ပါသည်။

၄. သက်ရောက်နိုင်သောနေရာ

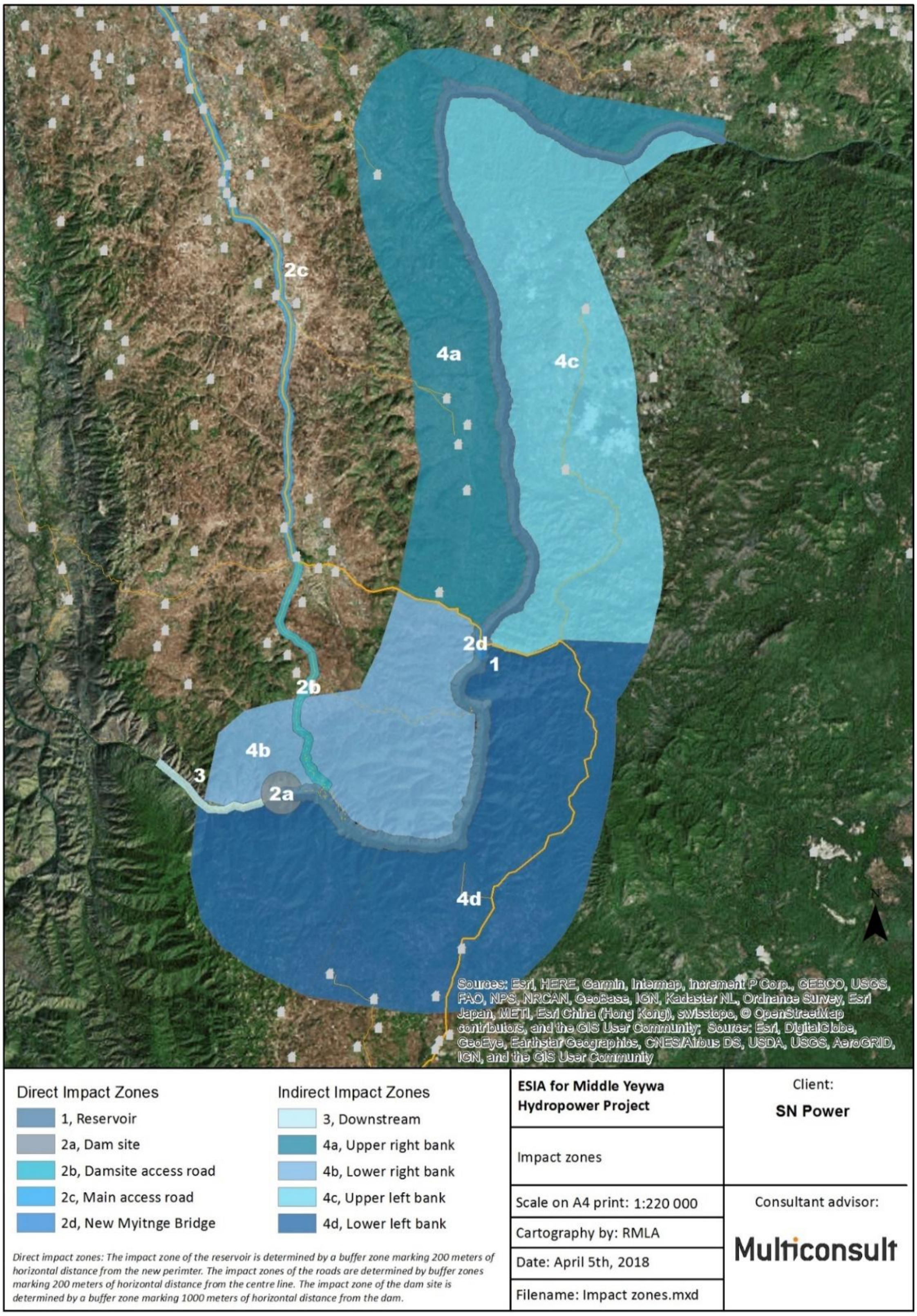
ပတ်ဝန်းကျင်ထိခိုက်မှုများ ဖြစ်ပေါ်နိုင်သော နေရာများကို ကြိုတင်လေ့လာခြင်း ရလဒ်များပေါ်မူတည်၍ သတ်မှတ်ခဲ့ပါသည်။ တိုက်ရိုက်ထိခိုက်မှု သက်ရောက်နိုင်သော နေရာနှင့် သွယ်ဝိုက်ထိခိုက်မှု သက်ရောက်နိုင်သော နေရာဟူ၍ ခွဲခြားထားပါသည်။ ထိုနေရာများကို ပေါင်း၍ စီမံကိန်း ဧရိယာ တစ်ခု သတ်မှတ်ပါသည်။ (အောက်ပါပုံတွင် ကြည့်နိုင်ပါသည်။)

၄.၁ တိုက်ရိုက်သက်ရောက်နယ်မြေ

တိုက်ရိုက်သက်ရောက်နယ်မြေသည် လုပ်ဆောင်မှုများတည်ဆောက်မှု များ၊ လည်ပတ်မှုများကြောင့် တိုက်ရိုက်ထိခိုက် သက်ရောက်နိုင်သော နေရာများကို သတ်မှတ်ပါသည်။ ထိုနယ်မြေတွင် စီမံကိန်း အစိတ်အပိုင်းများ တည်ရှိရာနေရာနှင့် ကြားခံ နေရာ ၂၀၀ မီတာ အပါအဝင်နယ်မြေတို့ပါဝင်ပါမည်။

၄.၂ သွယ်ဝိုက်ထိခိုက်နယ်မြေ

ထိုနယ်မြေသည် တိုက်ရိုက်သက်ရောက်နယ်မြေ၏ အပြင်ဘက်နေရာဖြစ်ပြီး တည်ဆောက်မှုများ၊ ဓာတ်အားပေးစက်ရုံလည်ပတ်မှုများကြောင့် ရုပ်သဘာဝများ၊ သက်ရှိများ၊ လူတို့၏ဝန်းကျင်နှင့် အခြားထိခိုက်မှုများကို ဖြစ်ပေါ်စေခြင်း၊ ဥပမာ- ရေအရည်အသွေးပြောင်းလဲမှု၊ လေထုညစ်ညမ်းမှုအဆင့်၊ သားရဲ တိရစ္ဆာန်များနေရာ ပျက်စီးခြင်းနှင့် ငါးတို့နေရာ ပြောင်းရွှေ့သွားလာမှု ပျက်ပြားခြင်း၊ လူတို့၏ စားဝတ်နေရေးပြောင်းလဲခြင်းနှင့် နီးစပ်ရာ လူ့အဖွဲ့အစည်း၏ ယဉ်ကျေးမှု အလေ့အထများ ပြောင်းလဲသွားခြင်းတို့ ပါဝင်မည်ဖြစ်ပါသည်။



Direct and indirect impact zone of the Middle Yeywa HPP.(အလယ်ရဲရွာ စီမံကိန်း တည်ဆောက်ရေး လုပ်ငန်းစဉ်၏ တိုက်ရိုက်နှင့်သွယ်ဝိုက် ထိခိုက်သက်ရောက်နိုင်သော နယ်မြေ)

၅ အခြေခံအခြေအနေများ

၅.၁ ရုပ်ပတ်ဝန်းကျင်

၅.၁.၁ မြေမျက်နှာသွင်ပြင်နှင့် ဘူမိရုပ်သွင်

စီမံကိန်းဧရိယာ ၇၀ ကီလိုတစ်လျှောက်တွင် ရှမ်းကုန်းမြင့်အလွန်နက်သော ချိုင့်ဝှမ်းကြီးဖြစ် ၍ ဒေါင်လိုက်နီးပါး ကမ်းပါးစောက်များနှင့် တောင်ကြား ကြီးများသဖွယ် မြေမျက်နှာသွင်ပြင်ရှိပါသည်။ စီမံကိန်းဧရိယာ တစ်လျှောက်တွင် ဘေးမှဝင်ရောက် စီးဝင်သော မြစ်လက်တက်များ၊ ချောင်းများ မြောက် များစွာ ရှိပြီး ဂုတ်ထိပ်ချောင်း၊ နန်းကမ်ချောင်း (ရေလှောင်ကန်တည်ဆောက်ရန်ရှိ) တို့ သည် ရေဝှံခွန် အဖြစ် ဖြစ်ပေါ်ပြီး နမ္မတူမြစ်ထဲသို့ စီးဝင်ပါသည်။

ရှမ်းကုန်းမြင့်သည် ဆက်တိုက်ရှိသော ဒိုလိုနိုက်ကျောက်များ၊ ထုံးကျောက်များ (အုပ်စု) သို့ ရှမ်းဒိုလိုနိုက် အုပ်စုတို့ဖြင့် ဖွဲ့စည်းထားပါသည်။

၅.၁.၂ ရာသီဉတု

မြန်မာနိုင်ငံသည် များသောအားဖြင့် အပူပိုင်း ရာသီဥတုဖြစ်ပြီး စုစုပေါင်း သုံးရာသီ ရှိပါသည်။ ဥပမာ- မုတ်သုံ (သို့) မိုးရာသီ (မေ - အောက်တိုဘာ) အေးသော ရာသီ (နိုဝင်ဘာ - ဖေဖော်ဝါရီ) နှင့် ပူသော နွေရာသီ (မတ် - ဧပြီ) တို့ ဖြစ်ပါသည်။ မြစ်ငယ် မြစ်ဝှမ်းဒေသသည် မိုးအများဆုံးလများမှာ ဒီဇင်ဘာမှ မတ်လ အထိဖြစ်ပါသည်။ ပျှမ်းမျှတစ်နှစ်တာ မိုးရေချိန်မှာ ၁၀၀၀ မီလီမီတာကို အရှေ့တောင်ပိုင်းတွင်တွေ့ရပြီး ၁၈၀၀ မီလီမီတာကို အနောက်မြောက်ပိုင်းတွင် တွေ့ရပါသည်။ နွေရာသီ နေ့စဉ် ပျှမ်းမျှ အပူချိန် ၂၇ ဒီဂရီ စင်တီဂရိတ် ဖြစ်ပြီး အအေးဆုံးလ ဇန်နဝါရီ၏ နေ့စဉ် ပျှမ်းမျှ အပူချိန်သည် ၁၇ ဒီဂရီ စင်တီဂရိတ် ဖြစ်သည်။

၅.၁.၃ ရေဗေဒနှင့် ရေအရည်အသွေး

မြစ်ငယ်မြစ်သည် မူလအစ ဧရာဝတီမြစ်ဘက်ကမ်း မြစ်လက်တက်ဖြစ်ပါသည်။ စုစုပေါင်း ရေစီး ဆင်း ဧရိယာမှာ ၃၄၈၀၀ စတုရန်းကီလိုမီတာ နှင့် ၅၃၀ ကီလိုမီတာ ရှည်လျားပါသည်။ အလယ်ရဲရွာ၏ ရေစုဧရိယာမှာ ၂၅၅၁၈ ကီလိုမီတာ စကွဲယားရှိပါသည်။ စီးဆင်းမှုသည် ရာသီဉတု ပေါ်မူတည် နေပြီးအားအနည်းဆုံး စီးဆင်းမှုသည် ၁၀၀ - ၁၅၀ ကျူစက် (m^3/s) ကို မတ်လမှ မေလ တွင် တွေ့ရပြီး အများဆုံးစီးဆင်းမှုကို ၉၅၀ ကျူစက် (m^3/s) ကို ဩဂုတ်လမှ စက်တင်ဘာလအထိ တွေ့နိုင်ပါသည်။ ၈ နှစ်တာ ပျှမ်းမျှ စီးဆင်းနှုန်းသည် ၄၅၈ ကျူစက် (m^3/s) ဖြစ်ပါသည်။

စီမံကိန်းနယ်မြေအတွင်း ရေအရည်အသွေးသည် ရေနေသတ္တဝါများ ရှင်သန်နိုင်သော အနေ အထားရှိ ပါသည်။ အောက်စီဂျင်စုပ်ယူမှု ပမာဏသည် ၄.၇ မှ ၈.၄ မီလီဂရမ်ပါလီတာရှိပြီး မိုးရာသီ ရေစီးရေလာ ကောင်းချိန်တွင် အမြင့်ဆုံးဖြစ်ပါသည်။ အနယ်အနစ်ပါဝင်မှု နှုန်းသည် အမြင့်ဆုံး စီးဆင်းသည့် မိုးရာသီတွင် အမြင့်ဆုံးဖြစ်၍ ၆၉ မှ ၁၁၅ NTU ဖြစ်ပြီး ခြောက်သွေ့သော ရာသီ၊ ပူသောရာသီတွင်

၅၀ NTU ဖြစ်သည်။ ၂၀ NTU ကို အေး၍ ခြောက်သွေ့သော ရာသီတွင် တွေ့ရသည်။ (NTU = Nephelometric Turbidity Unit)

၅.၂ ဇီဝပတ်ဝန်းကျင်

၅.၂.၁ အရေးကြီး ဇီဝမျိုးစုံမျိုးကွဲနေရာနှင့် ကာကွယ်ထားသောနေရာ

ကာကွယ်တောများသည် စီမံကိန်းနှင့် တိုက်ရိုက်(သို့မဟုတ်)သွယ်ဝိုက်ဆက်နွယ်ခြင်း ရှိ၊ မရှိ မသေချာသေးပါ။ အနီးဆုံး ကာကွယ်တော ဖြစ်သည့် ကမ္ဘာ့သတင်းအချက်အလက်များအရ ပြင်ဦးလွင် သားရိုင်းတိရိစ္ဆာန် ကာကွယ် တောသည် ရေကာတာ၏ ၃၅ ကီလိုမီတာ အနောက်ဘက်တွင် တည်ရှိပါသည်။ မြစ်ကမ်းဘက် ခြမ်းတွင် သစ်တောထိန်းသိမ်းတောများ ရှိ၊ မရှိသည်မှာ မသေချာသေးပါ။

အနီးစပ်ဆုံး သိရှိချက်အရ မယ်ဟုန်-ဒုဌဝတီမြစ် အရေးကြီး ဇီဝမျိုးစုံမျိုးကွဲနေရာ တွေ့ရပါသည်။ ဆိုက်ဇရိယာသည် ပြင်ဦးလွင်ကာကွယ်တောမှ စီမံကိန်း ရေလှောင်တမံဧရိယာအထိ ဖြစ်ပါသည်။ ထိုဒေသသည် တရားဝင်ကာကွယ်ထားသောအဆင့်ရှိသည့်ဒေသ ဖြစ်သည်ကိုတွေ့ရပါသည်။ အပြည်ပြည်ဆိုင်ရာ ငှက်ဖုံဟု သတ်မှတ်ထားပါသည်။ အဘယ်ကြောင့် ဆိုသော် ရှားပါး ဒေါင်းမျိုးစိတ်များတွေ့ရှိသောကြောင့် အပြည်ပြည်ဆိုင်ရာ ငှက်အဖွဲ့က သတ်မှတ်ထားခြင်းဖြစ်ပါသည်။ ထိုမျိုးစိတ်သည် ကင်မရာထောင်ချောက် များမှ တိုက်ရိုက်သက်ရောက်နေရာများတွင် တွေ့ရပါသည်။ သို့သော်လည်း ထိုမျိုးစိတ်များ၏ အဓိက ကျက်စားရာ နေရာများတော့ မဟုတ်ပါ။

၅.၂.၂ သဘာဝပေါက်ပင်များ

သဘာဝပေါက်ပင်အမျိုးအစား၊ တိုက်ရိုက်သက်ရောက်နေရာနှင့် သွယ်ဝိုက်သက်ရောက်နေရာ တို့၏ သစ်တောအမျိုးအစားသည် အဓိကအားဖြင့် ရွက်ကြွေအင်တိုင်း (Dipterocarp) သစ်တော များဖြစ်ပြီး၊ ယေဘုယျကျပြီး တစ်ပြည်လုံးနေရာအများစုတွင် ပေါက်ရောက်သော သစ်တော များဖြစ်ပါသည်။ မြစ်ငယ်ကမ်းပါး တစ်လျှောက် ပေါက်ရောက်သောသစ်တောနှင့် ချုံတော များသည် ကမ်းနားနှင့် ဆိုင်သာ မြစ်ကမ်းနားသစ်တော အမျိုးအစားအစစ်များမဟုတ်ကြဘဲ၊ ကုန်းမြင့်ဒေသတွင် ပေါက်ရောက်သည့် မျိုးစိတ်များဖြစ်ပြီး၊ မြစ်ကမ်းနား သစ်တောအမျိုးအစား သီးသန့်မရှိကြပါ။ အဆိုပါ အင်တိုင်း သစ်တောများသည် မြစ်ရေစပ်ထိတိုင် ကျယ်ပြန့်ပေါက်ရောက်ကြ သည်။

စီးဆင်းသော ချောင်းငယ်လက်တက်များ၏ ထိပ်တွင် ရေမှုန်ရေမွှားထွက်၍ ဖြစ်ပေါ်လာသော စိုစွတ် နေရာများကိုလည်း တွေ့ရပြီး ရာသီအလိုက် ဖြစ်ပေါ်နေသော ရေမှုန်ရေမွှားနေရာများ ဖြစ်ပါသည်။ အလွန်စိတ်ဝင်စား ဖွယ်ကောင်းသော ရေမှုန်ရေမွှားနေရာမှာ နမ်းကမ် ချောင်းဝ ဘယ်ဘက်အခြမ်း သာစည်ရွာအနီး အမြင့်မှ ကျလာသော ရေတံခွန်မှ မြစ်ထဲသို့ မဝင်မီ ဖြစ်ပေါ်သော နေရာ ဖြစ်ပါသည်။

ဘေးအန္တရာယ်ကျရောက်နေသောအပင်မျိုးစိတ်များ၊ အပင်မျိုးစိတ်ပေါင်း ၆၂ ပင် (အခြားမျိုးစိတ် များပါ) များကို တိုက်ရိုက်နှင့်သွယ်ဝိုက်သက်ရောက် နယ်မြေများမှ ကောက်ယူနိုင်ခဲ့ပါသည်။ ထိုမျိုးစိတ်ထဲမှ ၅ မျိုးသည် ဘေးအန္တရာယ် ကျရောက်နေသော အပင်မျိုးစိတ်များအဖြစ် ကမ္ဘာ့မျိုးတုံးပျောက်ကွယ်မည့်

အပင်များ စာရင်းတွင်တွေ့ရှိရပါသည်။ ထို့အပြင် မျိုးစိတ်များကို ထပ်မံအဆင့်ခွဲခြားရာ၊ မျိုးတုံးပျောက်ကွယ် လုနီးပါး (NT), ဘေးအန္တရာယ်ကျရောက်နေသော (VU), မျိုးတုံးပျောက်ကွယ်နေသော (EN), သိသာ ထင်ရှားစွာ မျိုးတုံး ပျောက်ကွယ်နေသော (CR), ဟု အဆင့်ဆင့် ခွဲခြားထားပါသည်။ သို့ရာတွင် ကမ္ဘာလုံးဆိုင်ရာ မျိုးတုံးပျောက်ကွယ်မှု အဆင့်ရှိအပင်များသည် ပရောဂျက်သက်ရောက်နေရာပြင်ပတွင် လည်း တွေ့ရှိနေနိုင်ပါ သေးသည်။

၅.၂.၃ ကုန်းနေသတ္တဝါများ

အဓိကကုန်းနေသတ္တဝါတို့နေထိုင်ကျက်စားရာ စားကျက်များသည် အဓိကမြစ်တစ်လျှောက် မြစ်လက်တက်များ၊ မြစ်ဘေးသစ်တောများနှင့် အထက်ပိုင်းရွက်ကြွေတောများဖြစ်ပါသည်။ အလွန်အမင်း အသွင်ပြောင်းလဲပြီးသော စိုက်ပျိုးမြေများသည်လည်း စာကျက်များဖြစ်ပါသည်။

သတ္တဝါလေ့လာရေးအဖွဲ့သည်လည်း ၂၀၁၅-၂၀၁၈ ခုနှစ် အထိ သတ္တဝါမျိုးစိတ် ၃၄၀ ကို အမျိုးမျိုးသော သတ္တဝါအုပ်စုများတွင်တွေ့ရပါသည်။ သို့ရာတွင် တစ်ချိန်က ရှိခဲ့သော မျိုးစိတ်များဖြစ်သည် မဖြစ်သည်မှာ သေချာစွာ တိုက်ဆိုင်စစ်ဆေးမှု မပြုလုပ်နိုင်ပါ။။

နို့တိုက်သတ္တဝါအုပ်စု ၄၅ မျိုးစိတ်ကို ထုတ်ဖော်နိုင်ခဲ့ပြီး၊ အချို့ကို မေးမြန်းစုံစမ်းခြင်းဖြင့်သာ ရရှိခဲ့ ပါသည်။ နို့တိုက်သတ္တဝါမျိုးစိတ်များလျော့ပါးလာရသည့် အဓိက အကြောင်းရင်းမှာ လူများ၏ နှောင့်ယှက် ဖျက်စီးမှုများကြောင့် ဖြစ်ပါသည်။

သိသာစွာမျိုးတုံးပျောက်ကွယ်လာနေသော မျိုးစိတ်တစ်ခုမှာ တရုတ်မျိုးစိတ် သင်းခွေချပ်များ ဖြစ်ကြောင်း မေးမြန်းချက်အရ သိရှိခဲ့ရသည်။ မျိုးတုံးပျောက်ကွယ်မှု စာရင်းတွင် နို့တိုက်သတ္တဝါမျိုးစိတ် ၆မျိုး ပါဝင်နေကြောင်း သိရပါသည်။ ကျား၊ အာရှတောခွေး၊ မျောက်ညို၊ သစ်ရွက်စားမျောက်၊ ဝံကြောင်၊ မျောက်လွှဲကျော် တို့ကို မေးမြန်းချက်အရသိရှိရသော်လည်း တိုက်ရိုက်တွေ့ရှိမှုတော့ မရှိခဲ့ပါ။ ကျက်စားရာနေရာ အရည်အသွေးနှင့် လူတို့၏နှောင့်ယှက်ဖျက်စီးမှုများကို အခြေခံပြီး မည်သည့် မျိုးစိတ် မှ ဦးရေတည်တံ့ရန် တိုက်ရိုက်နှင့် သွယ်ဝိုက်သက်ရောက်နယ်မြေများတွင် ထိန်းမထားနိုင်ပါ။

ကမ္ဘာ့မျိုးတုံးပျောက်ကွယ်မှုစာရင်းအရ မျိုးစိတ် ၁၂ မျိုး ပါဝင်သည်ကို တွေ့ရပါသည်။ ထိုမျိုးစိတ် အမျိုးမျိုးကို ဓါတ်ပုံ ထောင်ချောက်များမှ ရရှိခဲ့ပါသည်။ (ကျားသစ်) အင်းကျားသစ်ခြေရာများ၊ မျောက်တံ ငါနှင့် မျောက်ပုတီးတို့အပြင် သစ်တောဌာနမှထုတ်ဝေသော မျိုးတုံးပျောက်ကွယ်မည့် စာရင်းတွင် နိုင်ငံလိုက်ဆိုင်ရာ ကာကွယ်ထားသော မျိုးစိတ်များ (သတိပေးစာအမှတ် ၅၈၃/၉၄) အရလည်း ဖော်ပြထား ပါသည်။ ကောက်ယူရရှိသော မျိုးစိတ်များရှိမည်ဟုမှန်းဆရသော မျိုးစိတ်များတွင် တရုတ်သင်းခွေချပ်၊ တောန္ဒား၊ ကျား၊ ကျားသစ်၊ ကျားတူကျားသစ်၊ မျောက်လွှဲကျော်၊ တောကျွဲများကိုလည်း ဖော်ပြထား ပါသည်။

များပြားလှသော၊ တွားသွားသတ္တဝါများသည်လည်း လူသားတို့၏ အနှောင့်အယှက် ပေးမှုကြောင့် အလျှင်အမြန် လျော့ကျနေရပါသည်။ လေ့လာမှုအရ တွားသွားသတ္တဝါ ၄၀ မျိုး၊ ရေနေကုန်းနေသတ္တဝါ ၉ မျိုးတို့ရရှိခဲ့ပါသည်။ အားလုံးသော တွားသွားသတ္တဝါမျိုးစိတ်များသည် မျိုးတုံးပျောက်ကွယ်မည့် စိုးရိမ်သတ္တဝါများ စာရင်းတွင် (**IUCN Red List**) အနည်းငယ်စိုးရိမ်နေရသော စာရင်းဝင် သတ္တဝါများ

ဖြစ်ပါသည်။ တွားသွားသတ္တဝါ (၄) မျိုးမှာ မျိုးတုံးမှု အန္တရာယ်ကျရောက် နေကြောင်း မေးမြန်းစုံစမ်း ချက်အရ တွေ့ရှိရပါသည်။ မျိုးတုံးပျောက်ကွယ် နေသော အင်းကြင်းလိပ်၊ မျိုးတုံး မှုအန္တရယ် ကျရောက်နေသော မြန်မာစပါးကြီးမြွေ၊ မျိုးတုံးမှုအန္တရာယ် ကျရောက်နေ သည့် တောကြီးမြွေဟောက်၊ မျိုးတုံးမှု အန္တရာယ်နှင့် နီးစပ်နေသော အိန္ဒိယလိပ်မဲများ ကို တွေ့ရပါသည်။

ငှက်မျိုးစိတ် ၁၁၈ မျိုးကို မြစ်၏ကမ်း ၂ ဖက်တွင်တွေ့ရှိရပါသည်။ မျိုးစိတ်အားလုံးကိုမျက်မြင် နှင့် အသံ တို့ကိုမူတည်၍ မျိုးစိတ်ခွဲခြင်းဖြစ်ပါသည်။ မျိုးတုံးပျောက်ကွယ်နေသည့် ဒေါင်းမျိုးစိတ် တစ်ခုကိုတွေ့ ရှိရပြီး၊ သစ်တောဌါနမှ ပြဒါန်းသော (သတိပေးနိုးဆော်စာအမှတ် ၅၈၄/၉၄) တွင်လည်းပါဝင်ပါသည်။ မျိုးတုံးပျောက်ကွယ်လုနီးပါးမျိုးစိတ် ၆ မျိုးဖြစ်သည့် သစ်တောက်ငှက်မျိုးစိတ် တစ်မျိုး (Olive-backed woodpecker)၊ ကုလားမကြက်တူရွေး /ကျေးကုလားမ၊ ကြက်တော /ကျေးဖောင်းကား၊ ကျေးကုလား၊ Long-tailed Parakeet (မြန်မာအမည်မရှိ) နှင့် စစ်တလိုင်း ငှက်များကို တွေ့ရှိရပါသည်။

ရေငှက်မျိုးစိတ်အနည်းငယ်ကိုလည်းတွေ့ရှိရပါသည်။ အင်းဆက်နှင့် ကျောရိုးမဲ့မျိုးစိတ်များ၊ အင်းဆက် နှင့် အချို့သောကျောရိုးမဲ့ မျိုးစိတ်များတွင် လိပ်ပြာများ၊ ပိုးတောင်မာများ၊ ပုစဉ်းများ၊ မြက်ခုတ် ကောင်များ၊ ကျိုင်းကောင်များ၊ ပင့်ကူများ၊ ကင်းမြီးကောက်မျိုးစိတ်များ၊ ရှိုးကောင်များ ကိုလည်း ကောက်ယူ ရရှိခဲ့ပါသည်။ မျိုးစိတ်ပေါင်း ၁၃၈ မျိုး မျိုးခွဲနိုင်ခဲ့ပါသည်။ အဆိုပါမျိုးစိတ်များသည် မျိုးတုံးပျောက်ကွယ်မှုစာရင်းတွင်သိသာစွာ ဖော်ပြထားခြင်းမရှိသေးပါ။ ထို့ကြောင့် တိကျရှင်းလင်းသော ထိန်းသိမ်းစောင့်ရှောက်နိုင်မှုပြုလုပ်ရန် မလွယ်ကူပါ။

၅.၂.၄ ရေနေဂေဟစနစ်

နေရာဒေသ တိုက်ရိုက်သက်ရောက်နေရာ၏ လူနေ နေရာဒေသများသည် ငါးများ၊ ရေအောက်နေ သေးငယ်သော ကျောရိုးမဲ့များ နှင့် အခြားရေနေသက်ရှိများအတွက် မြစ်ငယ်မြစ်တစ်လျှောက်နေရာဒေသ ၆ ခုကို ခွဲခြားသတ်မှတ်နိုင် ပါသည်။ ရေတံခွန်များ၊ ရေတံခွန်ငယ်များ၊ ရေစီးမြန်ရေတိမ်နေရာများ၊ ရေစီးမြန် ကျောက်ကြမ်း နေရာများ၊ ရေစီးမြန်ကြမ်းခြင်း မရှိသောနေရာများ၊ ရေစီးနေးသောနေရာ၊ ရေငြိမ်နေရာနှင့် စီးဝင် မြစ်ချောင်းများတို့ပါဝင်ပါသည်။

ရေနေရာများပျံ့နှံမှုသည် အပြောင်းအလဲ အလွန်မြန်ဆန်ပြီး မြစ်ရေစီးဆင်းမှု အရှိန်နှုန်း ၊ ရေအနက်၊ တိုက်စားမှု၊ ပုံသဏ္ဍာန် ပြောင်းလဲမှုတို့ အပေါ် မူတည်နေပါသည်။ မည့်သည့်ရေနေရာမှ သီးသန့် သတ်မှတ်၍ မရနိုင်ပါ။

ငါးမျိုးစိတ် ၃၃ မျိုး မျိုးခွဲနိုင်ခဲ့ပါသည်။ အများစုမှာ တံငါသည်များကိုမေးမြန်းခြင်းဖြင့် လည်းကောင်း၊ ထက်ဝက်ခန့်သည် တံငါသည်များဖမ်းမိသောငါးများမှ နမူနာစံပြုရယူမျိုးခွဲခဲ့ပါသည်။ ငါးမျိုးစိတ်များတွင် ငါးကြင်းမျိုးစိတ်သည် အတွေ့ရများပါသည်။ မျိုးစိတ်ပေါင်း ၁၉ မျိုးတွေ့ရှိ မျိုးခွဲနိုင်ခဲ့ပါသည်။ ငါးမျိုးစိတ် ၅ မျိုးသည် မေးမြန်းစုံစမ်းချက်အရ မျိုးတုံး ပျောက်ကွယ်လုနီးပါး မျိုးစိတ်များသတ်မှတ်နိုင်ပါသည်။ အခြားရေနေမျိုးစိတ်များဖြစ်သည့် ကဏန်း၊ ပုဇွန်နှင့် ခရုများသည်လည်း မျိုးတုံးမှုနှင့် အနည်းငယ်သက်ဆိုင် ခြင်း၊ အချက်အလက်မပြည့်စုံခြင်းနှင့် မျိုးတုံးပျောက်ကွယ်မှုစာရင်း မဝင်ခြင်း စသည်တို့ပါဝင်ပါသည်။

၅.၃ လူတို့နှင့် သက်ဆိုင်သော ပတ်ဝန်းကျင်

၅.၃.၁. နိုင်ငံရေးအင်အားစုများနှင့် အတိုက်အခံများ

ရှမ်းပြည်နယ်သည် လွတ်လပ်ရေး ရရှိပြီးချိန်မှစ၍ လက်နက်ကိုင် အတိုက်အခံများနှင့် တမ်မတော်တို့ကြား ပဋိပက္ခများဖြစ်ပေါ်ခဲ့ပါသည်။ မြစ်ငယ်မြစ်၏ဘယ်ဘက်ခြမ်းတွင် လှုပ်ရှားမှုရှိသော လက်နက်ကိုင်အဖွဲ့အစည်းမှာ ရှမ်းပြည်နယ် ပြန်လည်ထူထောင်ရေး ကောင်စီ (RCSS) နှင့် ရှမ်းပြည်နယ်တောင်ပိုင်း လက်နက်ကိုင်အဖွဲ့ (SSA-S) တို့ဖြစ်ပြီး ရှမ်းပြည်နယ် ပြန်လည်ထူထောင်ရေး ကောင်စီသည် ၂၀၁၂ ခုနှစ် ဇန်နဝါရီလတွင် အစိုးရနှင့် ငြိမ်းချမ်းရေး သဘောတူ ခဲ့ပါသည်။ သို့ပါ၍ စီမံကိန်း နယ်မြေသည် ထိုအချိန်မှစ၍ တည်ငြိမ်းအေးချမ်းလျက် ရှိပါသည်။

၅.၃.၂ လူဦးရေနှင့် လူမျိုးစုများ

စီမံကိန်းနယ်မြေသည် ဓနုလူမျိုး အများစုနေထိုင်ကြပြီး၊ ရှမ်းလူမျိုး အနည်းငယ်လည်း ပူးပေါင်း နေထိုင် ကြပါသည်။ တတိယ လူမျိုးစုဖြစ်သော ပလောင်လူမျိုးစုများသည်လည်း စီမံကိန်း ဧရိယာတွင် ပျံ့နှံ့နေထိုင်ကြပါသည်။

<u>ဓနု</u>။ ဓနု ဘာသာစကားသည် မြန်မာဘာသာစကားနှင့် အလွန်နီးစပ်ပြီး တစ်ခုသော မြန်မာဘာသာ အသံကွဲ တစ်ခုဖြစ်ပါသည်။ ဓနုလူမျိုးစုသည် အစိုးရ၏ တရားဝင်သတ်မှတ်ထားသော လူမျိုးစုများတွင် တစ်ခု ပါဝင်ပြီး ကမ္ဘာ့ငွေကြေးအဖွဲ့ လုပ်ဆောင်ချက် (၇) တွင်ပါဝင်သော အချက်အလက်များနှင့် ကိုက်ညီသော တိုင်းရင်းသား လူမျိုးစုများဖြစ်ပါသည်။ လူမှုဘဝလေ့လာရေး ကျေးရွာအစည်းအဝေး မေးမြန်းချက်များအရ ဓနုလူမျိုးများသည် ဖယ်ကြဉ်ခံထားရသော၊ အတိဒုက္ခကြုံတွေ့နေရသော လူမျိုးများ မဟုတ်ကြပါ။ မြန်မာ လူမျိုးစုများနှင့် ဘာသာစကားတူ ရင်းနှီး ကျွမ်းဝင်သူများဖြစ်ကြပါသည်။

<u>ရှမ်း</u>။ ရှမ်းရွာများ၊ ရှမ်းအများစုနေထိုင်သော ရွာများသည် စီမံကိန်း၏ သွယ်ဝိုက်သက်ရောက်သောနေရာများ တွင်သာတွေ့ရှိရပါသည်။ အထူးသဖြင့် မြစ်ညာဘက်အပေါ်ခြမ်းနှင့် ဘယ်ဘက်အောက်ခြမ်းနေရာတို့တွင် နေထိုင်ကြပါသည်။ ကမ္ဘာ့ငွေကြေးအဖွဲ့ လုပ်ဆောင်ချက် (၇) တွင်ဖော်ပြချက်အရ ထင်ရှားသော လူမျိုးစု၊ သီးသန့်နယ်မြေတွင် နေထိုင်သော လူမျိုးစု၊ ယဉ်ကျေးမှု သီးသန့်ရှိ၍ လူမှုရေးလုပ်ဆောင်ချက်သီးသန့်ရှိသော ဘာသာစကားသီးသန့်ရှိသည့် တိုင်းရင်းသား လူမျိုးများဖြစ်ကြပါသည်။ သို့ရာတွင် ထိုလူမျိုးတို့သည် ဖယ်ကြဉ်ခံရသော ၊ အတိဒုက္ခကျရောက်နေသော လူမျိုးများဟု မသတ်မှတ်နိုင်ပါ။ ထိုလူမျိုးတို့၏ အခွင့်အရေး၊ စိတ်ဝင်စားမှု၊ မြေယာပြဿနာ၊ သဘာဝ အရင်းအမြစ်များနှင့် ယဉ်ကျေးမှုအမွေအနှစ်များသည်လည်း ထိန်းသိမ်းစောင့်ရှောက်နိုင်ပါသည်။

<u>ပလောင်(တအောင်း)</u>။ ပလောင်လူမျိုးစုသည်လည်း စီမံကိန်းနယ်မြေတွင် တတိယမြောက်တွေ့ရှိ ရသော လူမျိုးစုများဖြစ်ပါသည်။ ပလောင်လူမျိုးစုသည်လည်း အစိုးရက တရားဝင်သတ်မှတ်ထားသော လူမျိုးစုများ ဖြစ်ပါသည်။ ကမ္ဘာ့ငွေကြေးအဖွဲ့၏ လုပ်ဆောင်ချက် သတ်မှတ်ချက် (၇) ချက် အရလည်း တိုင်းရင်းသား လူမျိုးစုများဖြစ်ပါသည်။

၅.၃.၃ ပရောဂျက်နယ်မြေစီးပွားရေးနှင့် အချက်အလက်များ

စိုက်ပျိုးရေး- မြစ်ငယ်မြစ်၏ ၂ ဖက်လုံးသည် ရေသွင်းစိုက်ပျိုးမှုမရှိသော တောင်ပေါ်စိုက်ခင်းများဖြစ်ပါသည်။ အိမ်ထောင်စုအများစုသည် ရွှေ့ပြောင်းတောင်ယာ စနစ်ကို ကျင့်သုံးဆဲဖြစ်ပြီး၊ စွန့်ပစ်မြေအဖြစ် ၁ နှစ် မှ ၃ နှစ်ထိစွန့်ပစ်ထားတတ်ပါသည်။ ရွာများတွင် လူဦးရေတိုးပွားလာသည့်အလျောက် ပျမ်းမျှစိုက်ပျိုးမြေ အကျယ်အဝန်းမှာ သေးငယ်လာပါသည်။ သို့ပါ၍ စွန့်ပစ်ဆိုင်းငံ့ထားသော စိုက်ပျိုးမြေများ အလွန်နည်းပါး လာပါသည်။

အိမ်ထောင်စု အများစုသည် စီမံကိန်း သက်ရောက်နယ်မြေများကို ဖြတ်၍ ၎င်းတို့၏စိုက်ပျိုးမြေများဆီကို သွားရောက်ကြပါသည်။ နယ်မြေအများစုသည် လူဦးရေနည်းပါးသော်လည်း စိုက်ပျိုးမြေချဲ့ထွင် လိုမှုကြောင့် တောင်ကုန်းမြင့်စိုက်ခင်းများတိုးချဲ့မှုသည် သစ်တောများခုတ်ထွင် ရှင်းလင်းမှုကို ဖြစ်ပေါ်စေပါသည်။ လယ်သမား အနည်းငယ်သာ၊ မိရိုးဖလာ စိုက်ပျိုးမှုများလုပ်ကိုင်ပြီး၊ အများဆုံးစိုက်ပျိုးသီးနှံများ မှာ ပြောင်းဖူးနှင့် ကြံများ ဖြစ်ပါသည်။

ဝင်ငွေအဆင့်နှင့် ဆင်းရဲနွမ်းပါးမှု - စီမံကိန်းသက်ရောက်နယ်မြေအတွင်းနေထိုင်သူတို့၏ဝင်ငွေ အဆင့်အတန်းသည် ကမ္ဘာ့ဘဏ်စံစစ်တမ်း (သတ်မှတ်ချက်) များအရ ၁,၃၀၃ ကျပ် (၁.၁ ဒေါ်လာ) သတ်မှတ်ထားပြီး၊ ကမ္ဘာ့အဆင်းရဲဆုံး (ဝင်ငွေအနည်းဆုံး) သတ်မှတ်ချက်သည် ၂ ဒေါ်လာ ဖြစ်ပါသည်။ လေ့လာဆန်းစစ်ချက် ၁၃ ရွာ အရ သွယ်ဝိုက် သက်ရောက်နယ်မြေအတွင်း နေထိုင်သောရွာများရှိ အိမ်ထောင်စုတစ်စု တစ်နှစ်တာဝင်ငွေမှာ ၄,၁၀၅,၅၆၇ ကျပ် ဖြစ်ကြောင်းတွေ့ရပြီး၊ ဒေါ်လာတန်ဖိုးအားဖြင့် ၃,၀၅၉ ဒေါ်လာ ဖြစ်ပြီး၊ တစ်နေ့တာ ပျမ်းမျှ ဝင်ငွေမှာ ၈.၃ ဒေါ်လာ ရှိပါသည်။ ပျမ်းမျှအားဖြင့် စိုက်ပျိုးရေးမှ ရသောဝင်ငွေသည် ဝင်ငွေအားလုံး၏ ၈၀ ရာခိုင်နှုန်း ဖြစ်သည်ကို တွေ့ရပါသည်။

၅.၃.၄ သက်ရောက်နယ်မြေများတွင် သဘာဝအရင်းအမြစ်များသုံးစွဲမှု

သစ်တောသယံဇာတ။ သစ်တောသယံဇာတတွင် သစ်များပါဝင်ပါသည်။ ဆောက်လုပ်ရေးနှင့် လောင်စာထင်း များ အစားအစာအဖြစ်ထုတ်ယူသောအပင်များ (စားသုံးရန်၊ ရောင်းဝယ်ရန်) အမဲလိုက်ခြင်း (စားသုံးရန်၊ ရောင်းဝယ်ရန်) ပါဝင်ပါသည်။ သို့ရာတွင် ထိုဝင်ငွေမှာ ရေဘုယျအားဖြင့် အဓိကဝင်ငွေ မဟုတ်ဘဲ အထောက်အပံ့မျှသာဖြစ်ပါသည်။ အမဲလိုက်ခြင်းသည် တစ်ချိန်က တွင်ကျယ်သည့် လုပ်ငန်း တစ်ခုဖြစ်ခဲ့သော်လည်း ယခုအခါ သတ္တဝါများရှားပါးမှုကြောင့် မလုပ်နိုင်တော့ပါ။

မြစ်ရေအရင်းအမြစ်။ မေးမြန်းခဲ့သော ၁၃ ရွာလုံးသည် သွယ်ဝိုက်သက်ရောက်နယ်မြေတွင် ရှိသောကြောင့် ရေအရင်းအမြစ်အတွက် မြစ်ကိုမှီခိုခြင်းမရှိပါ။ အိမ်ထောင်စု အနည်းငယ်သာ အားလပ်သည့်အခါများတွင် အပျော်သဘော ငါးဖမ်းကြပါသည်။ သို့ရာတွင် အိမ်ထောင်စုဝင်ငွေအတွက် သိသာထင်ရှားစွာ အထောက်အပံ့မပြုနိုင်ပါ။ မည်သည့် အိမ်ထောင်စုမှ ပျမ်းမျှဝင်ငွေ၏ ၁ ရာခိုင်နှုန်းကျော်ကို ငါးဖမ်းခြင်းမှ မရရှိပါ။ မေးမြန်းသော အိမ်ထောင်စု ၈၀၀ တွင် ၃၀ သာ ငါးဖမ်းကြသည်ကိုတွေ့ရပါသည်။

၅.၃.၄ ရှေးဟောင်းနယ်မြေနှင့် ယဉ်ကျေးမှုအမွေအနှစ်များ

စီမံကိန်း တိုက်ရိုက်သက်ရောက် နယ်မြေအတွင်း ရှေးဟောင်းနယ်မြေ နှင့် ယဉ်ကျေးမှု အမွေအနှစ်များအတွက် သီးခြားသတ်မှတ်ထားသော နေရာများ လုံးဝမတွေ့ရပါ။ သို့ရာတွင် သွယ်ဝိုက်သက်ရောက် နယ်မြေရှာများတွင် စေတီများ၊ ဘုန်းတော်ကြီး ကျောင်းများ ၊ ဘုရားကျောင်းများရှိပြီး ဒေသခံများက သွားရောက်လည်ပတ်ပြီး ပြုပြင်ထိန်းသိမ်း ကြပါ သည်။

၆။ သက်ရောက်မှုများနှင့် လျော့ပါးသက်သာစေခြင်းများ

၆.၁ ရုပ်ပတ်ဝန်းကျင်

၆.၁.၁ မြစ်ရေစီးဆင်းမှု ကောင်းမွန်စေခြင်း

အလယ်ရဲရွာ ရေလှောင်တမံ ဆောက်လုပ်နိုင်ရန်အတွက် ယာယီအားဖြင့် မြစ်ညာနှင့် မြစ်ခြေ ၂ ဖက် စလုံးကို ယာယီရေလွှဲဆည် နှင့် ရေလွှဲမြောင်းများသို့ လွှဲထားမည်ဖြစ်ပါသည်။ ထိုရေလွှဲထားမှုသည် သဘာဝ မြစ်ရေစီးဆင်းမှုကို ထိခိုက်မည်မဟုတ်ဘဲ ရေလှောင်ကန်ရေပြည့်ချိန်အထိ ကြာမြင့်မည်ဖြစ်ပါသည်။ ရေလှောင်ကန် ရေစတင်သိုလှောင်မည့် အချိန်တွင်လည်း လိုအပ်သောရေပမာဏကို စီးဆင်းစေမည်ဖြစ်ပါသည်။

လုပ်ငန်းလုပ်ဆောင်မှုအရ တမံကိုယ်ထည်ရှိ ရေပိုလွှဲမှ ရေလွှတ်ချိန် သို့မဟုတ် ရေပိုလွှဲတံခါးများ ဖွင့်လွှတ်သည့်အချိန်များမှ လွှဲ၍ ရေလှောင်တမံ အောက်ဖက်မှ တာဘိုင်စက် ရေထုတ်ပြွန်နေရာအထိ ခန့်မှန်း ၂၀၀ မီတာ အကွာအဝေး အတွင်းရှိ ယာယီရေထုတ်ပြွန်နေရာ အနည်းငယ်သည်သာလျှင် အပြည့်အဝ (သို့မဟုတ်) တစ်စိတ်တစ်ပိုင်း ခြောက်သွေ့နေမည်ဖြစ်ပါသည်။

နေ့စဉ်အမြင့်ဆုံးလုပ်ဆောင်နိုင်ချိန်သည် အမြင့်ဆုံးထုတ်လုပ်နိုင်စွမ်းကို ရောက်ရှိမည် ဖြစ်ပြီး၊ ဥပမာ- မြေအောက်ခြေရေစီးဆင်မှုနှင့် ရေအနိမ့်အမြင့် အမြန်အဆန် အတက်အကျကို ဖြစ်ပေါ်စေနိုင်ပါသည်။ စက်ရုံ၏လည်ပတ်စွမ်းအားသည် အဆက်မပြတ်ရေစီးဆင်းမှု ကွာခြားချက်ပေါ်မူတည်သော်လည်း အမြင့်ဆုံး ရေစီးအားသည် တစ်စက္ကန့်လျှင် ၆၈၈ မီတာ ဖြစ်ရပါမည်။ အထူးသဖြင့် မိုးတွင်းကာလတွင်ဖြစ်ပြီး၊ အပြည့်အဝ လည်ပတ်မှုသည် နာရီအနည်းငယ်သာ ဖြစ်ပေါ်ပါမည်။

၆.၁.၂ ရေလှောင်ကန် အလွှာကွဲပြားခြင်း

အလယ်ရဲရွာ ရေကာတာသည် ကြီးမားနက်ရှိုင်းသော ရေလှောင်ကန်ပြုလုပ်မည် ဖြစ်၍ မြစ်၏ ရုပ်ဂုဏ်သတ္တိများ ပြောင်းလဲသွားမည်ဖြစ်ပါသည်။ ရေလှောင်ကန်ဖြစ်နေပြီးသောအချိန်တွင် ရေလှောင်ကန် အောက်ခြေသည် အောက်စီဂျင်ကင်းမဲ့သော ရေအလွှာဖြစ်ပေါ်လာမည်ဖြစ်ပါသည်။

အောက်စီဂျင်မဲ့သောရေများ မြစ်အောက်ဖက်သို့စွန့်ပစ်ရာတွင် အဆင့်ဆင့်ရှိသော ပြန်လည်စုပ်ယူ သည့် ကိရိယာများကို တပ်ဆင်ရမည် ဖြစ်ပါသည်။ ရေလွှတ်မြောင်းတွင် ရေကာတာ အနိမ့်များ ကို အောက်စီဂျင် စုပ်ယူနိုင်ရန် တပ်ဆင်နိုင်ပါသည်။ သို့ရာတွင် တာဘိုင်မှ ထုတ်လွှတ်လိုက်သော ရေများ သည် အောက်ဖက်ရှိ ရဲရွာတမံ၏ မြစ်ညာပိုင်းကို ရောက်ရှိသွားပြီး၊ ရေအရည်အသွေး ထိန်းနေရာသို့ရောက်ရှိမည်ဖြစ်၍ ဒီဇိုင်းသီးသန့် ပြင်ရန် အထူးမလိုအပ်ပါ။

၆.၁.၃ ရေညစ်ညမ်းမှု

တည်ဆောက်ရေးကာလတွင် မြေသားလုပ်ငန်းများ လုပ်ဆောင်ရမည် ဖြစ်၍ ယာယီရေထိန်းတမံ တည်ဆောက်ခြင်း၊ မြေကျင်းဖောက်ခြင်း၊ မိုင်းခွဲခြင်း၊ ကျောက်ခွဲခြင်းများကြောင့် မြစ်အတွင်းတမံနေရာ တစ်ဝိုက်တွင်လည်းကောင်း၊ လက်ရှိရဲရွာရေလှောင်ကန်၏ အခြားနေရာများတွင် လည်းကောင်း အနယ်အနှစ်များကျရောက် ဖြစ်ပေါ်မည်ဖြစ်ပါသည်။ ထို့အပြင် လုပ်ငန်းသုံး ယန္တရားများမှ၊ မတော် တဆ လောင်စာဆီ ယိုဖိတ်မှုများ၊ အမိုးနီးယားနှင့် နိုက်ထရိုဂျင်ယိုဖိတ်မှုများသည်လည်း ရေညစ်ညမ်း မှုကို ဖြစ်ပေါ်စေနိုင်ပြန်ပါသည်။ သို့ပါ၍ ထိရောက်သောကာကွယ်မှုများကို လုပ်ဆောင်ရမည်ဖြစ်ပါသည်။

အလုပ်သမားတန်းလျားများမှထွက်သော အညစ်အကြေး စွန့်ပစ်ပစ္စည်းများ၊ သက်ရှိအညစ် အကြေးများသည် မြေပြင်ပေါ်ရေများကို ညစ်ညမ်းစေမည် ဖြစ်ပါသည်။ စွန့်ပစ်ပစ္စည်းများ၊ စွန့်ပစ်ရေများမှာ နေအိမ်များနှင့် ဆောက်လုပ်ရေးလုပ်ငန်းများမှ ထွက်ရှိလာနိုင်သဖြင့် ထိရောက်စွာ ထိန်းသိမ်းထားရပါမည်။ (ဥပမာ-အကြွင်းအကျန်သတ္တု၊ သစ်သား၊ ပလတ်စတစ်၊ ဘိလပ်မြေအိတ်၊ သုံးပြီးကားတာယာများ၊ ဖုန်းဘက်ထရီဟောင်းများ စသည်ဖြင့်) ထိုအညစ်အကြေးများသည် မြေပေါ်နှင့် ရေထဲတွင်ပါ ညစ်ညမ်းမှုများ ဖြစ်စေပါသည်။ အလုပ်သမားများနေထိုင်သော အတိအကျနေရာများပေါ် မူတည်၍ ထိုညစ်ညမ်းမှုများသည်နေရာ ဒေသအတွင်းကျရောက်ခြင်း သို့မဟုတ် မြစ်ငယ်အတွင်း ကျရောက် ခြင်းများ ဖြစ်နိုင်ပါသည်။

၆.၁.၄ အနည်အနှစ်ဖမ်းခြင်းနှင့် စွန့်ထုတ်ခြင်းရေကန်

အလယ်ရဲရွာမှ ရေစွန့်ထုတ်ပြွန်သည် အောက်ရဲရွာ၏ တာဘိုင်တို့နှင့် ဝေးကွာခြင်းမရှိဘဲ၊ အထက်ရဲရွာမှ အနည်အနှစ်များဖမ်းယူပြီးဖြစ်၍ အလယ်ရဲရွာစီမံကိန်းသည် အကျိုးဆက် သက်ရောက်မှု နည်းပါးသွားမည်ဖြစ်ပါသည်။

၆.၁.၅ မြေတိုက်စားခြင်းနှင့် မြေပြိုခြင်းဖြစ်နိုင်ခြေ

တည်ဆောက်ရေးကာလတွင် မြေပေါ်အပင်များ ကိုရှင်းလင်းခြင်း၊ မြေခြစ်ခြင်း၊ မြေဖို့ခြင်း၊ မြေသိပ် ခြင်း၊ မြေတူးခြင်း၊ မြေပုံများပုံခြင်း၊ မြေဖယ်ရှားခြင်း၊ စသည်တို့ကို ပြုလုပ်မည် ဖြစ်ပါသည်။ လမ်းများအဆင့်မြှင့်တင်ခြင်းနှင့် တည်ဆောက်ခြင်းတို့ကိုလည်း မတ်စောက်သော မြစ်ငယ်ချိုင့်ဝှမ်းတွင် ပြုလုပ်မည်ဖြစ်ပါသည်။ လျှပ်စစ်ထုတ် စက်ရုံတည်ဆောက်ပြီးသောအခါ၊ အမြင့်ဆုံးလုပ်ဆောင်ချိန်တွင် ရေဆွဲယူမှု အားကောင်းခြင်းကြောင့် မြစ်အထက်ပိုင်းကမ်းစပ်များ ပြိုကျခြင်းများ နေရာကျယ်ကျယ်ပြန့်ပြန့် ဖြစ်နိုင်ပါ သည်။

၆.၁.၆ ဖန်လုံအိမ် ဓါတ်ငွေ့ထုတ်လွှတ်မှု

တည်ဆောက်ရေးကာလတွင် ဖန်လုံအိမ်ဓါတ်ငွေ့ထုတ်လွှတ်မှုသည် ကားများမောင်းနှင်မှုကြောင့် လည်းကောင်း၊ ဒီဇယ်စက်များမောင်းနှင်မှုကြောင့်လည်းကောင်း ထွက်ပေါ်နိုင်ပါသည်။ ထို့အပြင် ရေလှောင် ကန်အတွင်း သစ်ပင်များ ရှင်းလင်းမှုမှ ဖြစ်ပေါ်လာသော သစ်တောပြုန်းတီးမှုကြောင့် ကာဗွန်ဒိုင်အောက်ဆိုက် ခန့်မှန်း ၄၇၈,၀၀၀ တန်ခန့် ထုတ်လွှတ်နိုင်ပါသည်။ မြေအသုံးချ

အပြောင်းအလဲကြောင့် ဖန်လုံအိမ် ဓါတ်ငွေ့ ထုတ်လွှတ်မှု မြင့်မားသော်လည်း ရာသီဥတုပြောင်းလဲမှု အပေါ်တွင် သက်ရောက်မှု နည်းပါး ပါသည်။

အလယ်ရဲရွာစီမံကိန်းသည် ပြန်လည်ဖြည့်တင်းမြဲ စွမ်းအင်ကို နည်းပညာဖြင့် ထုတ်ယူပံ့ပိုးပေးမည့် အစီအစဉ်ဖြစ်၍ ဖန်လုံအိမ်ဓါတ်ငွေ့ထုတ်လွှတ်မှုကို ပမာဏ နည်းပါးရန် လျော့ချထားနိုင်ပါသည်။

၆.၁.၇ ဖုန်နှင့် အသံထုတ်လွှတ်မှု

တည်ဆောက်ရေးကာလတွင် လေထုညစ်ညမ်းမှု၊ ဖုန်များပါဝင်မှုသည် တည်ဆောက်ရေး ယန္တရားများ ဖောက်ခွဲမှုများ၊ ကျောက်တူးဖော်ခြင်းများ၊ မြေတူးခြင်း၊ မြေလုပ်ငန်းများလုပ်ကိုင်ခြင်း၊ ဘိလပ်မြေ ရောခြင်း၊ လမ်းဖောက်လုပ်ခြင်းအပြင် ကားများအသွားအလာများကြောင့် ထွက်ပေါ်လာမည် ဖြစ်ပါသည်။ ၎င်းအပြင် ထွက်ပေါ်မှုသည် ယန္တရားများ၊ ကားများနှင့် ဒီဇယ်အင်ဂျင်များမှ အခြားဓါတ်ငွေ့များ (NO_2 and SO_2) လည်း ထွက်ပေါ်လာနိုင်ပါသည်။

၆.၂ ဇီဝပတ်ဝန်းကျင်

၆.၂.၁ မြေပေါ်ပင်များ ရှင်းလင်းခြင်း

ရေလှောင်တမံတည်ဆောက်ခြင်းကြောင့် အင်းတိုင်းသစ်တောများ၊ ဘယ်ဘက်ခြမ်းရှိ ထူထပ်သစ်တောများ အပါအဝင် ဇီဝအရင်းအမြစ်ဆုံးရှုံးမှုများ၊ ရေမြုပ်ခြင်းများ ဖြစ်ပေါ်မည်ဖြစ်ပါ၍၊ သစ်တော ၈၁၆ ဟက်တာ ခန့်ဆုံးရှုံး မည်ဖြစ်ပါသည်။ ထို့အပြင် နမ်းကမ်ချောင်းမှ ရာသီအလိုက်ဖြစ်ပေါ်နေသော ရေမှုန်ရေမွှားနယ်မြေ ရေမြုပ် ဆုံးရှုံးမည်ဖြစ်ပါသည်။

အပင်မျိုးစိတ်အများစုသည် အင်တိုင်း သစ်တောအမျိုးအစား များဖြစ်ပြီး၊ နယ်မြေအတော်များများတွင် ပျံ့နှံ့ပေါက်ရောက်နိုင်၍ မျိုးတုံးပျောက်ကွယ်မည့် မျိုးစိတ်စာရင်းတွင် ပါဝင်သော်လည်း အဓိက ကာကွယ်တားဆီးရေးအဖြစ် စဉ်းစားရန် မလိုအပ်သေးပါ။

၆.၂.၂ ကုန်းမြေနေသတ္တဝါတို့၏ နေထိုင်ရာနေရာများကို အနှောင့်အယှက်ပေးခြင်း

တည်ဆောက်ခြင်းအတွက် ရှင်းလင်းခြင်းခံရသော တိုက်ရိုက်သက်ရောက် နေရာသည် ကုန်းနေသတ္တဝါတို့အတွက် အမှန်တကယ် ဆုံးရှုံးသောနေရာဖြစ်ပါသည်။ အလုပ်သမား များနှင့်ပေါင်း ပြီး ဒေသခံများသည် တရားမဝင်သစ်ခုတ်ခြင်းများလည်း ဖြစ်ပေါ်လာနိုင်ပါသည်။ ထိုနေရာတွင် ထိန်းသိမ်းစောင့်ရှောက်ရန် အရေးတကြီးလိုသော မျိုးစိတ်များမတွေ့ရှိရပါ။

တည်ဆောက်ရေးကာလတွင် အလုပ်သမားများ၊ မိသားစုဝင်များကြောင့် အထူးသဖြင့် ချေများ၊ တောကြက်များအား တရားမဝင်အမဲလိုက်ခြင်းများ ဖြစ်ပေါ်နိုင်ပါသည်။ အန္တရာယ်ဖြစ်စေသောပစ္စည်းများကြောင့် အထူးသဖြင့် ဆောက်လုပ်ရေးနယ်မြေများတွင် စွန့်ပစ်မှုများကြောင့် ထိခိုက်နိုင်ပါသည်။

မြစ်ရိုးတစ်လျှောက်ရှိအင်းဆက်များ၊ လိပ်များအတွက် အရေးကြီးသော သဲသောင်ခုံများသည် ရာသီအလိုက် ရေလွှမ်းမိုးမှုများ ရှိလာနိုင်ပါသည်။ နမ့်ကန်ချောင်းရှိ ရေမှုန်ရေမွှားဇုန်သည် အစိတ်အပိုင်း

အားဖြင့် နစ်မြုပ်မည်ဖြစ်ပါသည်။ သို့ရာတွင် ထိုနေရာတွင် သီးသန့်ပေါက်သောအပင်မျိုးစိတ်များ မရှိပါ။ ရေမမြုပ်သော အထက်ပိုင်းနေရာများတွင် တူညီသော ရေမှုန်ရေမွှားဇုန်များရှိလာနိုင်ပါသည်။

၆.၂.၃ ရေဂေဟစနစ်

ရေလှောင်တမံတည်ဆောက်ခြင်း၊ ရေလှောင်ကန် ပြည့်ခြင်းများကြောင့် မြစ်ကမ်းဘေး သစ်တောနေရာများပျောက်ဆုံးသွားပြီး၊ ကြီးမားသောရေကန်သဘာဝ ဖြစ်ပေါ်လာမည်ဖြစ်ပါသည်။ အချို့မျိုးစိတ်များသည် စီးဆင်းရေတွင် ရှင်သန်နိုင်ကြသော်လည်း ၎င်းတို့အလေ့အကျင့် နေရာများ ပျောက်ဆုံးသွားမည်ဖြစ်ပါသည်။ အကန့်အသတ်သာရှိသော ချောင်းလက်တက် နေရာများတွင် မြစ်ကမ်း ဘေး သစ်တောများ အကွက်လိုက် ကျန်ရှိမည်ဖြစ်ပါသည်။

ယာယီရေထိန်းဆည် တည်ဆောက်ရာတွင်၊ ထိုလုပ်ငန်းများကြောင့် မြစ်ညှာသို့ သွားရောက်ကြမည့် ငါးများ၏လမ်းကြောင်းကို အနှောင့်အယှက် ဖြစ်စေပါသည်။ မြစ်ညှာမြစ်ခြေမှ မည်သည့်ငါးမျိုးမဆို အတားအဆီးဖြစ်မည်ဖြစ်ပါသည်။ သို့ရာတွင် အောက်ဖက်ရှိ ရဲရွာနှင့် အထက်ရဲရွာတည်ဆောက်မှုကြောင့် ငါးလမ်းကြောင်းများ အလိုအလျောက် တာဆီးခြင်းခံရပြီးဖြစ်ပါသည်။ အလယ်ရဲရွာတည်ဆောက်ခြင်းအတွက် အထူးအထွေထပ်မံ ထိခိုက်နိုင်ဖွယ်မရှိပါ။ သို့ပါ၍ မြစ်ညှာသို့သွားရန် ရေကာတာတွင် ငါးလမ်းကြောင်းထည့်သွင်း တည်ဆောက်ရန် စဉ်းစားဖို့မလိုအပ်တော့ပါ။

လုပ်ငန်းအကောင်အထည်ဖော်သူသည် လိုအပ်သော ကျောက်တုံးပမာဏကို ရေလွှတ်ပေါက် ၁ ကီလိုမီတာ အဝေးတွင် ချထားပြီး မြန်မာအစိုးရ၏ လိုအပ်ချက်အရ ဖြစ်၍ လွတ်လပ်စွာစီးဆင်းခြင်းကို အလယ်ရဲရွာနှင့် အောက်ရဲရွာအကြားတွင် ဖန်တီးထားခြင်း ဖြစ်ပါသည်။ အခြားကျန်ရှိသော ဂေဟစနစ်နှင့်ဆိုင်သောအချက်များကို ဆိုးကျိုး မဖြစ်ပေါ်နိုင်ရန် သေချာစဉ်းစားဆောင်ရွက်သွားမည် ဖြစ်ပါသည်။

မြစ်တွင်နေထိုင်သော မျိုးစိတ်များသည် ရေလှောင်ကန်အတွင်း နေထိုင်နိုင်ရန် အထူးပင် ကြိုးစားအားထုတ်ရပေမည်။ အဘယ်ကြောင့်ဆိုသော် မြစ်အသွင်မှကန်အသွင် ပြောင်းလဲဖြစ်ပေါ်လာမည့်ရေလှောင်ကန်သဘာဝကြောင့် ဖြစ်ပါသည်။ အပင်မွှားလေးများ၊ အကောင်မွှားလေးများ ထူးကဲစွာပေါက်ပွားများပြားလာမည်ဖြစ်၍ ထိုအရာများကိုစားသော မျိုးစိတ်များအတွက် များပြားသော အထောက်အပံ့များရရှိစေမည်ဖြစ်ပါသည်။ ငါးအမျိုးမျိုးသည်လည်း မျိုးစိတ်ဖွဲ့စည်းပုံများ ပြောင်းလဲဖြစ်ပေါ်လာပြီး ကန်နှင့်တူသော ရေနေသဘာဝ ဖြစ်ပေါ်လာမည်ဖြစ်ပါသည်။

စီမံကိန်းသည် ရရှိမည့် ရေအားကို အပြည့်အဝ အသုံးပြုလည်ပတ် မည့်ပုံရသော်လည်း၊ ထုတ်လုပ်မှု ကွပ်ကဲထိန်းချုပ်ရေး အဖွဲ့သည် နောက်ပိုင်းမှ မည်သို့ထုတ်လုပ်မည်ကို အသေးစိတ်စဉ်းစားမည်ဖြစ်ပါသည်။ အဓိကနေ့စဉ်ရေစီးဆင်းမှု ခြားနားချက်ကို ရေလွှတ်ပေါက်မှ အောက်ရဲရွာအကြား တစ်နစ်အတွက် တိုင်းတာသွားမည်ဖြစ်ပါသည်။ စီးဆင်းမှုနှင့် မြစ်ရေအတက်အကျသည် သိသာထင်ရှားသော ဆိုးကျိုးများကို ရေနေသတ္တဝါတို့အပေါ် အချိန်တိုအတွင်း ဖြစ်စေနိုင်ပါသည်။ မြစ်ကြမ်းပြင်ကို လုံးဝခြောက်သွေ့သွားခြင်း မဖြစ်ပေါ်စေဘဲ၊ အနည်းဆုံးရေစီးဆင်းမှုကို အဆက်မပြတ်ဖြစ်ပေါ်စေခြင်းသည် ပတ်ဝန်းကျင်သဘာဝကို ထိန်းသိမ်းပေးရာရောက်ပါသည်။ (ဥပမာ။ ငါးများရှင်သန်နိုင်မှု ခက်ခဲအောင် ဖန်တီးခြင်းများ ကင်းဝေးစေရန်နှင့် လူများမြစ်ကမ်းအနီးသို့ အနီးကပ်လာရောက်မှု ကိုကင်းဝေးစေရန်အတွက်)

၆.၃ လူတို့၏ပတ်ဝန်းကျင်

၆.၃.၁ စီမံကိန်းနေရာ၏ စီးပွားရေးအခြေအနေ

အလယ်ရဲရွာ ရေအားလျှပ်စစ်စီမံကိန်းသည် ဒေသခံလူများအတွက် အလုပ်အကိုင်ရရှိရေးကို တိုက်ရိုက် သော်လည်းကောင်း၊ သွယ်ဝိုက်၍သော်လည်းကောင်း ဖန်တီးပေးနိုင်မည် ဖြစ်ပါသည်။ တည်ဆောက်ရေးကာလသည့် ဒေသခံများအတွက် ကောင်းမွန်သော အကျိုးသက်ရောက်မှုများကိုသာ ပေးမည် ဖြစ်ပါ သည်။

၆.၃.၂ နေရာရွှေ့ပြောင်းခြင်းနှင့် ပြန်လည်နေရာချထားခြင်း

လက်ရှိအနေအထားသည် စီမံကိန်းအစီအစဉ်ရေးဆွဲခြင်းနှင့် အကျယ်အဝန်းနှင့် နေရာများ အတိအကျ ဆုံးဖြတ်မှု မပြုရသေးပါ။ လမ်းအမှတ် (၄၁) သည် နောင်ချိုမှ တောင်ရှည်ရွာ၊ တောင်ရှည်ရွာလမ်းဆုံမှ ရေတွင်းကြီးသည် စီမံကိန်းအဓိကလမ်းကြောင်း ဖြစ်မည် ဖြစ်ပါသည်။ ထိုလမ်းကြောင်းသည် ရွာအများအပြားကို ဖြတ်သန်းသွားပြီး၊ လမ်းကျယ်ဘောင် ချဲ့မည်ဖြစ်၍ ရုပ်ပိုင်းဆိုင်ရာအနေဖြင့် စီးပွားရေးအသုံးချမြေ နှင့် အိမ်နေရာများအချို့ ရွှေ့ပြောင်း ပေးရမည်ဖြစ်ပါသည်။

ရေလှောင်ကန်ဧရိယာကို စဉ်းစားရာတွင် အလွန်နက်သော ချောက်ကမ်းပါးများဖြစ်၍ အခြေချ နေထိုင်သော နေရာများ မရှိပါ။ သို့သော် ယာယီငါးဖမ်းတဲများ၊ တရားမဝင်သစ်ခုတ်တဲ များသာရှိပါသည်။

၆.၃.၃ လူဦးရေအဆမတန်တိုးပွားခြင်း

အဓိက ဆောက်လုပ်ရေး အချိန်ကာလအတွင်း ယာယီလူဦးရေတိုးပွားမှု အလျင်အမြန် ဖြစ်ပေါ် လာမည် ဖြစ်ပါသည်။ လူဦးရေအဆမတန်တိုးပွားမှုသည် ယာယီဖြစ်သော်လည်း ဒေသခံအဆောက်အဦး မလုံလောက်မှု၊ အထောက်အပံ့၊ အသုံးအဆောင်များ၊ လူအဖွဲ့အစည်း ကျန်းမာရေးအခြေအနေနှင့် သန့်ရှင်း မှုများကို ထိခိုက်မည် ဖြစ်ပါသည်။ ဒေသခံပံ့ပိုးမှုများသည် ဒေသခံပြည်သူများ အပေါ် လျော့ကျသွား သလို ပြောင်းရွှေ့လာ သူများ အတွက်လည်း မလုံမလောက် ဖြစ်မည်ဖြစ်ပါသည်။

၆.၃.၄ လူမှုအသိုင်းအဝိုင်းလုံခြုံမှု

လုပ်ငန်းခွင် အန္တရာယ်ကင်းရှင်းရေး အစီအမံများကို အလယ်ရဲရွာ စီမံကိန်းတွင် ထည့်သွင်း စဉ်းစားရမည် ဖြစ်ပါသည်။ လမ်းပန်းဆက်သွယ်ရေး မတော်တဆဖြစ်ပွားမှုများ၊ အညစ်အကြေး ထိန်းသိမ်းမှုများကို စီမံရပါမည်။ အသွားအလာ များပြားလာသည်နှင့်အမျှ မတော်တဆမှုများလည်း များပြားလာမည် ဖြစ်ပါ သည်။ ကြီးမားပြင်းထန်သော မတော်တဆမှုများလည်း အဓိကလမ်းမကြီးများတွင် ဖြစ်ပေါ်နိုင်ပါသည်။

အကယ်၍ အန္တရာယ် ဖြစ်စေနိုင်သော စွန့်ပစ်ပစ္စည်းများ၊ အသုံးပြုပစ္စည်းများနှင့် အသုံးပြုပစ္စည်းများ သယ်ဆောင်ရာတွင် လုံခြုံရေး အစီအမံများ အထူးလိုအပ်ပါသည်။ ထိုပစ္စည်းများသည် ရေထု၊ လေထုနှင့်မြေထုပေါ်တွင် ပြင်းထန်သော ပျက်စီးညစ်ညမ်းခြင်းများ ဖြစ်ပေါ်နိုင်ပါ သည်။

၆.၃.၅ သစ်တောသယံဇာတ အသုံးပြုခြင်း

တည်ဆောက်ရေးကာလ အဆောင်များ ဆောက်လုပ်ခြင်း၊ လမ်းများဖောက်လုပ်ခြင်းသည် ရှည်လျားမတ်စောက်သော ကမ်းပါးယံမှ ရေကာတာနေရာအထိ ဖောက်လုပ်မည်ဖြစ်၍ သစ်တောများ ပျက်စီးဆုံးရှုံးမည် ဖြစ်ပါသည်။ နီးစပ်ရာ ကျေးရွာများမှ အသုံးပြုသော ထိခိုက်မှုနှင့် ကွာခြားပါသည်။ ရွာသားများသည် သစ်ခုတ်ခြင်း၊ အမဲလိုက်ခြင်းများကို သွားလာရန် အလွန်ခက်ခဲသော နေရာများတွင် လုပ်ဆောင်ခြင်းမရှိပါ။

ငါးဖမ်းခြင်းကြောင့်ရရှိသော ဝင်ငွေသည် ၁ ရာခိုင်နှုန်း ထက်နည်းသော စုစုပေါင်းဝင်ငွေ ပမာဏ သာ ရရှိသည်ဟု လူမှုဘဝလေ့လာရေးရလဒ်၌ ဖော်ပြထားပါသည်။ သို့ရာတွင်ဆည်ကြီးတည်ဆောက် ပြီးပါက ရေတွင်းကြီးကဲ့သို့သော နီးစပ်ရာရွာများသည် ငါးဖမ်းခြင်းလုပ်ငန်းကိုတွင်တွင် ကျယ်ကျယ်လုပ်ကိုင် နိုင်ပြီး၊ အစာအာဟာရအထောက်အပံ့များပို၍ ရရှိလာနိုင်သည့် အခွင့်အရေးများ ရှိပါသည်။

၆.၃.၅ ထိခိုက်မှုအကျဉ်းချုပ်

အောက်ပါဇယားသည် ထိခိုက်မှုများ လျော့နည်းပပျောက်အောင် လျှော့ချနိုင်သည် နှင့် မလျှော့ချ နိုင်သည့် အကြောင်းကို အကဲဖြတ်ထားသော ဇယားဖြစ်ပါသည်။

အကြောင်းအရာ	တန်ဖိုး/ထိခိုက်လွယ်သည့် အခြေအနေ	သက်ရောက် သည့် ပမာဏ	သက်ရောက်မှု	
			လျှော့ချခြင်း မပါဝင်ပါ။	လျှော့ချခြင်း ပါဝင်သည်။
တည်ဆောက်ရေးကာလ				
သဘာဝပတ်ဝန်းကျင်				
မြေမျက်နှာသွင်ပြင်နှင့်ရှုခင်း	**အသင့်အတင့်**	**နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)**	**-/- -**	**-**
မြေကြီးနှင့်မြေဆီလွှာ	**မသက်ဆိုင်ပါ**	**အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)**	**- -**	**-**
ရာသီဥတု	**များ**	**နည်း (ဆိုးကျိုးဘက်သို့)**	**-**	**0 /-**
လေအရည်အသွေး	**များ**	**နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)**		**-**
ဆူညံမှုနှင့်တုန်ခါမှု	**များ**	**နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)**	**-/- -**	**-**
ရေဂုဏ်သတ္တိနှင့်ရေစီးကြောင်း	**မသက်ဆိုင်ပါ**	**နည်း (ဆိုးကျိုးဘက်သို့)**	**-/- -**	**-**
အနည်စီးကြောင်း	**များ**	**နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)**	**-/- -**	**-**
ရေအရည်အသွေး	**အသင့်အတင့်များ**	**နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက် သို့)**	**-/- -**	**-**

အကြောင်းအရာ	တန်ဖိုး/ထိခိုက်လွယ်သည့် အခြေအနေ	သက်ရောက် သည့် ပမာဏ	သက်ရောက်မှု	
			လျှော့ချခြင်း မပါဝင်ပါ။	လျှော့ချခြင်း ပါဝင်သည်။
ဇီဝပတ်ဝန်းကျင်				
ကာကွယ်နေရာများ	နည်း	မသိသာပါ	0	0
အပင်ပေါက်ရောက်မှု	အသင့်အတင့်	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-	0/-
မြေပြင်ပေါက်ပင်များ	အသင့်အတင့်	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	-
ရေပိုင်းဆိုင်ရာဂေဟာဗေဒဝန်ဆောင်မှုများ	အသင့်အတင့်	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	-
လူမှုပတ်ဝန်းကျင်				
စီမံကိန်းဒေသစီးပွားရေး	များ	နည်း-အသင့်အတင့် (ကောင်းကျိုး)	++	++/+++
ရွှေ့ပြောင်းရေးနှင့်ပြန်လည်နေရာချထားရေး	များ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-/- -	0
စီးပွားရေးရွှေပြောင်းခြင်းနှင့်လူမှုနေထိုင်ပုံစံဆုံးရှုံးမှု	များ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-/- -	0
လူဦးရေတိုးပွားခြင်းနှင့် အချိုးအစားပြောင်းလဲမှုများ	များ	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	-
လူ့အဖွဲ့အစည်း လုံခြုံမှု	များ	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	-
သစ်တောအရင်းအမြစ်များအသုံးပြုမှု	များ	မသိသာပါ - နည်း (ဆိုးကျိုးဘက်သို့)	-	- /0
မြစ်အရင်းအမြစ်များအသုံးပြုမှု	များ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- /- -	-
ရှေးဟောင်းနေရာများနှင့်ယဥ်ကျေးမှုနှင့်သက်ဆိုင်သောနေရာများ	များ	မသိသာပါ	0	0
လုပ်ငန်းလည်ပတ်သည့်ကာလ				
သဘာဝပတ်ဝန်းကျင်				
မြေမျက်နှာသွင်ပြင်နှင့်ရှုခင်း	အသင့်အတင့်	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်)	- -	-
မြေကြီးနှင့်မြေဆီလွှာ	မသက်ဆိုင်ပါ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်)	- -	-
ရာသီဥတု	များ	နည်း-အသင့်အတင့် (ကောင်းကျိုး)	+	++
လေအရည်အသွေး	များ	မသိသာပါ	0	0
ဆူညံမှုနှင့်တုန်ခါမှု	များ	မသိသာပါ	0	0

အကြောင်းအရာ	တန်ဖိုး/ထိခိုက်လွယ်သည့်အခြေအနေ	သက်ရောက် သည့်ပမာဏ	သက်ရောက်မှု	
			လျော့ချခြင်း မပါဝင်ပါ။	လျော့ချခြင်း ပါဝင်သည်။
ရေဂုဏ်သတ္တိနှင့်ရေစီးကြောင်း	မသက်ဆိုင်ပါ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- /- -	- /- -
အနည်စီးကြောင်း	များ	နည်း-အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	-	0 /-
ရေအရည်အသွေး	အသင့်အတင့် - များ	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	- /- -
ဇီဝပတ်ဝန်းကျင်				
ကာကွယ်နေရာများ*	နည်း	မသိသာပါ (သို့) နည်း (ဆိုးကျိုးဘက်သို့)	0 (သို့) -	0 (သို့) -
အပင်ပေါက်ရောက်မှု	အသင့်အတင့်	နည်း (ဆိုးကျိုးဘက်သို့)	-	0 / -
မြေပြင်ပေါက်ပင်များ	အသင့်အတင့်	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	- -/ -
ရေပိုင်းဆိုင်ရာ ဂေဟဗေဒ ဝန်ဆောင်မှုများ	အသင့်အတင့်	အသင့်အတင့် (ဆိုးကျိုးဘက်သို့)	- -	- - / -
လူသားပတ်ဝန်းကျင်				
စီမံကိန်းဒေသစီးပွားရေး	များ	နည်း-အသင့်အတင့် (ကောင်းကျိုး)	+	++
ရွှေ့ပြောင်းရေး နှင့် ပြန်လည်နေရာချထားရေး	များ	မသိသာပါ	0	0
စီးပွားရေး ရွှေ့ပြောင်းခြင်း နှင့် လူမှုနေထိုင်မှုပုံစံ ဆုံးရှုံးမှု	များ	မသိသာပါ	0	0
လူဦးရေ တိုးပွားခြင်း နှင့် အချိုးအစား ပြောင်းလဲမှုများ	များ	နည်း (ဆိုးကျိုးဘက်)	-	-
လူမှု အဖွဲ့အစည်း လုံခြုံမှု	များ	မသိသာပါ	0	0
သစ်တောအရင်းအမြစ်များအသုံးပြုမှု	များ	နည်း (ဆိုးကျိုးဘက်)	0	+
မြစ်အရင်းအမြစ်များအသုံးပြုမှု	များ	အသင့်အတင့်-နည်း (ဆိုးကျိုးဘက်)	-	0
ရှေးဟောင်းနေရာများ၊ယဉ်ကျေးမှုနှင့် သက်ဆိုင်သောနေရာများ	များ	မသိသာပါ	0	0

* ဆန်းစစ်လေ့လာမှုသည် လက်ဝဲဖက်ကမ်းရှိ အချို့သော နေရာများ၏ သစ်တောထိန်းထိမ်းထားရှိ/မရှိ အခြေအနေပေါ်တွင်မူတည်နေပါသည်။

၇။ ပါဝင်ပတ်သက်သူများနှင့် ညှိနှိုင်းတိုင်ပင်မှု

၇.၁ ပထမအကြိမ် ညှိနှိုင်းတိုင်ပင်ခြင်း

၂၀၁၅ ခုနှစ် ဖေဖော်ဝါရီ နှင့် မတ်လတွင် မြစ်ညာဘက်ခြမ်းကျေးရွာ ၆ ရွာနှင့် တွေ့ဆုံဆွေးနွေးခဲ့ပါသည်။ ယေဘုယျအားဖြင့် ဆန့်ကျင်ကန့်ကွက်ခဲ့သူ မရှိဘဲ ရေအားလျှပ်စစ်လုပ်ငန်းကို သဘောကျနှစ်သက်ကြပါသည်။ လျှပ်စစ်လိုအပ်မှု၊ ရေရရှိမှု၊ လမ်းပန်းဆက်သွယ်ရေး ကောင်းမွန်မှုနှင့် အလုပ်အကိုင်အခွင့်အလမ်း များကို တောင်းဆိုခဲ့ကြပါသည်။

ရေလွှမ်းမိုးမှုနှင့်ပတ်သက်၍ ကျေးရွာများမှ စိုက်ပျိုးမြေများသည် ရေလှောင်တမံ တည်ဆောက်ခြင်းကြောင့် လုံးဝဆုံးရှုံးမှုမရှိပါ။ အချို့သော မြေယာအချို့သာ လမ်းဖောက်လုပ်ခြင်းကြောင့် ဆုံးရှုံးနိုင်ပါသည်။ ရေလှောင်တမံ အနီးဝန်းကျင်နှင့် ရေတွင်းကြီးရွာအနီးတဝိုက် တွင် စခန်းများ ဆောက်လုပ်ခြင်းကြောင့်မြေများ ဆုံးရှုံးရနိုင်သည်။

၇.၂ ဒုတိယအကြိမ်ညှိနှိုင်းတိုင်ပင်ခြင်း

၂၀၁၆ ခုနှစ် မေလတွင် ဆည်အနီးပတ်ဝန်းကျင် ရွာသားများကို ဖိတ်ခေါ်၍ အစည်းအဝေးများပြုလုပ်ခဲ့ပါသည်။ ပါဝင်တက်ရောက်လာသူများက လုပ်ငန်းများအကြောင်း ကြိုတင်အသိပေး၍ ကျေးဇူးတင်ကြောင်း ပြောကြားမှုကို ကြားသိခဲ့ရပါသည်။ ရွာသားများက လျှပ်စစ်မီးရရှိမှုကို စိတ်ဝင်စားကြောင်း ထပ်တလဲလဲပြောဆိုပြီး အခြားအကျိုးရလဒ်များ မည်မျှရရှိနိုင်မည်ကို မေးမြန်းခဲ့ပါသည်။ အချို့ရွာများမှ မြစ်ငယ်မြစ်ကူးတံတားနှစ်မြုပ်နိုင်မှု ရှိ/မရှိ မေးမြန်းခဲ့ပါသည်။ ထိုညှိနှိုင်းဆွေးနွေးမှုမှ ရွာသားများကို လေ့လာရေးလုပ်ဆောင်မှုများနှင့် ၎င်းတို့နစ်နာချက်များကို တင်ပြနိုင်ရန် အသိပေးခဲ့ပါသည်။

၈။ ပတ်ဝန်းကျင်နှင့်လူမှုရေးစီမံခန့်ခွဲမှု အစီအစဉ်

၈.၁ အသင်းအဖွဲ့ နှင့် အလုပ်သမားများဖွဲ့စည်းပုံ

လုပ်ငန်းအကောင်အထည်ဖော်သည့်အဖွဲ့သည် ပတ်ဝန်းကျင်နှင့် လူမှုရေးဆိုင်ရာအဖွဲ့အစည်းတစ်ခုဖွဲ့စည်း မည်ဖြစ်ပါသည်။ ပြည်တွင်းမှ မန်နေဂျာတစ်ဦးကဦးဆောင်၍ ထိုသူက စီမံကိန်းမန်နေဂျာကို တိုက်ရိုက်တင် ပြမည်ဖြစ်ပါသည်။ ထိုအဖွဲ့တွင် သီးခြားအဖွဲ့ ၅ ဖွဲ့ထားရှိပြီး သက်ဆိုင်ရာတာဝန်အလိုက် စောင့်ကြည့်လေ့လာပြီး ပတ်ဝန်းကျင်နှင့် လူမှုရေး စီမံခန့်ခွဲမှု အစီအစဉ်သို့ ရှင်းလင်းတင်ပြမည် ဖြစ်ပါသည်။ အဖွဲ့တစ်ခုချင်း စီတွင် အဖွဲ့ခေါင်းဆောင်တစ်ဦးစီရှိမည်ဖြစ်ပြီး အဖွဲ့ဝင်ကျွမ်းကျင်သူ ၃ဦး မှ ၄ဦးပါဝင်မည်ဖြစ်ပါသည်။ ပတ်ဝန်းကျင်နှင့် လူမှုရေးဆိုင်ရာအဖွဲ့အစည်းတွင် ပါဝင်မည့်အဖွဲ့ခွဲများမှာ- (၁) လျော်ကြေးပေးခြင်းနှင့်နစ်နာချက်များအဖွဲ့၊ (၂) လူမှုရေးအစီအမံနှင့်ညှိနှိုင်းရေးအဖွဲ့၊ (၃) ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးအဖွဲ့၊ (၄) အစုအဖွဲ့ပိုင်သစ်တောအဖွဲ့၊ (၅) အခြေခံအဆောက်အဦများ ထောက်ပံ့ရေးအဖွဲ့တို့ ဖြစ်ပါသည်။

၈.၂ ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုအစီအစဉ်

ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုအစီအစဉ်တွင် ဆင့်ပွါးအစီအစဉ်များ နှင့် စီမံချက်များပါဝင်ပါသည်။ ၎င်းတို့မှာ

- **ပတ်ဝန်းကျင်ဆိုင်ရာစီမံခန့်ခွဲမှုနှင့်ကြီးကြပ်မည့်အစီအစဉ်ကိုတည်ဆောက်ခြင်း**
  ကန်ထရိုက်တာသည် တင်ဒါစာရွက်စာတမ်းများတွင်ရေးသားဖော်ပြထားသော အန္တရာယ်ရှိ စွန့်ပစ်ပစ္စည်းများ၊ အန္တရာယ်မရှိစွန့်ပစ်ပစ္စည်းများ၊ လေထုညစ်ညမ်းမှုကို ထိန်းသိမ်းခြင်း၊ မြေတိုက်စားမှုကို ထိန်းသိမ်းခြင်း၊ အရေးပေါ် ကိစ္စများ၊ ကျန်းမာရေး၊ လုံခြုံရေးများနှင့်သက်ဆိုင်သော အကြောင်းအရာများကို စီမံကိန်းနေရာနှင့် သင့်လျော် သော တိကျသည့်အစီအစဉ်များအတိုင်းသော်လည်းကောင်း၊ တင်ဒါတွင် ဖော်ပြရေးသား ညွှန်ကြားထားချက်များအတိုင်း လိုက်နာအကောင်အထည်ဖော်လုပ်ဆောင်ရပါမည်။
- **ရေအရည်အသွေးကိုကြီးကြပ်မည့်အစီအစဉ်**
  အလယ်ရဲရွာစီမံကိန်းကြောင့် ပြောင်းလဲသွားသောရေအရည်အသွေးကို မှတ်တမ်းကောက်ယူရန် ရေအရည်အသွေးကို ကြီးကြပ်မည့်အစီအစဉ်ကို လက်တွေ့လုပ်ဆောင်ရပါမည်။ ထိုအစီအစဉ်မှ ထွက်လာသည့်ရလဒ်များကို နှစ်လတစ်ကြိမ် အစီရင်ခံစာများ ပြုစုထားရှိပြီး သက်ဆိုင်သော ဌာနဆိုင်ရာ အဖွဲ့အစည်းအသီးသီးနှင့် ပူးပေါင်းဆောင်ရွက်သွားရပါမည်။
- **ရေပိုင်းဆိုင်ရာဂေဟဗေဒစနစ်နှင့်ငါးလုပ်ငန်းများကိုစီမံခန့်ခွဲမည့်အစီအစဉ်**
  ရေပိုင်းဆိုင်ရာဂေဟစနစ်များနှင့် ငါးလုပ်ငန်းများကို စီမံခန့်ခွဲမည့်အစီအစဉ်သည် စစ်တမ်းများ ကောက်ယူပြီးပါက သင့်လျော်သောအစီအမံများကိုဆုံးဖြတ်ပြီး လုပ်ဆောင်ရပါမည်။ တည်ဆောက်ရေးလုပ်ငန်းလုပ်ဆောင်နေစဉ် နှင့် အထူးသဖြင့် လုပ်ငန်းလုပ်ကိုင်နေစဉ်များအတွင်း မျိုးတုံးလုနီးပါးမျိုးစိတ်များကို မထိခိုက်စေရန်၊ ငါးလုပ်ငန်းများလုပ်ကိုင်ရာတွင် အန္တရာယ်ရှိသော ငါးဖမ်းနည်းများကို မကျင့်သုံးမိစေရန် (ဥပမာ အဆိပ်၊ ဒိုင်းနမိုက်များ အသုံးပြုခြင်း)နှင့် တာရှည်ခံသော ငါးဖမ်း လုပ်ငန်း ကျင့်ထုံးများကိုသာ ကျင့်သုံးနိုင်စေရန် ဒေသခံပြည်သူများ၏ ခံစားချက်များကို တာဝန်ခံကာ လုပ်ဆောင်ရပါမည်။
- **ရေလှောင်ကန်များရှင်းလင်းခြင်းနှင့် ပြန်လည်ဖြည့်မည့်အစီအစဉ်**
  ရေလှောင်ကန်များရှင်းလင်းခြင်း နှင့် ပြန်လည်ဖြည့်မည့် အစီအစဉ်တွင်ပါဝင်သည်များမှာ (၁) ရေလှောင်ကန်ဧရိယာ သတ်မှတ်ခြင်း၊ (၂) ရောင်းတန်းဝင် သစ်များကို ယူဆောင်ခြင်း (ကန်ထရိုက်စနစ် (သို့မဟုတ်) ဌာနဆိုင်ရာအစီအစဉ်များဖြင့်) (၃) ရွေးချယ်ထားသော နေရာများကို ရှင်းလင်းခြင်းနှင့် မီးလောင်မှုများကို ထိန်းချုပ်ခြင်း (ကန်ထရိုက်တာမှ ဒေသခံများကို အခကြေးငွေပေး၍ ဆောင်ရွက်စေခြင်း) (၄) ပထမအဆင့် ရေလှောင်ကန် ရေစတင်သိုလှောင်ရာတွင် အနည်များကိုစုစည်းပြီး ဖယ်ရှားခြင်း။
- **ဇီဝမျိုးစုံမျိုးကွဲများနှင့်ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးအစီအစဉ်**
  ဇီဝမျိုးစုံမျိုးကွဲများနှင့် ပတ်ဝန်းကျင်ထိန်းသိမ်းရေး အစီအစဉ် တွင်ပါဝင်သည်များမှာ သစ်တောပိုင်းဆိုင်ရာ အာဏာပိုင်အဖွဲ့အစည်းများ၊ ဒေသတွင်းရှိ အာဏာပိုင်အဖွဲ့အစည်းများ၊ ဒေသခံ ကျေးရွာလူထု တို့နှင့် ညှိနှိုင်းတိုင်ပင် ဆွေးနွေး၍ မြစ်ကမ်းနှစ်ဖက်ပေါ်ရှိ ရေလှောင်ကန်

ဝန်းကျင်တွင် တစ်ခု(သို့) တစ်ခုထက်ပိုသော ကာကွယ်တောများကို ဖြစ်မြောက်အောင်ဆောင်ရွက်နိုင်မည့် အလားအလာများကို အစီအစဉ်ရေးဆွဲခြင်းများပါဝင်ပါသည်။ ဤအစီအစဉ်တွင် မျိုးတုံးလုနီးပါးဖြစ်နေသောမျိုးစိတ်များကို ထိန်းသိမ်းခြင်း လုပ်ငန်းများ၊ အထူးသဖြင့် စီမံကိန်းနေရာနှင့်တစိတ်တပိုင်း ထပ်တူကျနေသော မယ်ဟုန်-ဒုဌတီ အနီးတဝိုက်ဒေသ၏ ဇီဝမျိုးစုံမျိုးကွဲများထိန်းသိမ်းသည့် ပင်မဧရိယာတွင်တွေ့ရသည့် မျိုးတုန်းလုနီးပါးဖြစ်သည့် ဒေါင်းမျိုးစိတ်များကို ထိန်းသိမ်းခြင်းများ ပါဝင်ရပါမည်။

- **အစုအဖွဲ့ပိုင်သစ်တောအစီအစဉ်**
  အစုအဖွဲ့ပိုင်သစ်တောအစီအစဉ်တွင် သဘာဝအလျောက်ပေါက်သောအပင်များကို ထိန်းသိမ်းသည့် အစီအစဉ်နှင့် လူအကူအညီဖြင့် သစ်ပင်မျိုးစိတ်များ ပြန်လည်ပျိုးထောင်သည့်အစီအစဉ်များ၊ လက်ရှိ သစ်တောများကို ဆက်လက်ထိန်းသိမ်းခြင်းနှင့် သစ်တောရောစိုက်ပျိုးကျင့်သုံးမှုများကို ပြန်လည် မြှင့်တင်ခြင်းများ ပါဝင်ပါသည်။ ရည်ရွယ်ချက်များမှာ (၁) စီမံကိန်းနှင့် တိုက်ရိုက်သက်ရောက်နေသော နေရာ ပြင်ပရှိ ဦးစားပေး သစ်တောများကို ပြန်လည်ထိန်းသိမ်းခြင်းဖြင့် အလယ်ရဲရွာ ရေလှောင်ကန်အနီး ဆုံးရှုံးသွားသော သစ်တောများကို ပြန်လည်အစားထိုးခြင်း။ (၂) ရေမြေ ထိန်းသိမ်းခြင်းနှင့် ဇီဝမျိုးစုံမျိုးကွဲများကိုထိန်းသိမ်းခြင်းအပြင် ဒေသခံပြည်သူများ ဦးဆောင်သော တာရှည်ခံမည့် သစ်တောစီမံကိန်းများလုပ်ဆောင်ကာ ဒေသခံပြည်သူတို့၏ ဂေဟဗေဒစနစ် ဝန်ဆောင်မှုများကို အသုံးပြုနိုင်စွမ်းတိုးတက်စေခြင်း တို့ပါဝင်ရပါမည်။
- **စတင်လုပ်ဆောင်ကာလ - ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုနှင့်သက်ဆိုင်သော မူဘောင်**
  စတင်လုပ်ဆောင်ကာလ - ပတ်ဝန်းကျင်စီမံခန့်ခွဲမှုနှင့်သက်ဆိုင်သော မူဘောင်သည် လုပ်ဆောင်သည့်ကာလ မစတင်ခင်ကတည်းက ပြည့်စုံစွာတည်ဆောက်ပြီးဖြစ်ရပါမည်။ ဤမူဘောင်သည် ဆောက်လုပ်ရေးကာလတွင် စတင်သည့်လျှော့ချရေးအစီအစဉ်အမျိုးမျိုးပေါ်တွင် တည်ဆောက်ထားရပါမည်။ ထို့အပြင် အောက်ပါပတ်ဝန်းကျင်ဆိုင်ရာပြဿနာများ အကြမ်းဖျင်း ပါဝင်ရပါမည်။ (၁) စွန့်ပစ်ပစ္စည်းများကို စီမံခန့်ခွဲခြင်းနှင့်လေထုညစ်ညမ်းမှုကိုထိန်းသိမ်းခြင်း။ (၂) ရေအရည်အသွေးကို ကြီးကြပ်ခြင်း။ (၃) ငါးလုပ်ငန်းများကိုစီမံခန့်ခွဲခြင်းနှင့် ရေပိုင်းဆိုင်ရာ ဂေဟဗေဒစနစ်များ ကြီးကြပ်ခြင်း။ (၄) ပတ်ဝန်းကျင်ဆိုင်ရာ ထိန်းသိမ်းသည့်လုပ်ငန်းများ နှင့် (၅) သစ်တောစီမံခန့်ခွဲမှုများ။

၈.၃ လူမှုလုပ်ငန်းများစီမံခန့်ခွဲခြင်းအစီအစဉ်

လူမှုလုပ်ငန်းများစီမံခန့်ခွဲခြင်းအစီအစဉ်တွင်အောက်ပါအစီအစဉ်များနှင့်ပရိုဂရမ်များပါဝင်ပါသည်။

- **ပါဝင်သူများစေ့စပ်ညှိနိုင်းဆွေးနွေးခြင်းအစီအစဉ်**
  လုပ်ငန်းမစမီကာလနှင့် စပြီးကာလများတွင် ဆက်လက်လုပ်ဆောင်နေသည့် ပါဝင်သူများနှင့် တိုင်ပင် ဆွေးနွေးခြင်းများတွင် ဒေသခံပြည်သူများ၏တိုးတက်မှု အစီအစဉ်များကို ဦးစားပေး ဆွေးနွေးရပါမည်။ တိုးတက်မှုအစီအစဉ်ဆိုရာတွင် လမ်းပန်းဆက်သွယ်ရေး တိုးတက်အောင်

ပြုလုပ်ခြင်း၊ SN Power မှ ရန်ပုံငွေပေးသော လျှပ်စစ်မီးဆက်သွယ်မှုများ တိုးတက်အောင် ပြုလုပ်ခြင်းတို့ ပါဝင်ပါသည်။

- **ဆုံးရှုံးသွားသောမြေများ၊ လုပ်ငန်းများနှင့် ပုံသေပိုင်ဆိုင်မှုများအတွက် အလျော်ပေးခြင်းအစီအစဉ်**
  လမ်းဆက်သွယ်မှုများကို အသေးစိတ်ဆုံးဖြတ်ပြီးသည်နှင့် တစ်ပြိုင်နက် ဆုံးရှုံးမည့်မြေပမာဏနှင့် လမ်းပန်းဆက်သွယ်ရေးများ တည်ဆောက်ရာတွင်ကုန်ဆုံးမည့် ပမာဏများကိုစစ်တမ်းများ ကောက်ယူရပါမည်။ ပြောင်းလဲနေထိုင်ရသည့်အတွက် ကုန်ဆုံးမည့်ပမာဏများကို အပြည့်အဝ လျော်ကြေး ပေးဆောင်ရပါမည်။
- **ဆောက်လုပ်မည့်နေရာများတွင် ပြုလုပ်မည့်လူမှုလုပ်ငန်းများအစီအစဉ်**
  စီမံကိန်းကြောင့် ရွှေ့ပြောင်းလာမည့် လူပမာဏပေါ်မူတည်၍ လိုအပ်ပါက ရေပေးဝေခြင်းနှင့် သန့်ရှင်းရေး လုပ်ငန်းများကို စီမံကိန်းနှင့်သက်ဆိုင်သော ဝန်ထမ်းများ(သို့)လုပ်သားများ နေထိုင်မည့်ရွာများတွင် တိုးတက်စေရန်လုပ်ဆောင်ရပါမည်။ လုပ်ငန်းသုံး ယာဉ်၊ စက်ယန္တရား အသွားအလာများကြောင့် ဖြစ်ပေါ်လာမည့် မတော်တဆထိခိုက်မှုများ လျှော့ချရန် အရှိန်ထိန်းစနစ်များနှင့် ကျောင်းများတွင် ယာဉ်အန္တရာယ်ကင်းရှင်းရေး၊ ယာဉ်စည်းကမ်း၊ လမ်းစည်းကမ်းဆိုင်ရာဟောပြော ပို့ချပေးမည့် အစီအစဉ်များ လုပ်ဆောင်ပေးရပါမည်။

- **လူမှုအဖွဲ့အစည်း တိုးတက်စေမည့်အစီအစဉ်**
  လူမှုအဖွဲ့အစည်း တိုးတက်စေမည့်အစီအစဉ်တွင် လမ်းများအဆင့်မြှင့်ခြင်း၊ စီမံကိန်းနှင့်တိုက်ရိုက် မသက်ရောက်သော ရွာများတွင်လျှပ်စစ်မီးများ တပ်ဆင်ပေးခြင်းတို့ပါဝင်ရပါမည်။ လူမှုအဖွဲ့အစည်း တိုးတက် စေမည့်အစီအစဉ်ကို သက်ဆိုင်ရာ အစိုးရအဖွဲ့များနှင့် အတူတကွ ညှိနှိုင်းတိုင်ပင် လုပ်ဆောင်ပြီးမှ အသေးစိတ်အစီအစဉ်များ ရေးဆွဲနိုင်ပါမည်။
- **အလုပ်သမားများခေါ်ယူခြင်းနှင့်အလုပ်အကိုင်ပေးခြင်း**
  စီမံကိန်းသည် လုပ်ငန်းဆောင်ရွက်မည့် ကန်ထရိုက်တာများအား ဒေသခံ ပြည်သူများကို ဦးစားပေး၍ အလုပ်အကိုင်ပေးရန် စီစဉ်ညွှန်ကြားပေးရပါမည်။ အလုပ်အကိုင်ပေးရာတွင် စီမံကိန်းနေရာ အတွင်း နေထိုင်နေသောရွာများရှိ လုပ်ငန်းကျွမ်းကျင်သော ဒေသခံရွာသားများနှင့် အနည်းငယ်ကျွမ်းကျင်သော ရွာသားများကို စာရင်းကိုပြုစုကာ ကန်ထရိုက်တာများထံ ကြိုတင် ပေးပို့ထားရမည် ဖြစ်ပါသည်။

၈.၄ ပတ်ဝန်းကျင်နှင့် လူမှုလုပ်ငန်းများစီမံကိန်း (ESMP) အတွက် ဘတ်ဂျက်စာရင်း

အောက်ပါဇယားသည် ESMP အတွက်ခန့်မှန်းဘတ်ဂျက်စာရင်းဖြစ်ပါသည်။

အမှတ်စဉ်	အကြောင်း အရာ	တည်ဆောက်ရေးလုပ်ငန်း မစခင်ကာလ	တည်ဆောက်ရေးလုပ်ငန်း ဆောက်ရွက်စဉ်ကာလ						စုစုပေါင်း (USD)
		ပထမနှစ်	ပထမနှစ်	ဒုတိယနှစ်	တတိယနှစ်	စတုတ္ထနှစ်	ပဥ္စမနှစ်	ဆဌမနှစ်	
၁	စီမံကိန်းတိုက်ရိုက်ကျသင့်ငွေ (ESU)	၃၉၉,၆၀၀	၄၄၅,၂၀၀	၄၄၅,၂၀၀	၃၉၂,၄၀၀	၃၉၂,၄၀၀	၃၉၂,၄၀၀	၃၉၂,၄၀၀	၂,၈၅၉,၆၀၀
၂	ဌာနဆိုင်ရာကိစ္စရပ်များ အတွက်ကျသင့်ငွေ	၅၀,၃၀၀	၅၀,၃၀၀	၃၉,၅၀၀	၃၉,၅၀၀	၃၉,၅၀၀	၃၉,၅၀၀	၃၉,၅၀၀	၂၉၈,၁၀၀
၃	ပတ်ဝန်းကျင်ထိန်းသိမ်းရေး စီမံကိန်းအတွက် ကျသင့်ငွေ	၁၃၀,၀၀၀	၁၀၀,၀၀၀	၁၀၀,၀၀၀	၁၁၀,၀၀၀	၂၆၅,၀၀၀	၂၆၅,၀၀၀	၁၈၅,၀၀၀	၁,၁၅၅,၀၀၀
၄	လူမှုရေး လုပ်ငန်းများ နှင့် ဒေသဖွံ့ဖြိုးရေးလုပ်ငန်း အတွက်ကျသင့်ငွေ	၄၉၂,၀၀၀	၁,၈၅၃,၀၀၀	၂,၄၁၈,၇၅၀	၁,၉၈၇,၅၀၀	၁,၀၀၂,၅၀၀	၁,၀၀၂,၅၀၀	၁၈၂,၅၀၀	၈,၉၃၈,၇၅၀
	EMP/SMP စုစုပေါင်း ကျသင့်ငွေ (USD)	**၁,၀၇၁,၉၀၀**	**၂,၄၄၈,၅၀၀**	**၃,၀၀၃,၄၅၀**	**၂,၅၂၉,၄၀၀**	**၁,၆၉၉,၄၀၀**	**၁,၆၉၉,၄၀၀**	**၇၉၉,၄၀၀**	**၁၃,၂၅၁,၄၅၀**

လက်ရှိတွင် စီမံကိန်းတစ်ခုလုံးအတွက် အရေးပေါ်အစီအစဉ်များအတွက် အရန်ငွေကြေးသတ်မှတ်မှုများ မဆုံးဖြတ်ရသေးပါ။

EXECUTIVE SUMMARY

This Environmental Impact Assessment (EIA) for the Middle Yeywa Hydropower Project on the Myitnge (Nam Tu) River located in the Shan State, Myanmar was produced by a combined team of international and national experts on behalf of SN Power, based on field work carried out from 2015 to 2018.

The project is proposed in an area characterised by a plateau landscape with a deeply incised river valley. Most of the surrounding plateau consists of agricultural fields while some forest left on the upper slopes of the valley. The steeper slopes towards the lower part of the valley are forested. The construction of the Middle Yeywa Hydropower Project will create a 70 km long and narrow reservoir that will submerge the forest at the lower part of the valley.

There are a number of villages in the indirect impact zone of the project. These villages rely on agriculture as their main source of income with sugar cane and maize as the main cash crops. The villages on the right bank of the river have reasonably good road access while the tracks that connect to the villages located on the upper left bank are in a very poor state. None of the indirect impact zone villages have electricity grid connections. The income levels in the villages are considerably higher than the World Bank’s poverty line for Myanmar.

The main impacts on the natural environment during the construction phase are related to terrestrial fauna and aquatic ecosystems. Without mitigation measures, the impacts on these two environmental components have been assessed as medium negative.

For human environment, the impact on local area economy has been assessed as medium positive while impacts in terms of physical and economic displacement have been assessed as low to medium negative. Impacts during the construction phase on community safety as well as impacts caused by population influx have been assessed as medium negative. Finally, the impacts of the project on the local population’s use of forest and river resources have been assessed as low negative and low to medium negative.

The most important impacts during the operation phase are likely to be impacts on water quality, terrestrial fauna and aquatic ecosystems which, without mitigation measures, have been assessed as medium negative. For the human environment, operation phase impacts will be insignificant except for a low negative impact for use of river resources and a low positive impact for local economy.

Programmes and plans for mitigation of negative impacts and enhancement of positive impacts were identified. The main environmental mitigation interventions include a Community Forest Programme, an Aquatic Ecology and Fisheries Management Plan, a Biodiversity and Conservation Protection Plan and a Reservoir Clearance and Filling Plan.

In terms of social mitigation and benefit sharing, comprehensive Community Development Initiatives aiming to improve and upgrade access roads to a number of indirect impact zone villages, as well as connecting villages along the improved roads to the electricity grid, have been proposed.

Directly affected people who will have to relocate building infrastructure, or will be losing agricultural or commercial land, will receive full compensation based on market prices after implementation of an asset surveys and valuation process.

In an overall perspective, it may be concluded that the Middle Yeywa Hydropower Project has moderate environmental and social impacts which can be reduced, and with regard to social impacts, fully mitigated through timely implementation of the identified mitigation plans and programmes.

1. Introduction

1.1. Background

SN Power (SNP) signed on the 2nd of July 2014 with MoEP (Ministry of Electric Power of Myanmar) a Memorandum of Understanding (MoU) for the study and possible development of the Middle Yeywa Hydropower Project on the Myitnge (Nam Tu) River located in the Shan State, Myanmar.

The proposed project is located between the Lower Yeywa hydropower project in operation and the Upper Yeywa hydropower project currently under construction, forming a cascade. Among the seven considered alternatives the main project alternative involves a 160 m high arch dam that will create a reservoir of about 70 km length.

A Pre-Feasibility ESIA (Environmental and Social Impact Assessment) was finalised in August 2015, based on a preliminary engineering design (Pre-Feasibility Study by Pöyry). SN Power subsequently decided to proceed with a full engineering Feasibility Study and an Environmental Impact Assessment (EIA).

1.2. Project Developer

SN Power (SNP) is a Norwegian-owned international renewable energy company with focus on emerging markets. The overall business concept is to develop, build, acquire, own and operate sustainable renewable energy projects, with a main focus on hydropower, throughout sub-Saharan Africa, Central America and South-East Asia.

2. The EIA Study

Environmental and social baseline data have been collected over an extended period from 2015 to 2018. In the pre-feasibility phase (2015), SN Power retained the services of two companies in Myanmar, MIID (Myanmar Institute for Integrated Development) and NEPS (National Engineering and Planning Services), supervised by two experienced international consultants.

In March 2017, SNP signed a contract with Multiconsult of Norway for the purpose of completing a full EIA for the Middle Yeywa Hydropower Project. Multiconsult conducted an initial site visit in April 2017 and prepared a Gap Report in October2017 which recommended that certain aspects be studied in further detail in order to meet both national and international requirements. Additional field studies were carried out by Multiconsult and MIID in October 2017 (socio-economic surveys and consultations mainly in left bank villages) and in December 2017 (installation of wildlife camera traps and supplementary sampling of vegetation, wildlife and testing of methods for potential further aquatic studies).

3. Project Description

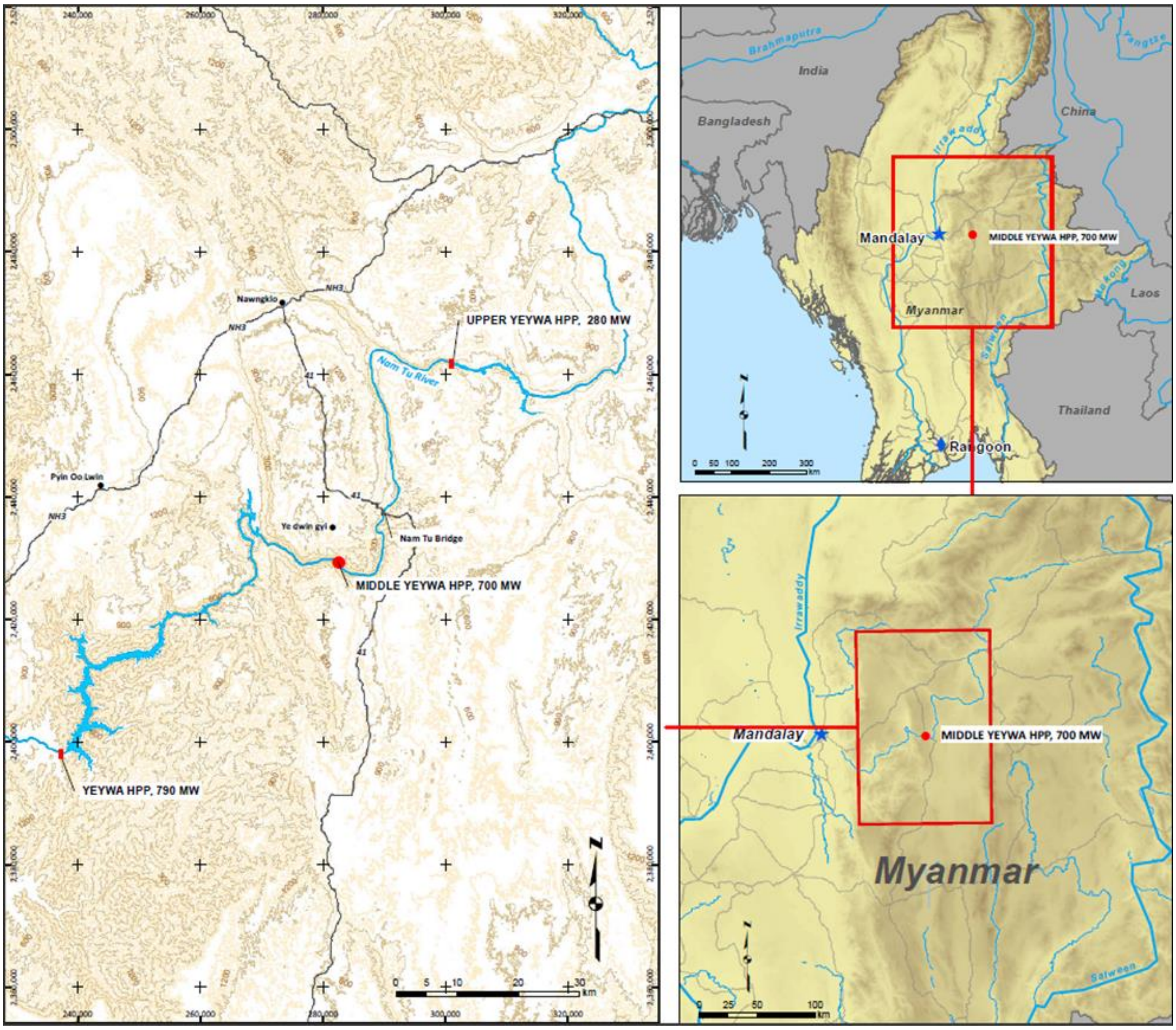
3.1. Location

The area of the Middle Yeywa Hydropower Project is located in Shan State, approximately 80 km east of Mandalay, 55 km east of Pyin Oo Lwin town, on the Myitnge River, a tributary of the Ayeyarwady (Irrawaddy) River (see figure below).

The Myitnge generally flows through deeply incised V-shape gorges with steep slopes, which will result in a narrow reservoir with a very limited live storage. The dam and related structures and facilities will mostly be located in the townships of Nawnghkio and Lawksawk, while the 70 km long reservoir will extend into the township of Kyaukmae where the Upper Yeywa Hydropower Project is being constructed.

3.2. General Layout

The main project alternative is to take advantage of the head available between the existing Yeywa reservoir (185 masl. at FSL) and the Upper Yeywa hydropower project (323 masl. tailwater level). The dam will be located at the bottom of a series of rapids in a narrow section of the Myitnge River, while the powerhouse will be located underground about 150 - 200 m downstream of the dam site.



Project location (Source: Pöyry 2015).

3.3. Project Components

3.3.1. Dam

The type of dam will be an arch dam with a maximum height above foundation level of 160 m and a crest length of 330 m. The proposed dam will support a centrally located crest spillway of two (2) bays and a left bank located spillway with three (3) bays. All the spillway bays are gated and composed of a conventional concrete chute channel ended by a flip bucket.

3.3.2. Powerhouse

The underground powerhouse complex will consist of a power cavern and a transformer cavern, as well as the required bus duct and access tunnels. The power cavern will contain four 183.75 MW vertical axis Francis turbines with a total installed capacity of 735 MW.

3.3.3. Reservoir

The Middle Yeywa dam will create an approx. 70 km long and narrow reservoir that will be around 135-140 m deep immediately upstream of the dam and gradually shallower towards the upper end. At the full supply level of 317 masl the total area impounded by the reservoir will be about 11 km^2 with a total volume of 400 million m^3.

3.3.4. Roads

The existing unpaved roads and village tracks/footpaths will be upgraded and a new road of 3.8 km length will be built into the gorge to arrive immediately downstream of the project location

At full supply level the Middle Yeywa reservoir will submerge the existing Myitnge Bridge which therefore has to be replaced. The new bridge will be 300 m long and be constructed immediately downstream of the existing bridge. The main road will be realigned accordingly.

4. Area of Influence

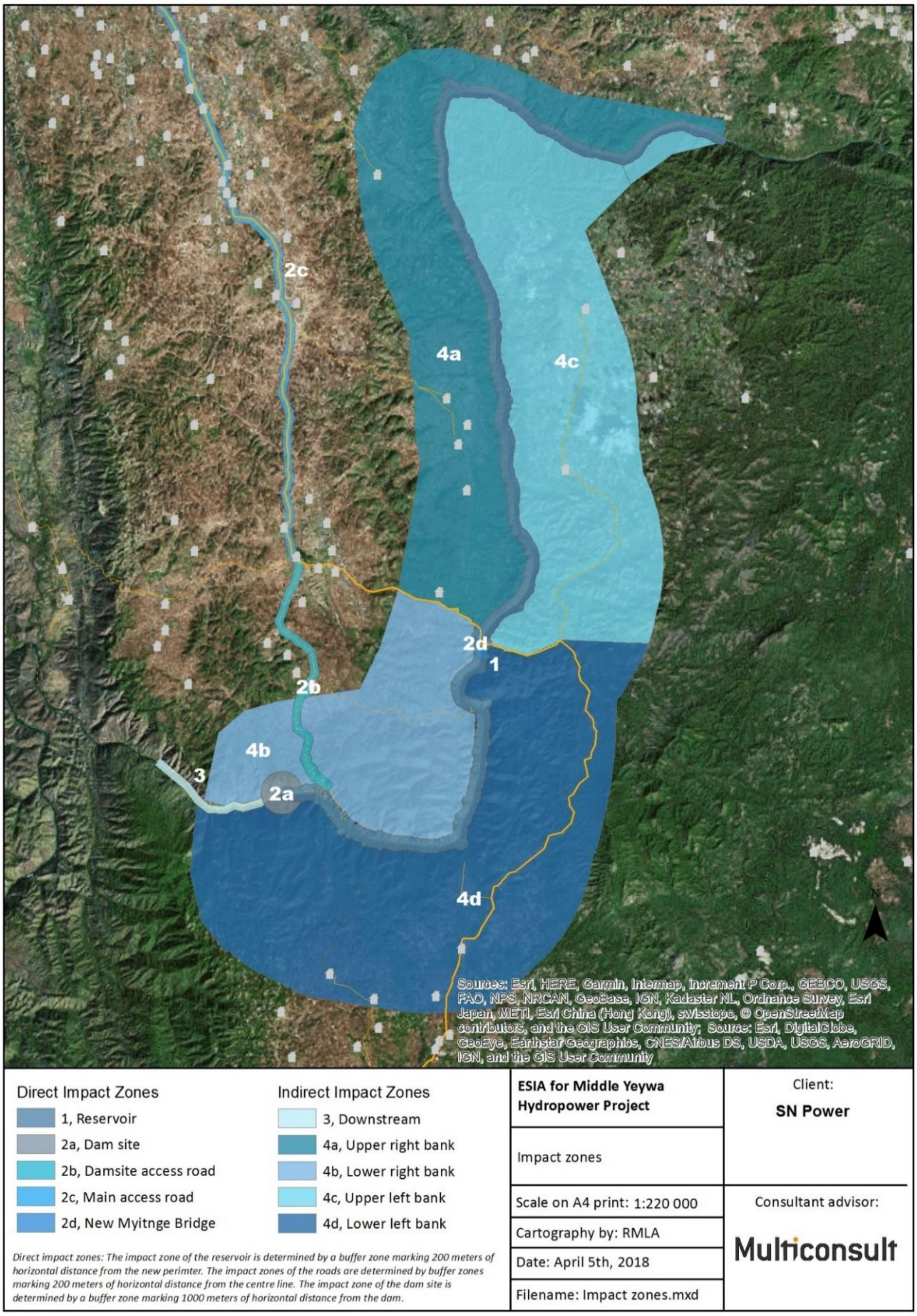
The spatial boundaries of EIA study have been defined based on a preliminary analysis of the direct (primary) and indirect (secondary) impacts of the proposed project and consequently divided into a direct and indirect impact zones. These zones constitute the project's area of influence (see figure below).

4.1. Direct Impact Zone

The direct impact zone covers all areas that will be physically affected by the construction and operation of the Middle Yeywa Hydropower Project. This zone includes the following areas as well as an approximately 200 m buffer zone surrounding each project component.

4.2. Indirect Impact Zone

The indirect impact zone consists of an area beyond the direct impact zone where the construction or operation of the power plant may indirectly affect the physical, biological and human environment through, among others, changes in water quality characteristics, air pollution levels (in the "airshed"), long-distance wildlife and fish migrations, and livelihoods and cultural behaviour of neighbouring communities.



Direct and indirect impact zone of the Middle Yeywa HPP.

5. Baseline Conditions

5.1. Physical Environment

5.1.1. Topography and Geology

The project area covers 70 km of river reach in a deeply incised valley through the Shan Plateau with several near vertical cliffs creating a canyon-like topography. Several tributary rivers and streams join the main Myitnge River within the affected reaches, including the Gohteik River in the upstream end of the planned reservoir and Namkam River which flows down a cascade of waterfalls before emptying into the main river further downstream.

The Shan Plateau is built up of a sequence of dolomites, limestones, and some shales, referred to as Plateau Limestones (Group) or the Shan Dolomite Group.

5.1.2. Climate

Myanmar has a largely tropical climate with three seasons, i.e. the monsoon or rainy season (May-October), the cool season (November-February) and the hot season (March-April). In the Myitnge basin, rainfall maximum occurs in June to August, whilst the driest months are December to March. Mean annual precipitation ranges from 1,000 mm in the south-eastern part of the basin to 1,800 mm in the north-western part. Mean daily temperature during the summer months is around 27 °C, while the coolest month is January with a mean monthly temperature of approximately 17 °C.

5.1.3. Hydrology and Water Quality

The Myitnge River is a primary left tributary of the Ayeyarwady River. The total drainage area is 34,800 km^2 and the river is about 530 km long. The catchment area at the Middle Yeywa dam site is approx. 25,518 km^2. The inflows are characterised by a marked seasonal variability with low flows of about 100-150 m^3/s in March to May and high flows of about 950 m^3/s in August to September. The mean annual inflow is 458 m^3/s.

The water quality in the affected reaches of Myitnge River is generally favourable to aquatic life. Dissolved oxygen (DO) values range from 4.7 to 8.4 mg/l with consistently higher values during the monsoon season at peak river flow. Turbidity levels are higher during high flows (monsoon season) with values ranging from 69 to 115 NTU, compared to less than 50 NTU in the wet/hot season and less than about 20 NTU in the cold/dry season.

5.2. Biological Environment

5.2.1. Key Biodiversity Areas and Protected Areas

There are no confirmed protected areas in the direct or indirect impact zones. The nearest protected area recorded in the World Database on Protected Areas is Pyin Oo Lwin Wildlife Sanctuary located approximately 35 km west of the dam site. There is an unconfirmed forest reserve in parts of the project area on the left bank.

The closest recognised area of particular biodiversity importance is the Mehon-Doke-hta Wady River key biodiversity area (KBA). This KBA is found between the Pyin Oo Lwin Wildlife Sanctuary and the dam site. The area does not have any legal status but is considered an International Bird Area (IBA) by Birdlife International due to occurrence of the endangered Green Peafowl. This species was recorded in the direct impact zone towards the dam site using wildlife camera traps, but the project's direct impact zone is not considered a key habitat for this species.

5.2.2. Vegetation

Vegetation types: The vegetation in the project's direct and indirect impact zones is predominantly deciduous Indaing (*Dipterocarp*) forest, common and widespread throughout most of the country. The forest and shrubs growing along the Myitnge River do not form a true riparian or riverine vegetation type, as the dominant species are similar to those growing at higher elevation and there is no distinct riverine zone due to the steep topography. Thus, the Indaing forest generally extends all the way down to the edge of the river.

There are some small spray wetlands along tributaries, all of which appear to be seasonal spray zones. The most interesting of these are on the Namkam River which flows down a cascade of waterfalls before emptying into the main river on the left bank near Thar Si village.

Threated plant species: A total of 462 species of flora (including some fungus species) were identified within the project's direct and indirect impact zones. Of these, five (5) species are classified as threatened according to the IUCN Red List, that is, species in the categories 'near threatened' (NT), 'vulnerable' (VU), 'endangered' (EN), and 'critically endangered' (CR). The globally threatened species all have a wide occurrence far beyond the project's impact zone.

5.2.3. Terrestrial Fauna

The main habitat types for terrestrial fauna are the main river, small tributaries, riverine forest along the main river and tributaries, and dry deciduous forest above the riverine forest. There are also heavily modified habitats such as cultivated areas.

Fauna surveys undertaken in the period 2015-2018 identified more than 340 species across several groups, but there is uncertainty about correct identification as reported species may reflect historical presence.

Mammals: More than 45 mammal species were identified in the surveys; some only through interviews rather than direct observations. Mammal species' abundance has been greatly reduced by human disturbance.

One species, categorised as critically endangered, the Chinese pangolin was only reported through an interview. A total of six mammals identified were categorised as endangered on the IUCN Red List: Tiger, Dhole/Asiatic wild dog, Banteng , Pharyre's langur , Cappet langur, and White handed gibbon. Except for the Dhole, none of these were confirmed through direct observation. Based on habitat characteristics and human pressures in the project area, it is considered unlikely that any of these species maintain resident populations in the project's direct and indirect impact zone.

Twelve species were categorised as vulnerable by IUCN. Several of these species were identified through camera traps (Leopard), skin found locally (Clouded leopard) or foot prints (Long-tailed macaque and Pig tailed macaque).

In addition to the IUCN Red List, the Forest Department has published a list of nationally protected species (Notification No. 583/94). Among the mammal species recorded or reported in the project's impact zone, several appear on this list such as Chinese Pangolin, Banteng, Tiger, Leopard, Clouded Leopard, White handed gibbon, and Gaur.

Amphibians and reptiles: Abundance of amphibians and reptiles was also greatly reduced by human disturbance. The surveys identified 40 reptile species and nine amphibian species. All amphibian species are categorised as of least concern on the IUCN Red List. Four reptile species are threatened, all identified through interviews: Elongated Tortoise, the vulnerable Burmese Python, the vulnerable King cobra, and the near threatened Indian Black Turtle.

Birds: A total of 118 bird species were recorded across the two river banks. All species were identified through visual observation or birds calls. One endangered species was recorded, the Green Peafowl, which is also included on the Forest Department list of nationally protected species (Notification No. 583/94). Six near threatened species were observed: Olive-backed Woodpecker, Red-breasted Parakeet, Alexandrine Parakeet, Grey-headed Parakeet, Long-tailed Parakeet, and River Lapwing. A striking characteristic was that very few water birds were observed.

Insects and other invertebrate species: A range of insects and other invertebrate species were identified, including butterflies, beetles, dragonflies, grasshoppers, locusts, spiders, a species of scorpion and a species of praying mantis. A total of 138 species were identified. These species are typically not yet assessed in the IUCN Red List and therefore no clear overviews of conservation concern are available for these groups.

5.2.4. Aquatic Ecosystems

Habitats: The aquatic habitats in the direct impact zone that support fish, benthic macroinvertebrates and other aquatic life were categorised into six main habitats along the Myitnge River, including falls and rapids, fast-flowing shallows, fast-flowing rocky deep sections, fast-flowing without turbulence; slow-flowing areas, stagnant water and tributaries.

The distribution of the aquatic habitats is likely to be dynamic and change with varying river flows including water speed, water depth, erosion and deposition. None of these habitats are considered as unique.

Species: A total of 33 species of fish were identified, many through interviews with local respondents and approximately half of the species by voucher specimen caught by local fishermen. The fish fauna was dominated by cyprinids (family Cyprinidae) with 19 species. Five fish species identified primarily through the interview survey were categorised as near threatened. Other aquatic species included crabs, shrimps and snails which were either categorised as of least concern, data deficient or not evaluated in the IUCN Red List.

5.3. Human Environment

5.3.1. Political Factions and Conflict

The Shan State has since independence seen armed conflict, mainly between the Union Government/national army and the ethnically based armed factions. The dominant armed faction that claims control over the part of the project area east of the Myitnge River (left bank) is the Restoration Council of Shan State (RCSS) with its armed wing, the Shan State Army-South (SSA-S). The RCSS entered into an agreement with the Government in January 2012 and the project area has largely been peaceful since then.

5.3.2 Population and Ethnic Groups

The project area is dominated by the Danu with a limited number of the Shan also present. A third group, the Palaung, is also present in the wider project area.

Danu: The Danu language is quite close to Burmese, and is one of numerous Burmese dialects. The Danu are officially classed as an ethnic minority among the groups listed by the government, and they meet all of the criteria for qualifying as an indigenous group set forth in IFC’s Performance Standard 7 on Indigenous Peoples. However, the findings and evidence from socio-economic surveys, village meetings and consultations clearly indicates that the Danu are not marginalized or vulnerable because they are the dominant ethnic group in the project and also because of their close ethnic and linguistic affiliation with the Myanmar majority of the country.

The Shan: Shan villages or villages with substantial Shan populations are only found in the indirect impact zone of the project area, predominantly in the upper right bank and lower left bank area. With respect to IFC’s Performance Standard 7, they can be identified as an ethnic minority as they see themselves as distinct group, are attached to a geographically distinct area, have separate cultural and social institutions, and have a distinct language. However, they cannot be characterised as “marginalised or vulnerable” and their economic, social and legal status does not “limit their capacity to defend their rights to, and interest in, lands and natural and cultural resources”.

Palaung (Ta-ang): The Palaung is the third notable ethnic group that is present in the wider project area but not in the direct impact zones. The Palaung are officially classified as an ethnic minority by the government, and are likely to meet all of the criteria for qualifying as an indigenous group set forth in IFC’s Performance Standard 7- Indigenous Peoples.

5.3.3. Project Area Economy and Characteristics

Agriculture: On both sides of the Myitnge River, farmland consists of non-irrigated uplands fields. Many households rely on slash and burn techniques and have traditionally left the land fallow for 1-3 years between plantings. However, as population has grown in the villages and average plot sizes have decreased, the ability to leave the land fallow is decreasing.

Most households across the impact zones have access to their own land. In large part, this is a reflection of the low population density and the ability of households to clear forest land and create new upland agriculture plots. Very few farmers have any formal rights to their farmland. The most common crops are maize and sugar cane.

Income levels and poverty: Declared income levels within the project's impact zones are substantially above the World Bank's poverty line for Myanmar of 1,303 MMK (US$ 1.1) per adult per day as well as well as above the global poverty line of US$2/day. Average income across 13 surveyed indirect impact zone villages was MMK 4,105,567 per year, or US$ 3,059, which corresponds to US$ 8.3 per day. On the average, the on-farm income share represents around 80%.

5.3.4. Natural Resource Use in the Impact Zones

Forest resources: Forest resources include timber (for construction as well as firewood), foraged plants (for consumption and sale), and hunting (consumption and sale), but these contribute only marginally to income in general. Hunting was once popular but this is no longer the case due to the scarcity of animals.

River resources: None of the surveyed 13 villages within the indirect impact zones rely on the river as a water source. A limited number of households engage in recreational fishing, but this does not contribute in any significant way to household incomes. In no village did fishing account for more than 1% of average income, and only 30 of the 800 households in the survey reported any fishing income.

5.3.4. Archaeological Sites and Cultural Heritage

No archaeological or cultural heritage sites have been identified or reported in the project's direct impact zone. However, villages in the indirect impact zone have temples and sometimes more local Buddhist shrines that are visited and maintained by the local population.

6. Impacts and Mitigation Measures

6.1. Physical Environment

6.1.1. River Flow Modifications

To allow for the construction of the Middle Yeywa dam, the Myitnge River will be temporarily diverted by means of upstream and downstream cofferdams and a diversion tunnel. However, this bypass arrangement will not affect the "natural" flow regime until the time of initial filling of the reservoir. The reservoir filling plan will allow for a release of a continuous minimum flow.

Upon commissioning, the short diversion reach (less than 200 m from the dam axis to the turbine outlets) will be completely or partially dried out, except when there is spilling of water over the dam or the gates are open

The daily peaking operation will cause high ramping rates, i.e. rapid fluctuations in downstream river flows and water levels. The operation of the plant will most likely vary from running continuously at full capacity (688 m^3/s), especially in the rainy season, to running at full capacity only for a few hours.

6.1.2. Reservoir Stratification

The Middle Yeywa dam will create a large and deep reservoir changing many physical, chemical and biological characteristics of the river. Dependant on the reservoir residence time, there is a certain risk of development of an anoxic zone (water without oxygen) at the bottom layer of the reservoir.

The potential problem of releasing anoxic water downstream can be mitigated by installing multi-level withdrawal structures (power intakes) on the dam, or constructing aerating weirs in the tailrace. However, due to the fact that the turbine outflow will be released upstream of the existing Yeywa reservoir – an already modified water body that can act as a water quality buffer zone, there may be less need for design modifications.

6.1.3. Water Pollution

During the construction phase, soil erosion from earthworks, cofferdams, and runoff from rock material from drilling, blasting, stone crushing, etc. are expected to cause increased sediment load, and hence increased turbidity in the river reaches between the dam site and the tail of the existing Yeywa reservoir. In addition, accidental fuel and oil spills from construction machinery, and leaching of ammonia and nitrogen from the blasting and soil rock deposits, may cause pollution of the river unless effective mitigation measures are put in place.

The workers' camp will generate sanitary effluents which are potential sources for microbiological and organic pollution of surface and ground water. Unless the waste and wastewater from domestic or construction origin (e.g. scrap metal, wood, plastic, cement bags, used tires and batteries, etc.) is adequately managed, it may result in pollution of both surface and ground water sources. Depending on the exact location of the workers' housing facilities, such pollution may either be localised or enter the Myitnge River.

6.1.4. Sediment Trapping and Flushing

The fact that the tailrace outlet is located a short distance upstream of the existing Yeywa reservoir, combined with the trapping of sediments behind the Upper Yeywa dam, suggests that the relative contribution of the Middle Yeywa dam in altering sediment transport in the Myitnge River is relatively less than it would be without those cumulative impacts.

6.1.5. Soil Erosion and Landslide Risks

During construction, soil will be impacted by activities like vegetation stripping, grading, soil removal, backfilling, compacting, excavation and disposal of surplus soil, etc. This applies especially to the road upgrade/construction works on the steep slopes of the Myitnge valley. After commissioning of the power plant, peaking operations will create a narrow drawdown zone with some risk of shoreline erosion over a wide area.

6.1.6. Greenhouse Gas Emissions

During the construction phase, greenhouse gas (GHG) emissions will be generated from increased traffic and from diesel generators. In addition, pre-impoundment clearing of trees in the reservoir will cause emissions from deforestation, calculated to ca. 475,000 tonnes CO_2. This land use conversion represents a source of GHG emissions although the overall impact in terms of climate change is low.

The operation of the Middle Yeywa power plant is intended to supply renewable energy using a technology which is not generally considered to cause GHG emissions.

6.1.7. Dust and Noise Emissions

The main impact to air quality during construction will be from increased dust levels arising from construction machinery, blasting, quarrying, excavations, earthworks, cement mixing and road construction, as well as vehicular traffic. In addition to emissions of particles, there will be emissions of NO_x and SO_2 from construction machinery, vehicles and from diesel power generators.

6.2. Biological Environment

6.2.1. Vegetation Clearing

The construction of the hydropower plant will involve loss of about 816 ha of Indaing forest below FSL, including relatively intact forests on the left bank due to biomass clearing and inundation. In addition, the seasonal spray zone at the lower Namkam waterfalls will be submerged and lost.

Most of the trees that will be cut are common species of the Indaing forest vegetation type with a wide geographical distribution and that are not subject to major conservation risks, including those classified as threatened.

6.2.2. Disturbance and Loss of Habitat for Terrestrial Wildlife

Clearing of areas for construction will result in direct loss of habitat for terrestrial fauna. Workers and associated in-migration could result in illegal tree cutting for timber. No species of conservation concern are expected to lose significant parts of their habitats.

The presence of a large workforce and camp followers represents a threat to mammal species in particular (e.g. Muntjac) and partly species of birds (e.g. Red Jungle Fowl) due to a possible increase in illegal hunting during construction. Pollution risks in the form of hazardous materials will be experienced in virtually all construction sites but are expected to be localised.

Seasonally inundated sandbanks scattered along the river will also be inundated and these may be important for insect species and turtle species if they still exist in the area. At the Namkan tributary, a spray zone will be partly inundated. However, no unique species were found in this unusual habitat. There are similar spray zones available above the inundation area.

6.2.3. Aquatic Ecosystems

The construction of the dam and filling of the reservoir will result in loss of riverine habitats and creation of a larger lake habitat. Species adapted to flowing water will largely lose their habitats except in a limited number of tributaries along the reservoir that will provide small pockets of riverine habitat.

From the time of construction of coffer dams, the construction works will be a barrier to upstream fish migration. This will limit access to upstream river reaches for any fish downstream the dam. The presence of Yeywa dam downstream and Upper Yeywa upstream means long-distance fish migration in this river system has already been blocked and will not be further impacted by Middle Yeywa HPP. It is not considered feasible to construct an upstream fish passage at the dam.

The Developer is considering placement of substantial volumes of rocks in the river for a 1 km distance downstream of the tailrace in order to meet a potential requirement from the Government of Myanmar for a ‘free flowing’ river section between the Yeywa reservoir and the Middle Yeywa dam. Unless carefully designed with ecological objectives in mind, this will further impact the limited remaining riverine habitats negatively.

The typical river species will be largely outcompeted in the reservoir assuming the reservoir will be colonised by species well adapted to a lake-like system. Phytoplankton and zooplankton communities are likely to expand considerably and also provide the basis for an increased biomass of other species that feed on plankton. The fish community will change in species composition towards species favouring lake-like aquatic environments.

The project is likely to be run for hydro-peaking though the operational regime will only be determined later. This will introduce major daily flow variation between the tailrace and the downstream Yeywa reservoir for most of the year. This flow variation will have substantial negative impacts on aquatic life in the short but varying length of affected river section. Complete drying out of the river should be prevented by releasing a continuous minimum flow as well as identifying ramping rates that are acceptable in terms of environmental and safety concerns (e.g. avoiding excessive risks of stranding of fish and avoiding risks to people close to the river).

6.3. Human Environment

6.3.1. Local Project Area Economy

The Middle Yeywa HPP is likely to generate possibilities for employment for the local population, both directly and indirectly. The impact on local economy is assessed as positive for the local population and local businesses in the construction phase.

6.3.2. Displacement and Resettlement

At the present stage of planning and project development, the size and accurate location of the project lands have not yet been determined in detail. Road No. 41 from Nawnghkio to Taung Shey and further on from the junction on a local unpaved village road down to Yae Twin Gyi is likely to be chosen as the main project access road. This access passes through a number of villages and its widening may lead to some physical displacement of commercial and residential buildings located close to the roads.

With regard to the reservoir, it will be confined within the steep river valley where there are no settlements except for temporary fishing and illegal logging camps.

6.3.3. Population Influx

During construction, there will be a temporary increase in population in the area surrounding the main construction site. Population influx, even though temporary, will put considerable pressure on the local infrastructure, services and utilities, especially on community health and sanitation. This may lead to a reduction of the capacity of the local services to meet the needs of the local population as well as the needs of the in-migrants.

6.3.4. Community Safety and Security

A number of safety issues are likely to be caused by the Middle Yeywa HPP. These include traffic accidents and management of waste. Increased traffic is likely to lead to an increase in road incidents and serious accidents and injuries along the main access route.

If hazardous waste and materials generated in connection with project activities are not appropriately and safely managed, they may lead to serious contamination and pollution of water sources and ground water.

6.3.5. Forest Resource Use

During the construction phase, some forest resources may be lost due to building of the access road down the escarpment to the main construction site comprising the dam and powerhouse areas. This is unlikely to affect the forest resource use of the nearby villages. Villagers do not extract resources (timber or wild meat) in any significant degree due to difficulties in accessing the steep slopes of the valley.

The income from fishing appears to be insignificant constituting less than one percent of the total average income according to the socioeconomic survey. However, for some households in the villages surrounding the future Middle Yeywa reservoir, fishing appears to be a source of dietary supplement and for some also a source of income, including Yae Twin Gyi, closest to the dam site.

6.3.5. Summary of Impacts

The table below summarises the impact assessment without and with mitigation/enhancement measures.

Theme	**Value/ Vulnerability**	**Impact Magnitude**	**Overall Impact**	
			Without Mitigation	**With Mitigation**
CONSTRUCTION PHASE				
Physical Environment				
Topography and landscape	**Medium**	**Low - medium negative**	**–/– –**	**–**
Geology and soils	**N/A**	**Medium negative**	**– –**	**–**
Climate	**High**	**Low negative**	**–**	**0/–**
Air Quality	**High**	**Low - medium negative**		**–**
Noise and vibration	**High**	**Low - medium negative**	**–/– –**	**–**
Hydrology	**N/A**	**Low negative**	**–/– –**	**–**

Theme	Value/ Vulnerability	Impact Magnitude	Overall Impact	
			Without Mitigation	With Mitigation
Sediment transport	**High**	**Low - medium negative**	**–/– –**	**–**
Water quality	**Medium-high**	**Low - medium negative**	**–/– –**	**–**
Biological Environment				
Protected areas	**Low**	**Insignificant**	**0**	**0**
Vegetation	**Medium**	**Low - medium negative**	**–**	**0/–**
Terrestrial fauna	**Medium**	**Medium negative**	**– –**	**–**
Aquatic ecosystems	**Medium**	**Medium negative**	**– –**	**–**
Human Environment				
Local project area economy	**High**	**Low - medium positive**	**++**	**++/+++**
Physical displacement and resettlement	**High**	**Low - medium negative**	**–/– –**	**0**
Economic displacement and loss of livelihoods	**High**	**Low - medium negative**	**–/– –**	**0**
Population Influx and social fabric	**High**	**Medium negative**	**– –**	**–**
Community safety and security	**High**	**Medium negative**	**– –**	**–**
Forest resource use	**High**	**Insignificant - low negative**	**–**	**–/0**
River resource use	**High**	**Low - medium negative**	**–/– –**	**–**
Archaeological sites and cultural heritage	**High**	**Insignificant**	**0**	**0**
OPERATION PHASE				
Physical Environment				
Topography and landscape	**Medium**	**Low - medium negative**	**– –**	**–**
Geology and soils	**N/A**	**Low-medium negative**	**– –**	**–**
Climate	**High**	**Low - medium positive**	**+**	**+ +**
Air Quality	**High**	**Insignificant**	**0**	**0**
Noise and vibration	**High**	**Insignificant**	**0**	**0**
Hydrology	**N/A**	**Low - medium negative**	**–/– –**	**–/– –**
Sediment transport	**High**	**Low - medium negative**	**–**	**0/–**
Water quality	**Medium-high**	**Medium negative**	**– –**	**–/– –**
Biological Environment				
Protected areas*	**Low**	**Insignificant or low negative**	**0 or –**	**0 or –**
Vegetation	**Medium**	**Low negative**	**–**	**0/ –**
Terrestrial fauna	**Medium**	**Medium negative**	**– –**	**– –/–**
Aquatic ecosystems	**Medium**	**Medium negative**	**– –**	**– –/–**

Theme	Value/ Vulnerability	Impact Magnitude	Overall Impact	
			Without Mitigation	With Mitigation
Human Environment				
Local project area economy	**High**	**Low - medium positive**	**+**	**++**
Physical displacement and resettlement	**High**	**Insignificant**	**0**	**0**
Economic displacement and loss of livelihoods	**High**	**Insignificant**	**0**	**0**
Population influx and social fabric	**High**	**Low negative**	**–**	**–**
Community safety and security	**High**	**Insignificant**	**0**	**0**
Forest resource use	**High**	**Low negative**	**0**	**+**
River resource use	**High**	**Medium - Low negative**	**–**	**0**
Archaeological sites and cultural heritage	**High**	**Insignificant**	**0**	**0**

* Assessment depends on confirmation whether parts of the left bank have a forest protection status or not.

7. Stakeholder Consultations

7.1. First Consultation Campaign

Initial community meetings were held in the six right bank villages in February/March 2015. The general reactions to the proposed hydropower project were generally positive and nobody expressed opposition to the project. Issues raised included demands for electricity, water supply, roads and jobs.

With regard to flooding and loss of land, the villagers were assured that no farmland would be lost due to creation of the reservoir but that some limited land could be taken for access roads and camps in Yae Twin Gyi, the village nearest to the dam site.

7.2. Second Consultation Campaign

Consultation continued in selected villages surrounding the reservoir and the dam site in May 2016. Again, the consultations were well received by communities, and participants expressed thanks for keeping them informed. Villagers reiterated their interest receiving electricity and what other benefits the project could give the communities. Some villages were also concerned about the Myitnge Bridge and whether it would be flooded. These consultations also informed villagers of survey activities and established a grievance mechanism.

8. Environmental and Social Management Plan

8.1. Organisational Set-up and Staffing

In the project organisation of the Developer, an Environmental and Social Unit (ESU) will be established. The ESU will be headed by an expatriate manager who will report directly to the project Manager. The ESU will include five separate teams that will take responsibility for implementing the different mitigation activities and programmes described in in the ESMP. Each of the teams will have a Team leader who will be assisted by 3- 4 specialists. The proposed ESU teams are: 1) Compensation and Grievance Team; 2) Social Management and Consultation Team; 3) Environmental Management Team; 4) Community Forestry Team and 5) Infrastructure Team.

8.2. Environmental Management Plan

The Environmental Management Plan Comprises a number of sub-plans and programmes, including:

- *Construction Environmental Management and Monitoring Plan:* The Contractor will develop and implement site specific plans in accordance with standards and indicators in the Tender Documents for hazardous and non-hazardous waste, pollution control, erosion control, emergencies and health and safety.
- *Water Quality Monitoring Plan*: A water quality monitoring program will be implemented to document the water quality changes resulting from the Middle Yeywa project. The results of the water quality monitoring will be summarised in bi-monthly reports and made available to relevant GoM agencies.
- *Aquatic Ecology and Fisheries Management Plan:* The aquatic ecology and fisheries management plan will recommend measures that will be determined and refined after additional surveys. During construction and particularly during operation, sensitisation of local communities will be undertaken to avoid catching any threatened species, avoid use of harmful or unsustainable fishing methods (e.g. poison, dynamite), and promote sustainable fishing practices.
- *Reservoir Clearance and Filling Plan*: The Reservoir Clearance and Filling Plan includes (i) reservoir demarcation, (ii) harvesting of commercial timber (by contractor or State Enterprise), (iii) clearance of selected areas and controlled burning (by contractor employing local people), and (iv) residue collection and removal during initial filling of the reservoir.
- *Biodiversity and Conservation Protection Plan:* The Biodiversity and Conservation Protection Plan includes consultations with forest authorities, local authorities and communities to assess and consider possibilities for supporting establishment of one or more forest protected areas around the reservoir on both river banks. The plan also proposes conservation activities for selected species, particularly the endangered Green Peafowl (*Pavo muticus*) that is found in the Mehon - Doke-hta Wady River Key Biodiversity Area (KBA) that partly overlaps with the project's indirect impact zone.
- *Community Forest Program:* The Community Forest Program will consist of both natural and assisted regeneration of tree species as well as protection of existing forests and promotion of agro-forestry practices. The objectives are to (i) compensate for the loss of forest in the Middle Yeywa reservoir by restoring priority forests outside of the project's direct impact zone, and (ii) contribute to watershed management and biodiversity conservation whilst also improving the communities' access to ecosystem services through sustainable community-led forest management.
- *Operation Phase Environmental Management Framework*: An Operation Phase Environmental Management Plan will be developed well ahead of the start of the operation phase. The plan and should build on the different mitigation programmes initiated in the construction phase and should tentatively cover the following environmental issues: (i) waste management and pollution control, (ii) water quality monitoring, (iii) fisheries management and aquatic ecology monitoring, (iv) conservation protection activities, and (v) community forest management.

8.3. Social Management Plan

The Social management Plan is composed of the following plans and programmes:

- *Stakeholder Engagement Plan*: The continued stakeholder consultations in the pre-construction and the construction phase will focus on the planning of the community development initiatives (CDI), including access road improvement and grid connection which SN Power will be funding.

- *Compensation for Lost Land, Production and Fixed Assets*: Asset surveys to register and quantify loss of land and building infrastructure along the access roads will be carried out as soon as the road alignments have been determined and planned in detail. Full compensation at replacement cost will be provided.
- *Social Management for Construction Areas*: Depending on the actual number of in-migrants the project will attract, measures to improve water supply and sanitary conditions in the villages that receive in-migrants will be implemented if necessary. Measures to reduce traffic related accidents, including speed bumps and implementation of a road safety programme for schools, will also be implemented.
- *Community Development Initiatives*: Community Development initiatives will include upgrade and improvement of access roads as well as electrification for a number of villages in the indirect impact zone. The community development programme will be planned in detail in coordination with the government.
- *Workforce Recruitment and Employment:* The project will require contactors to give preference to employment of local labour. The employment process will also be facilitated by compiling lists of skilled and semi-skilled workers from project area villages that will be presented to the contractors.

8.4. Environmental and Social Management Plan Budget

The table below summarises the estimated budget for the ESMP:

No	Item	Pre-constr	Construction Phase						Total
		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	Pesonnel Costs - ESU	399 600	445 200	445 200	392 400	392 400	392 400	392 400	2 859 600
2	Government of Myanmanr Costs	50 300	50 300	39 500	39 500	39 500	39 500	39 500	298 100
3	Environmental Management Plan Costs	130 000	100 000	100 000	110 000	265 000	265 000	185 000	1 155 000
4	Social Management Plan and Community Initiatives	492 000	1 853 000	2 418 750	1 987 500	1 002 500	1 002 500	182 500	8 938 750
	Total EMP/SMP Costs	**1 071 900**	**2 448 500**	**3 003 450**	**2 529 400**	**1 699 400**	**1 699 400**	**799 400**	**13 251 450**

At this point contingency arrangements for the project as a whole have not been decided.

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ACRONYMS

BOD	Biological Oxygen Demand
CE	Critically endangered
CITES	Convention on International Trade of Endangered Species
COD	Chemical Oxygen Demand
DIZ	Direct Impact Zone
DO	Dissolved Oxygen
EMP	Enviromental Management Plan
EN	Endangered
EIA	Environmental Impact Assessment
ESIA	Envirommental and Social Assessment
ESMP	Environmental AND Social Management Plan
E&S	Environmental and Social
FAO	Food and Agricultural Organization of the United Nations
FSL	Full supply Level
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GIS	Geographic Information Systems
GOM	Government of Myanmar
GPS	Global Positioning System
GWh	Gigawatt hours
HH	Household
HPP	Hydropower Project
IFC	International Finance Corporation (World Bank Group)
ILO	International Labour Organisation
INDIZ	Indirect Imapct Zone
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
kg	Kilogram
km	Kilometre
km^2	Square Kilometre
kWh	Kilowatt hours
LC	Least Concern
masl	Metres above sea level
MoEP	Ministry of Electric Power
MOL	Minimum Oerating Level
MoNREC	Ministry of Natural Resources and Environmental Conservation
MTE	Myanmar Timber Enterprise
MW	Megawatt

NT	Near Threatened
NTFP	Non-timber-forest. product
MoU	Memorandum of Understanding
NE	North East
O&M	Operation and Maintenance
PAPs	Project Affected Persons
PMF	Probable maximum Flood
PS	Performance Standard
RCC	Roller Comapcted Concrete
RCP	Representative Concentration Pathway
RCSS	Restoration Council of Shan State
SIA	Social Impact Assessment
SNP	SN Power SS
SSA-S	Shan State Army South
SSE	South South-East
TSS	Total Suspended Solids
TN	Total Nitrogen
TWh	Terawatt hours
VU	Vulnerable

1 INTRODUCTION

1.1 Background

SN Power signed a Memorandum of Understanding (MoU) on the 2nd of July 2014 with MoEP (Ministry of Electric Power of Myanmar) for the study and possible development of the Middle Yeywa Hydropower Project on the Myitnge River located in the Shan State. In Shan language, the river is called Nam Tu. Hereafter in this EIA Report, Myitnge will be used as the name for the river on which development of the Middle Yeywa Hydropower Project is being planned.

The Project is located between the Lower Yeywa Hydropower Project in operation and the Upper Yeywa Hydropower Project currently under construction, potentially forming a cascade. The main project alternative involves a dam of 160 m height that will create a reservoir of about 70 km in length.

A Pre-Feasibility ESIA (Environmental and Social Impact Assessment) was finalised in August 2015, based on a preliminary technical design (Pre-Feasibility Studies by Pöyry). At the present stage in the project development, SN Power (SNP) has decided to proceed with a full technical feasibility study and Environmental Impact Assessment (EIA).

1.2 Project Developer

SN Power is an international renewable energy company with focus on emerging markets. The overall business concept is to develop, build, acquire, own and operate sustainable renewable energy projects, with a main focus on hydropower, throughout sub-Saharan Africa, Central America and South-East Asia. SNP was founded in 2002 by Statkraft (Norwegian State Utility) and Norfund (Norwegian Investment Fund for Developing Countries). After an agreement between Statkraft and Norfund in September 2017 to swap shares in their jointly owned international hydropower assets, SN Power is now fully owned by Norfund. Norfund is Norway's state-owned Development Finance Institution.

1.3 EIA Process

The present feasibility level EIA study is intended to meet the requirements of the Environmental Impact Assessment Procedure (ratified by the Burmese parliament in December 2015) as well as environmental compliance certificate and related permitting conditions under the Ministry of Natural Resources and Environmental Conservation (MoNREC). The ESIA shall also be "bankable" and comply with IFC Performance Standards for Environmental and Social Sustainability (2012).

Environmental and social baseline data have been collected over an extended period from 2015 to 2018. In the pre-feasibility phase (February-May 2015), SNP retained the services of two local companies; MIID (Myanmar Institute for Integrated Development) covering social aspects and NEPS (National Engineering and Planning Services) covering environmental aspects. These local consultants were supervised by two experienced international consultants, Mr. Ettore Romagnoli and Ms. Karen Jacob. A Pre-Feasibility EIA Report was produced in June 2015, and further comments and analysis were incorporated into the final report in August 2015.

Additional environmental data collection was undertaken from September to October 2015 (on the right bank of the Myitnge River) and from July to August 2016 (on the left bank). The environmental data thus cover the dry season (March-May, right bank), the rainy season (July-August, left bank) and the transition period after the rainy season (September-October, right bank).

On the 7th of March 2017, SN Power signed a contract with Multiconsult of Norway for the purpose of completing a full EIA for the Middle Yeywa Hydropower Project (see Annex 1 for Detailed Terms of Reference). The scope of work included an update of the Pre-Feasibility EIA Report by incorporating the additional baseline data (and consultation proceedings) that had been collected by the local consultants in late 2015 and 2016 combined with a gap analysis to identify the need for further investigations. Multiconsult conducted an initial site visit (from 3rd to 7th of April 2017) and prepared a

Gap Report in June 2017 which recommended that certain aspects be studied in further detail in order to meet both national and international requirements.

The additional fieldwork was carried out in October and December 2017 with short field visits in January, February and April 2018 to download pictures from deployed camera traps. The field work in October 2017 included socioeconomic surveys and village meetings in mainly left bank villages while in December further baseline data on fish and aquatic ecology, riparian vegetation, terrestrial fauna (including deployment of camera traps) were collected.

1.4 Report Structure

The EIA Report has been organized in 10 chapters covering all the required chapters and content of an EIA Report as specified in the Environmental Impact Assessment (EIA) Procedure of 2015. The report structure also includes all the items required by the IFC and other potential financing institutions.

The ESIA Report is structured in chapters as listed below:

- Executive Summary in English and Myanmar language
- Chapter 1: Introduction
- Chapter 2: Project Description
- Chapter 3: Approach and Methodology
- Chapter 4: Policy, Legal and Administrative Framework
- Chapter 5: Stakeholder Analysis and Consultation
- Chapter 6: Environmental Baseline Conditions
- Chapter 7: Social Baseline Conditions
- Chapter 8: Project Impacts and Mitigation Measures (including Cumulative Impacts)
- Chapter 9: Analysis of Alternatives
- Chapter 10: EMP and SMP Overview
- Chapter 11: Environmental Management Plan
- Chapter 12: Social Management Plan

The annexes of the EIA report include:

- Annex 1: Scope of Services
- Annex 2: Biodiversity Reports
- Annex 3: Indigenous Peoples Report
- Annex 4: Socioeconomic Survey Results and Village Profiles

1.5 ESIA Team of Experts

In the following, the social and environmental experts that have participated in studies and the preparation of the ESIA Report are briefly presented:

1.5.1 Multiconsult Team

Team Leader / Social Specialist: Jens Laugen

Mr. Laugen has more than 20 years of experience within the field of social development planning and assessment. Since joining Multiconsult in 2001 he has worked on a number of hydropower development project, including being full time Social and Environmental Manager (SED) for the Theun-Hinboun Hydropower Project in Laos from 2011 to 2015.

Environmental and Flora / Forestry Specialist: Dr. Jørn Stave

Dr. Stave holds a Ph.D. and M.Sc. in tropical ecology / botany and has more than 15 years of work experience in natural resource management. In his current position, Dr. Stave works as a Senior Environmental Advisor in Multiconsult's Natural Resources Division, where he has delivered a wide range of environmental consultancy services, especially to hydropower developers, including environmental assessments (EIA/ESIA), management plans (ESMP), resettlement plans (RPF/RAP), compliance monitoring/auditing, and due-diligence appraisals.

Water Resource and Aquatic Ecology Specialist: Leif Lillehammer

Mr. Lillehammer has a Cand. Scient Dissertation in Ecology from 1991, and an Assistant Professor qualification from 1994. Lillehammer has more than 25 years of experience in water resources, energy/hydropower projects as well as environmental management and research. He has worked five years as a researcher within the field of freshwater ecology and water resources.

Since 1996 he has worked as a consultant, carrying out a number of assignment in different fields such as integrated basin and water resources management, water and environmental strategy development, policy and vision formulation, strategic, cumulative and project specific environmental and socio-economic impact assessment, and institutional and regulatory assessment and strengthening of water resources and river basin organizations.

Fauna / Conservation Specialist: Svein Erik Hårklau

Mr. Hårklau has M.Sc. in Management of Natural Resources and Nature Conservation from the Norwegian University of Life Sciences. He has more than 17 years of work experience in natural resource management and environmental issues integrating ecological, economic and socio-cultural concerns while addressing problems and opportunities and finding workable solutions in infrastructure projects, including large and small hydropower projects. From 2001 to 2009 Mr. Hårklau worked for the World Wide Fund for Nature (WWF) as a program manager with responsibility for developing and following up field projects in Africa (natural resources management, conservation, energy and climate change). Mr. Hårklau's experience also includes numerous environmental and social studies at various stages of infrastructure development projects (e.g. hydropower, roads, railways, tunnels, transmission lines, mining, oil and gas). He has also worked extensively with conservation and sustainable use of biodiversity as well as protected areas management.

Anthropologist / Ethnic Minority Specialist: Dr. Jim Chamberlain

Dr. Chamberlain has had 45 years professional experience in Lao studies, including more than 45 years of experience in the field in SE Asia. He is fluent in the written and spoken forms of the Lao and Thai languages. In Laos, he has carried out numerous surveys and social analyses, including the Participatory Poverty Assessments, social impact assessments, socio-economic studies, ethnic group development plans, public involvement plans, institutional and policy analyses, evaluations, and technical studies for a number of international agencies, including the World Bank and Asian Development Bank.

GIS Expert: Rasmus Meyer Liebig-Andersen

Mr. Liebig-Andersen is an environmental geographer with experience from early phase planning to technical design of infrastructure, including impact assessments, risk assessments and environmental management planning. He holds a B.Sc. in Geography and a M.Sc. in Environmental Planning and Management with supplementary courses in freshwater ecology and resources. Mr. Liebig-Andersen has wide experience with spatial studies and application of GIS tools, including determining of Areas of Influence from physical interventions of infrastructure development, hydropower dams and flood management projects.

1.5.2 MIID Team

Social Team

Social Expert: Samuel J.A. Purch

Mr. Purch has a Master of Arts from Kings College in London and has worked as a consultant providing services to a number of international NGOs as well as private sector clients within the fields of research and analysis on political, economic and social issues. He has since 2015 been based in Yangon.

Social Expert: May Pannchi

Ms Pannchi is a social researcher with more than five years of experience conducting quantitative and qualitative research throughout in Myanmar across various sectors, such as nutrition, natural resources management, access to information and governance. She holds MSc in International relations from Dagon University.

Biodiversity Team

Ecologist / National Team Leader: Dr.Win Myint (Associated Professor, ex.)

Dr. Win Myint has a PhD in ethnobotany from the University of Yangoon and a MSc form the same university in Ecology. As a consultant he has conducted Biodiversity Impact Assessments and contributed to a number of EIA studies for infrastructure development projects in Myanmar, including hydropower development such as the Minhla and Nankam hydropower projects. Dr. Win also led the biodiversity studies that were carried out during the pre-feasibility phase for the Middle Yeywa Hydropower project.

Taxonomist: U Nyo Maung (Retired Professor)

U Nyo Maung has a MSc in plant taxonomy from the University of Mandalay and a BSc in plant biology from the same University. He was a member of the team that carried out the pre-feasibility biodiversity study for the Middle Yeywa Hydropower Project and has also worked on a number of other biodiversity impact studies, including hydropower projects

Taxonomist: Dr. Ei Ei Phyoe

Dr. Ei Ei Phyoe has a MSc in environmental studies as well as a PhD in Plant Taxonomy from the University of Yangon. His was team leader and supervisor for the plant identification studies and flora surveys in connection with the proposed national park of Lenya, located in the Taninthayi Region of Myanmar. Other notable project experience include biodiversity studies for the Middle Yeywa Hydropower project (pre-feasibility stage) and biodiversity studies for the Minhla and Nankam hydropower projects.

Botanist and GIS Expert: U Tun Thura

Mr. U Tun Thura has a BSc in botany and MSc in environmental science from the University of Yangon. In addition he has a BSc in computer science from the University of Computer Studies in Yangon. Hi project experience include biodiversity studies for the Middle Yeywa Hydropower project (pre-feasibility stage) and biodiversity impact assessments for the Minhla, Nankam and Baluchaung hydropower projects.

Assistant Taxonomist: U Thein Phyoe Aung

Mr. Thein Phyoe Aung has a BSc degree in biology from University of Yangon. He has participated as assistant taxonomist in many botanical surveys and vegetation surveys in connection with EIA studies in Myanmar. Among these are surveys undertaken for hydropower projects in the Shan State and the botanical survey in the Taninthayi forest. Through the participation in many projects Mr. Thein Phyoe Aung Even has thus proven himself as a highly qualified field taxonomist providing quick and accurate identification of vegetation types and plant species.

Bird and Mammal Specialist and Fauna Team Leader: U Tin Aung Tun

Mr Tin Aung Tun has a BA degree in biology from Shwebo University. Through his work experience and participation in fauna surveys he has gained expertise within the fields of ornithology as well as mammalogy. He worked for FFI (Fauna and Flora International) as a conservation biologist for four years and also had the position as species officer at BANCA (Biodiversity and Nature Conservation Association). From his work with FFI and the Myanmar Primate Conservation Program he gained comprehensive experience and expertise with installation and operation of wildlife camera traps

Amphibians and Reptiles Specialist: U Min Thein Htet

Mr Min Thei Htet has a BSc degree in zoology from Dagon University. He has participated in a number of EIA studies and is an experienced field zoologist. He has cooperated with BANCA (Biodiversity and

Nature Conservation Association) and participated in an number of conservation projects in Myanmar. His experience also includes herpetofauna studies undertaken for the Myit Son Hydropower Project.

Insect and Invertebrates Specialist: U Kyaw Naing Oo

Mr Kyaw Naing Oo has BSc degree in zoology from Ma U Bin University. He has participated in a number of EIA studies with responsibility for the entomology studies. Many of the EIA studies have been undertaken for hydropower projects in Myanmar.

2 PROJECT DESCRIPTION

2.1 Geographical Location

2.1.1 Environmental Setting

The area of the Middle Yeywa Hydropower Project is located in Shan State, approximately 80 km east of Mandalay and 55 km east of Pyin Oo Lwin town, on the Myitnge River, a tributary of the Ayeyarwady (Irrawaddy) River. The Project is located between the Lower Yeywa Hydropower Project already in operation and the Upper Yeywa Hydropower Project currently under construction, forming a potential cascade.

Between the Upper Yeywa dam site and the planned dam site for the Middle Yeywa HPP, the Myitnge River flows through a deeply incised river valley with an average width at river level of around 70 m. The minimum width of the valley is approximately 25 m and the maximum width approaches 160 m. The river valley sides raise up some 300 to 600 meters from the river with the steepest gradients found in the lower part of the valley. The shape of the valley will result in an around 70 km long and narrow reservoir with only a limited storage capacity when compared to the mean yearly inflow.

Access to the central part of the project is by National Highway No. 3 to Nawnghkio, which is located some 125 km northeast of Mandalay. From Nawnghkio, Road No. 41 leads into the central project area with around 45 km down to the bridge spanning the Myitnge River. The bridge lies around 22 – 23 km upstream of the planned dam site.

The terrestrial biodiversity found in the project area is not unique and has been considerably affected and degraded by human activities such as logging and conversion of forested areas into to agricultural land. However, there are some steep and less accessible areas on the slopes down towards the river that retains more of the original biodiversity of the area. The vegetation of lower valley that will be inundated is mainly composed of riverine forest and Indaing (dipterocarp) forest.

There are no protected areas in the Project's impact zones, the nearest being the Pyin Oo Lwin Wildlife Sanctuary which is located approximately 35 km west of the dam site.

2.1.2 Social Setting

The Middle Yeywa Hydropower Project lies fully within the borders of the Shan State. The dam and other related structures and facilities will mostly be located in the townships of Nawnghkio and Lawksawk while the reservoir will be stretching into the township of Kyaukmae where the Upper Yeywa Hydropower dam is located.

The economy in the project area is dominated by agriculture with sugar cane and maize as the most important commercial crops. The majority of inhabitants are farmers and regional townships provide services and markets for the local population. Other important crops include rice, peanuts and different kind of vegetables and fruits.

The local socioeconomic conditions are higher than average for rural Myanmar with considerable integration into a monetized system, relatively good infrastructure and reliance on cash crops. Water supply systems are found in most villages but do not always provide enough water over the whole year.

There are health clinics or health posts in the some of the project area villages but as elsewhere in rural Myanmar they are often struggling with lack of equipment and medicines. Although health care services nominally are free in Myanmar patients have to pay for the medicines and treatment. Malaria is common in the project area although the prevalence has been significantly reduced over the last years. Because of lack of clean water supply and sanitation facilities, diarrhoea is still a considerable problem, especially among young children. Other serious diseases that are occurring in the project area include tuberculosis and dysentery.

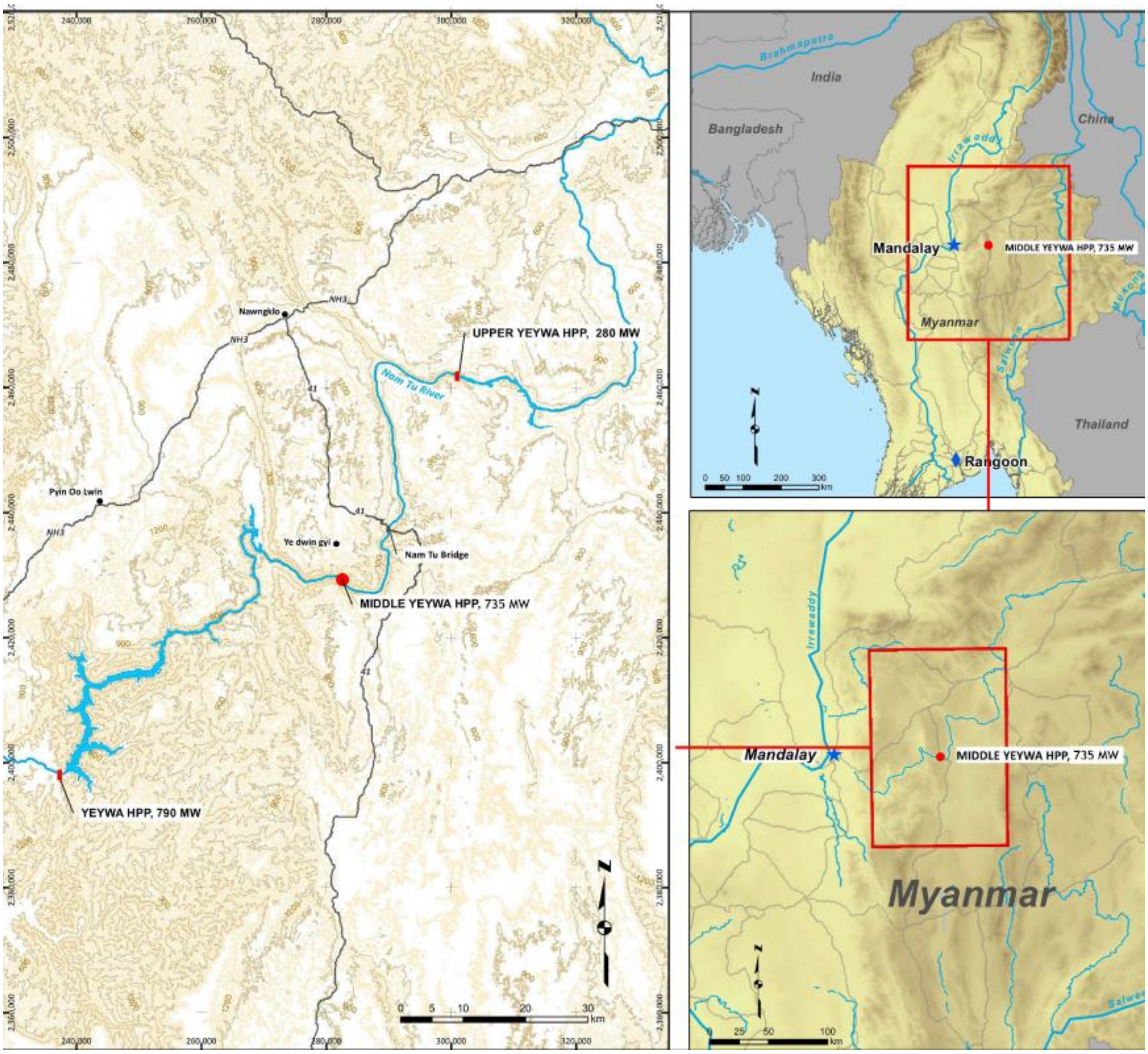


Figure 7-1: Project location (Source:Tractebel-Lahmeyer 2018).

2.2 General Layout and Salient Features

The layout for the Project presented here corresponds to the layout described in the Feasibility Studies Report (Tractebel-Lahmeyer 2018). The project will take advantage of the head available between the existing Yeywa reservoir (185 masl at FSL) and the Upper Yeywa HPP (323 masl. tail-water level), while keeping the constraint to have a 5 m difference between the tailwater of Middle Yeywa and the Full supply level of Yeywa as well as between the Full Supply level of Middle Yeywa and the Tailwater level of Upper Yeywa, during normal operations (
Figure ***7-2***). The Middle Yeywa HPP will have an installed capacity of 735 MW. The tailwater level is designed at 190 masl and the Full supply level at 317 masl.

The general layout of the main components in the dam and powerhouse area is shown in ***Figure 7-3***.

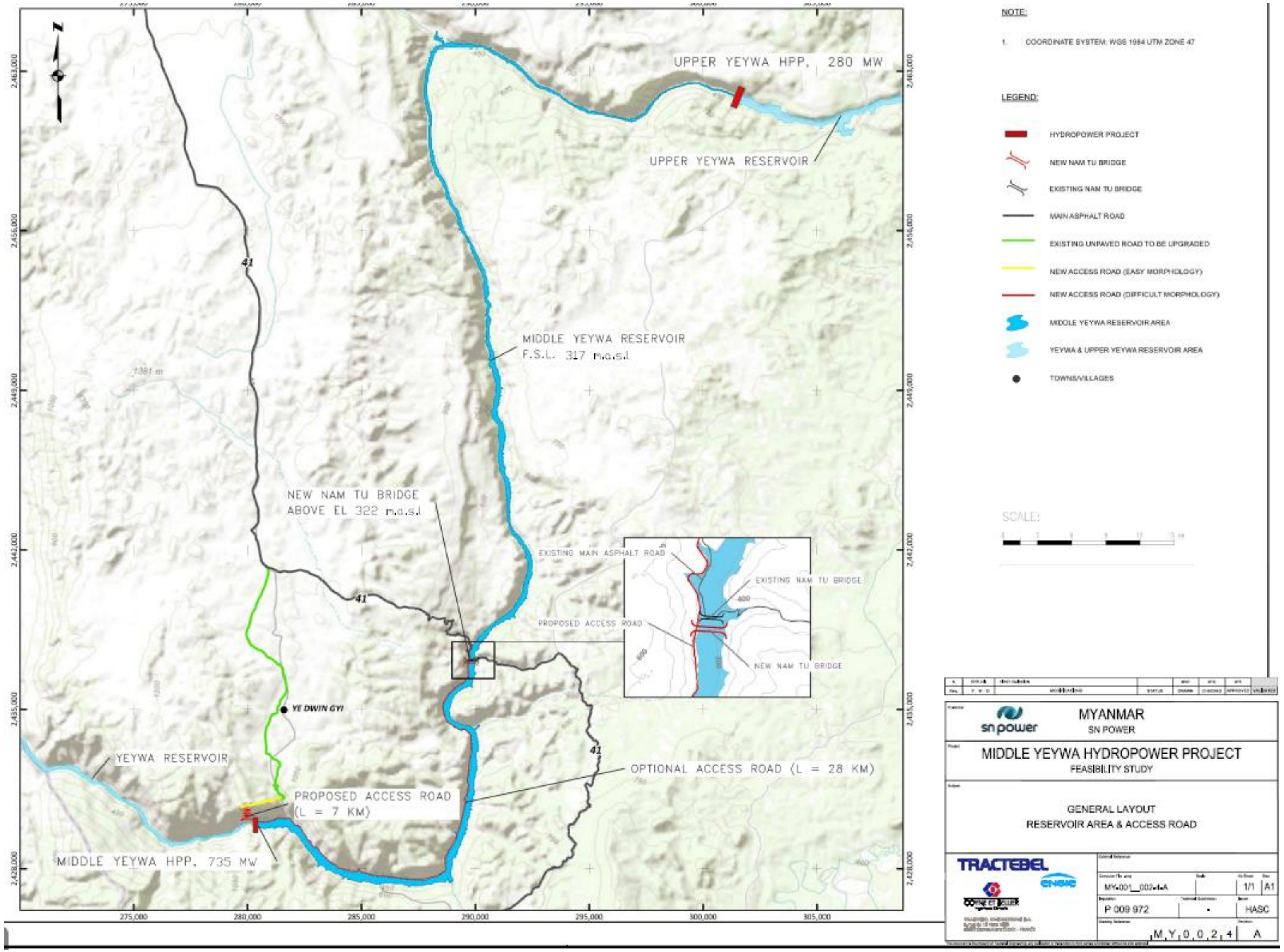


Figure 7-2: Overview of the Middle Yeywa HPP (Source: Tractebel-Lahmeyer 2018).

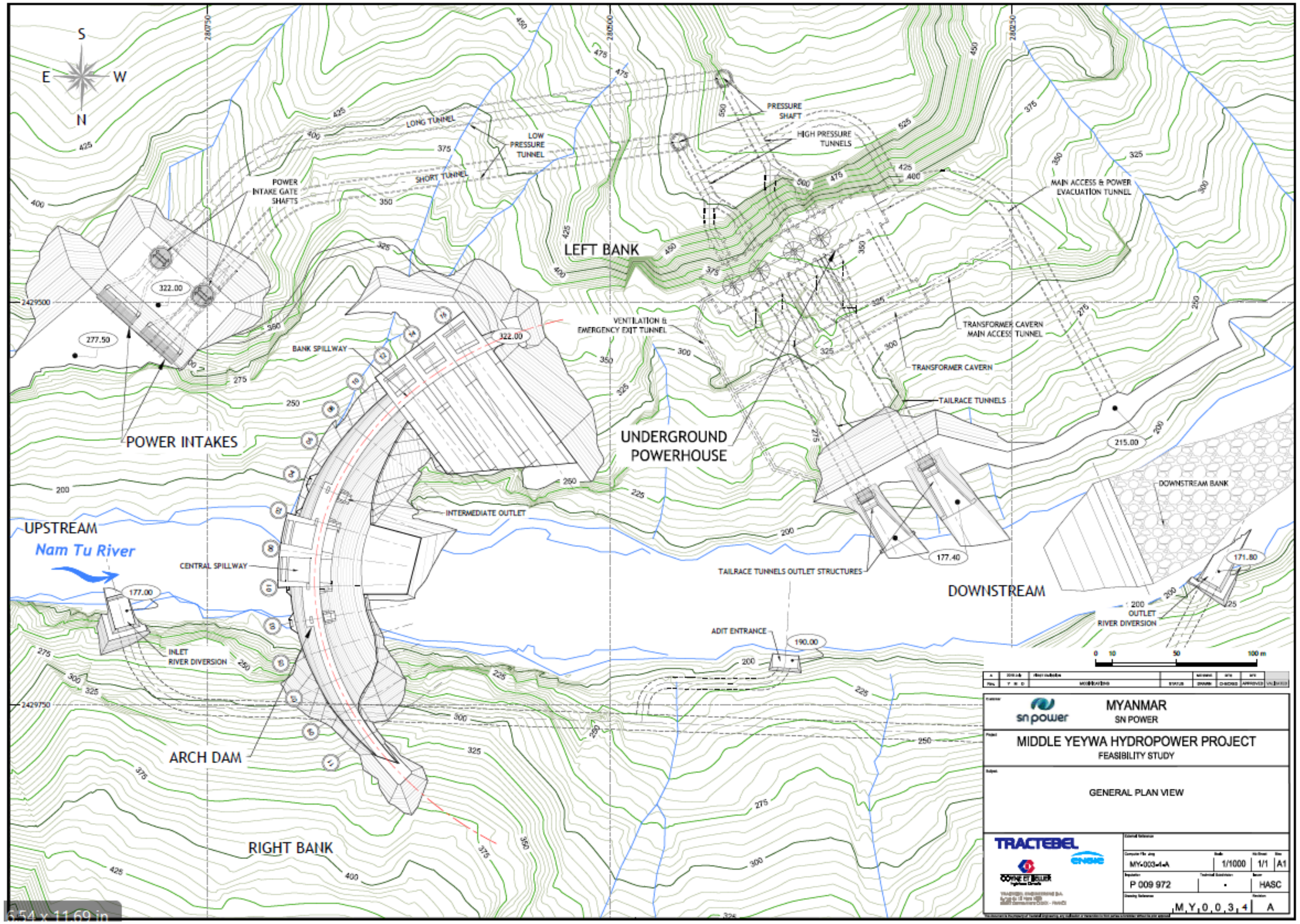


Figure 7-3: General layout of the Middle Yeywa HPP (Source: Tractebel-Lahmeyer 2018).

The dam and powerhouse will be located at the bottom of a series of rapids in the Myitnge River. The narrow river valley at this dam location does not allow the spillway structure and power intake to be constructed side by side on the dam unless large excavation works of one of the abutments is undertaken. The powerhouse will be located underground on the left bank of the river, in-between the main dam and the downstream cofferdam. To take up less space, the downstream cofferdam could possibly be constructed with hard-fill which will provide for a smaller and cheaper structure that than an embankment cofferdam. The upstream cofferdam, possibly to be made of roller-compacted concrete (RCC), may be positioned less than 50 m from the main dam. The diversion tunnel inlet structure will be constructed on the right bank of the river upstream of the cofferdam. The spillway plunge pool will be constructed between the main dam and the downstream cofferdam.

The salient features of the main alternative for the Middle Yeywa HPP are as follows:

- Reservoir FSL: 317 masl.
- Dam type: Arch dam
- Dam height: 160 m
- Spillway: 2 crest and 3 bays
- Powerhouse: 4 units (735 MW)
- Turbine type: Vertical axis Francis
- Powerhouse type: Underground
- Design discharge: 688 m3/s
- Design gross head (at FSL): 128,85 m
- Tail-water level: 190 masl
- Transmission Line: 2 double circuit 230 kV, 190 km
- Mean power production per year: 3,616.5 GWh

2.3 Project Components

2.3.1 Dam Type

The dam site is located at the tail end of (Lower) Yeywa Reservoir in an area with steep slopes. The topography his location is characterised by a V-shaped valley while the geological conditions are favourable with the whole river valley section consisting of consolidated and karst free dolomite rocks.

The chosen dam type is chosen is an arch dam since the valley shape is quite favourable.

The main characteristics and dimensions of the proposed Middle Yeywa arch dam are listed below:

- Dam type: Arch dam
- Maximum height above foundation level: 160 meters
- Crest length: 330 meters
- Width of the dam crest: 6,5 meters
- Width of the dam foundation: 37 meters
- Volume of foundation excavation (rock): 630 000 m3
- Volume of the dam (including bank spillway): 635 000 m3

The proposed dam will support a centrally located crest spillway of two (2) bays and a left bank located spillway with three (3) bays. All the spillway bays are gated and composed of a conventional concrete chute channel ended by a flip bucket. It must be noted that the discharge of the crest and left bank spillway impact the foundation on two separated areas. When the reservoir level is at 319.0 masl the spillway's total discharge with all gates open is about 12,000 m^3/s. An intermediate outlet conduit will be provided to enable the reservoir to be drawn down as may be required, and to pass the sediments in the Myitnge River thereby prolonging the life of the scheme. When the reservoir level is at 319.0 masl (3 meters below crest elevation), the intermediate outlet will be able to discharge about 3.000 m^3/s of water.

Lower level outlets will be constructed to enable the reservoir to be drawn down as may be required, and to pass the sediments in the Myitnge River to prolong the lifespan of the reservoir.

The following flexible sediment management plan is proposed in Middle Yeywa for the time being:

1. In general, close observations of sedimentation related phenomena at the reservoir, sediment sampling as well as a regular reservoir survey is recommended to get an understanding of the sedimentation processes and the propagation of the sediment foreset in the Middle Yeywa reservoir.
2. For the time being, a flushing interval of 4 years is recommended after the first necessity of flushing (the first necessity for flushing to occur in the fifteenth year of operation of Middle Yeywa).
3. In particular after the first flushing the new bed levels at the head of the Middle Yeywa reservoir as well as the change of the rating curve needs to be examined carefully.
4. If the simulated depositions downstream of the Upper Yeywa dam would really occur and effectively lead to a reduction of the available head at Upper Yeywa.
    a. local measures (determined based on the findings gained during the execution of point 1) should be taken, or
    b. a (time-)limited reservoir drawdown needs to be carried out in addition to the flushing itself in order to remobilize the sediments deposited in the upper reach of the reservoir. Since the maximum top elevation of the sediment delta is calculated to be approx. 321.0, a drawdown to MOL in Middle Yeywa - without a discontinuation of power generation - is expected to be sufficient.
5. If the above measures would not help to maintain at least the tailwater elevation at rated discharge at Upper Yeywa, the flushing frequency must be increased, in the worst case up to an annual flushing which has proven satisfactory according to the simulation results.

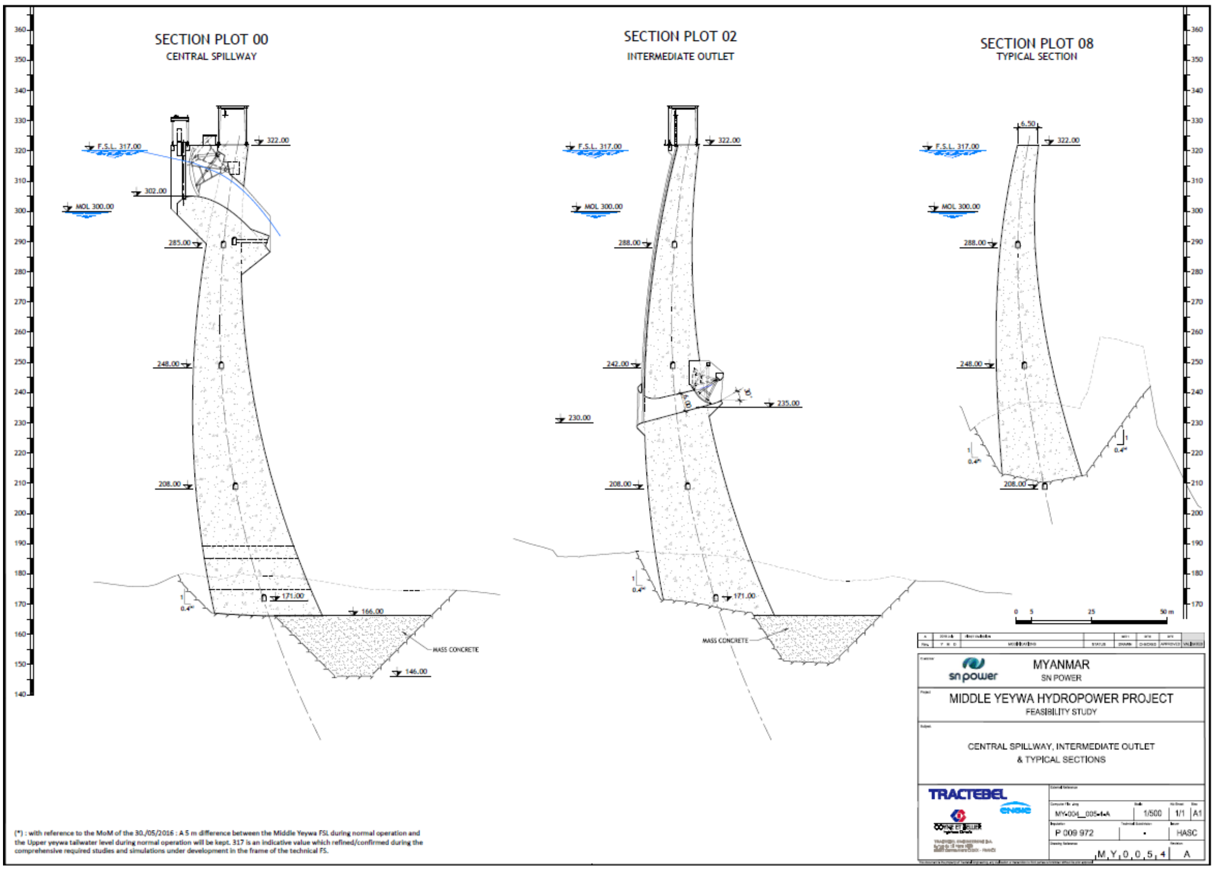


Figure 7-4: Cross-section of dam and spillway (Source:Tractebel-Lahmeyer 2015).

2.3.2 Intake and Power Waterways

There will be two power intakes on the right bank conveying the water through a pressurised twin power tunnel with concrete and steel lined sections designed to control and efficiently pass the reservoir water into the two power tunnels. Both intakes consist of an inclined bellmouths with trashracks leading to a transition section upstream of the gate shafts.

The invert of the power intake is placed at elevation 278.5 masl. for a Minimum Operation Level (MOL) of 300 masl., corresponding to a minimum submergence of 19,5 m. The nominal discharge for the intakes is 2 x 344 m 3 /s. The total trashrack net area for the two intakes is 2 x 405 m 2, giving a net velocity of circa 0.9 m/s. The trash-rack is supported by intermediate cross beams made of reinforced concrete. A 100 m long twin tailrace tunnel will lead the water from the powerhouse and into Lower Yeywa reservoir.

Because of the relatively low head of the Middle Yeywa power plant (maximum gross head of 128,85 m) and the short distance between the intake structure and the powerhouse, expensive and technically challenging surge chambers will not be required if reasonable limitations are imposed on the start-up and shut-down times of the turbines.

2.3.3 Powerhouse

The Feasibility study has confirmed that, due to the morphology of the dam site with a narrow gorge, construction of underground powerhouse is technically and economically preferred solution. The construction of the outdoor powerhouse would require massive excavation.

During the feasibility study the necessary geotechnical investigations (core drillings) could not be performed, since Consultant had limited access to the project site. However, based on the available geology it is assumed that the rock conditions are suitable for the construction of the underground powerhouse. This solution also allows works to progress at the power plant independently to any river diversion requirements, need of high cofferdam along the banks and dam construction.

The powerhouse complex will consist of a power cavern and a transformer cavern, as well as the required bus duct and access tunnels. The transformer cavern will be located approximately 40 m downstream of the power cavern and the two caverns are connected by two bus duct tunnels and one connection tunnel.

The power cavern will consist of the machine hall with machine blocks, an erection bay, a control room and rooms for the electro-mechanical auxiliaries. The transformer cavern contains the three phase step-up transformers and the GIS switchgear. The power cavern will be 105.9 m long, 31.8 m wide and 51.8 m high while the transformer cavern will measure 87.3 m x 17,2 m x 22.6 m.

The main access tunnel will cross the transformer cavern and enter the erection bay of the power cavern directly at the level of the machine hall floor. It will be 10 m high and 16 m wide and have a length of 220 m. The power evacuation route will be separated from the access section by reinforced concrete.

2.3.4 Reservoir

The building of the dam will establish a 70 km long and narrow reservoir that will be around 135-140 m deep immediately upstream of the dam. Over the 70 km towards the Upper Yeywa dam, the reservoir becomes gradually shallower with only a few metres depth at the upper end. The total area impounded by the reservoir will be around 11 km^2. Its long and narrow shape and limited depths will limit the residence time of the reservoir water and in that way reduce the risk for serious water quality issues after commissioning of the Project.

The geological investigations that have been carried out so far indicate that the risk for leakages through karstic formations is limited but further investigations are needed to confirm this assumption.

According to the Pre-Feasibility Study Consultant (Pöyry), the sediment load in the river flow is ranging between 200 to 400 m^3/year/km^2. Using the latest data from the Upper Yeywa HPP and using the highest sediment load figure, the life expectancy has been estimated to more than 50 years with the worst assumption of 0% trap efficiency at Upper Yeywa and 0% efficiency of the desilting facilities at the Middle Yeywa dam.

2.3.5 Roads

Access from Mandalay to the dam site is by National Highway No. 3 to Nawnghkio and from there continuing south on Road No. 41 down to Yae Twin Gyi village. The last section of Road No. 41 is unpaved with improvement works ongoing. From Yae Twin Gyi village to the dam site there is a village track that leads onto a footpath.

To reach the project site, the existing unpaved roads and village tracks/footpaths will be upgraded and a new road of around 3.8 km length will be built down the escarpment to the dam. A bridge will have to be built across the river downstream of the dam to access the dam and ancillary structure locations on the left bank. Due to the morphology on the left bank, it is foreseen that this bridge will also be used during operation with a deck at a higher elevation than the PMF level downstream the dam (206.6 masl.). A network of temporary access roads will also have to be constructed on both sides of the valley to provide good access to the construction sites, stockpile and spoil areas, site installations, etc.

The main design criteria for the access road design will be as follows:

- Overall width: 7.5 m to 9.0 m
- Carriageway width: 5.5 m to 7.0 m
- Maximum vertical gradient: 12 %
- Minimum horizontal radius: 30 m

The Middle Yeywa reservoir at FSL 317 masl will submerge the Myitnge Bridge which therefore has to be replaced. The new bridge will be 320 m long and will be constructed immediately downstream of the existing bridge. The main road will be realigned accordingly.

2.3.6 Auxiliary Components

The project will require housing facilities for workers and plant operators, storage areas for construction materials (including spoil tips) and equipment, crushing and batching plant(s), quarry, borrow pits, etc. However, at the present stage of project design, the exact locations of these components have not yet been determined. For the purpose of this ESIA study, it is assumed that all auxiliary components will be sited in the immediate vicinity of the dam/powerhouse and the access road on top of the plateau in the vicinity of Yae Twin Gyi village.

2.3.7 Associated Facilities

Before making a final decision on the connection point for Middle Yeywa a grid analysis will have be carried out. Nevertheless, it has been agreed with MOEE to use Miektila substation as connection point for the purpose of preparing a complete study and cost estimate for Middle Yeywa HPP. Two bays of Miektila substation will be equipped to accommodate the 2 incoming 230 kV transmission lines from the plant.

It should be noted that separate EIA reports will be prepared for the transmission line corridor, the quarries and the Myitnge Bridge.

2.4 Construction Schedule

2.4.1 Time Requirements

The construction work components which will determine the overall construction schedule are:

- Site access roads.
- Location and construction of the site facilities, contractor camp and yard,
- Batching plant and aggregate & cement stockpile.
- Diversion tunnel and cofferdams.
- Construction of the arch dam in different sections (river bed, spillway and abutment sections).
- Construction of the power caverns and the installation of the turbines and generators.

Before the main construction activities can commence, a number of pre-construction activities will have to be carried out, including construction of the access roads and preparation of the areas for other project infrastructure such as camps, workshops and batching plant. It is expected that the pre-construction works will take around one to one and a half year to complete and that they will be tendered as one separate Advance Contract. A new bridge will also have to be constructed across the Myitnge River before the filling of the reservoir.

The main construction works, which is expected to be awarded under one main contract, will then commence and continue for around five years. The total construction time for the Middle Yeywa Project, including the preparatory works, will consequently be six years.

The Feasibility Consultant has estimated the construction time requirements for the different woks as shown in the table below.

Table 7-1: Principal construction quantities and time requirements (Source: Feasibility Study Report, Tractebel-Lahmeyer 2018)

Activity	Quantity	Time (months)	Production Rate
Advance contract			
Access roads	7 km	9.0	25 m/d
Main contract			
Excavation of river diversion and temporary adit	750 + 100	3.0*	5.0 m/d
Concrete lining in diversion tunnel	750 m	3.0*	5.0 m/d
Excavation for dam foundation on abutments (including LB spillway)	530,000	5.9	3,000 m 3 /d
Excavation for dam foundation in river bed area	100,000	6.5	2,000 m 3 /d****
Production and placing of concrete in the main dam, including galleries, u/s and d/s facing, etc.	500,000	17.0	1,000m 3 /d**
Placing of central spillway concrete (crest, chute and ski-jump, piers & walls)	28,000	1.9	500 m 3 /d**
Placing of left bank spillway concrete (crest, chute and ski-jump, piers & walls)	80,000	5.3	500 m 3 /d**
Excavation of tunnels (on average)	1,625 m	11.0	5.0 m/d
Excavation of pressure shafts	160 m	1.5	2.0 m/ day
Concrete lining	1,625 m	11.0	5.0 m/d
Steel lining to pressure shaft	160 m	1.8	3.0 m/day
Excavation of power and transformer caverns	181,000	12.0	500 m 3 /d
Placing of structural concrete in power caverns	36,500	12.0	100 m 3 /d

* There are at least two excavation faces, and two starting points for the concrete lining.
** Average placement rate.
*** This volume is tentative since it mainly depends on the acceptable dam foundation level which will not be known before the completion of the site investigations.
**** Average rate including excavation in the river pit as well as at low elevation in the banks.

2.4.2 Preparatory Works

The most critical aspect of the preparatory works will be the construction of the access road to the project site, which will enable start-up of the main project components such as the dam and the diversion tunnel. The construction of the access road is estimated to take 9 months. Prior to the commencement of concrete works, a quarry will have to be established in order to provide for concrete aggregates. An aggregate crushing and screening plant, together with a concrete batching plant, would also need to be installed. Finally, camps and storage areas will have to be sited and constructed.

2.4.3 Diversion Works

The critical activities prior to the commencement of the diversion tunnel works are completion of the main access road to the Project location, and the site access road to the tunnel (and adit) portals (Advance Contract). Access to the inlet portal could be from the main access road above, or along the river from the outlet structure.

The diversion tunnel will be excavated from a temporary adit located about the flood level to enable the diversion tunnel to be excavated on 2 faces (from the adit intersection with the diversion tunnel alignment towards downstream, and from the inlet structure towards downstream to the adit intersection).

The construction programme currently considers tunnel excavation and concrete lining from these two faces.

It is noted that prior to the commencement of any concrete works, a quarry would need to be opened (together with a quarry access road) to provide concrete aggregates. An aggregate crushing and screening plant, together with a concrete batching plant, would also need to be installed (in addition to camps and storage areas, etc.).

2.4.4 Dam Excavation and Construction

During the first rainy season, the dam abutment excavations will proceed down to the elevation of the predicted maximum flood level in the river (El 190.0 masl). It will not be possible to go below this elevation without working in water. Accordingly, a large volume of material will still require removal in the “river bed” area following river diversion (which will take place at the commencement of the second dry season).

The arch dam concrete placement will require 2 years. In this regard, it is noted that when the river passes through the site (as well as the diversion tunnel) during the second rainy season (after the main contract award), the dam foundation excavation will be complete. Accordingly, levelling concrete and the initial placement of arch dam concrete will take place at the end of the preceding dry season to provide protection to the excavated surface. Concrete will be placed in the riverbed, and across the full width of the valley, up to El. 190 masl. Temporary openings will be left in the arch dam bottom during the whole construction period to allow water passing during the whole rainy season (in addition to the diversion tunnel).

Arch dam concrete can be placed during wet season: an average production rate of 1 000 m3 / day has been considered.

The time-consuming installation of the spillway/outlet structures are on the critical path for the dam.

Accordingly, concrete placement will focus on bottom outlet blocks, from El. 190 masl to El 250 masl, which is the elevation of the bottom outlet construction.

When El 250 masl has been reached, concrete placement will move to the right and left abutment sections. These activities will run in parallel with the installation of the steel liner and conventional concrete of the outlet structures. The construction time of the four bottom outlets is estimated to 6 months.

As soon as the outlet structures are completed, concrete placement will continue above, within the central spillway blocks. Once the central spillway elevation is reached, structural concrete and equipment installation will start: the construction time of the central spillway is estimated to be 5 months.

Then the left bank spillway will be completed: construction time is estimated to be 9 months.

2.4.5 Powerhouse and Underground Works

The underground works include the following components/ activities:

- Power intake structure and intake shaft excavation and concreting.
- Low pressure tunnel excavation and concrete lining (2 nr).
- Pressure shaft excavation and lining (2 nr).
- Pressure tunnel excavation and concrete lining (2 nr).
- Power cavern excavation and concreting.
- Transformer cavern excavation and concreting.
- Excavation and concrete lining of two bus duct tunnels and an access tunnel between the power cavern and the transformer cavern.
- Power cavern main access tunnel and emergency exit/ ventilation tunnel excavation and concrete lining.
- Bypass tunnel from the main access tunnel to the high-pressure tunnel location.
- Tailrace tunnel excavation and concrete lining (2 nr).
- Tailrace tunnel outlet structure excavation and concreting.

The power cavern activities are on the project's critical path and delays in the execution will impact the total project construction.

2.4.6 Summary of Construction Schedule and Programme

The whole construction phase from construction of the site access road and the new bridge across Myitnge River through to commercial operation of the Middle Yeywa is expected to be around 6 years (see 2.4.1).

It is expected that the following main sequences of activities will be on the critical path in the construction programme, including:

- Construction of the site access road;
- Completion on time of the diversion tunnel;
- Completion of the dam excavation in the river bed during a single dry season;
- Commencement of concrete placement at the end of the second dry season (March in Year 2 of main contract),
- Concreting of the spillway crest and the installation of the gates;
- Underground works for the power caverns, including installation and testing of electro-mechanical equipment.

It needs to be noted that prior to the start-up of construction activities, the environmental assessment and permitting phase must have been successfully concluded. This will include the following the following steps and milestones:

1. Submission and approval by the Ministry of Natural Resources and Environmental Conservation of the EIA Report, including environmental and social management plans;
2. Issuance of a Environmental Compliance Certificate (ECC) by the Ministry;
3. Asset survey of land areas and building infrastructure affected by project components such as access roads and camps based on technical detailed plans and siting, and with identification of all persons/households that will be entitled to compensation;
4. Calculation of compensation amounts and acceptance of the offered compensation by the project affected persons households;
5. Transfer of awarded compensation to all entitled persons/households.

In the figure below, the timing of the EIA schedules, including Environmental and Social Management Programmes, in relation to the construction schedule, is illustrated.

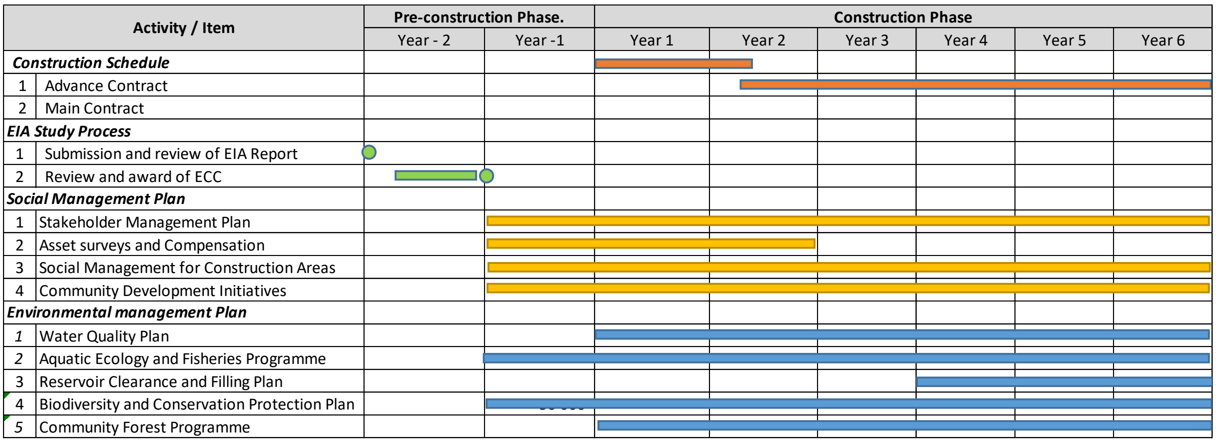


Figure 7-5: Timing of EIA Process and Mitigation Programme activities in relation to construction schedule

2.5 Construction Materials

The dolomite constitutes by far the predominant rock in the surroundings of the dam sites. The dominant facies are massive to bedded, but with bed joints relatively tight. The brecciated facies are quite frequent, but the rock is still well cemented and hard.

The most favourable setting for quarry should correspond to one of the numerous cliffs, which indicate already good strength characteristics. Rocks from excavations and much of the thick, blocky colluvium, could be also used.

As far as the strength is concerned, these rocks are expected to perform conveniently for their use as concrete aggregates. The durability tests and, especially, the alkali-reactivity shall be dully verified with the adequate tests.

At this stage, the construction materials are not considered as a discriminating criterion in the process of dam site selection.

2.6 Manpower Requirements

At this stage of planning, the number of workers that will be necessary for construction of the Middle Yeywa HPP has not been estimated. However, experience from other hydropower projects of a similar size and nature in the region indicate that the number of workers may reach more than 1,000 people during the peak of Construction Phase. According to the Construction Schedule, the construction activities may reach a peak in the second and third year of the 6-year construction phase.

2.7 Power Plant Operation

The reservoir operation is generally determined according to energy purchase price policies by the off-taker together with the energy tariff structure defined in the Power Purchase Agreement (PPA). However, it is assumed that the PPA to be negotiated by SN Power will be based on a fixed tariff. The simulation results show that Middle Yeywa HPP should be operated as a run-of-river plant as close as possible to FSL with daily peaking to achieve the highest revenues since head losses due to reservoir drawdown are minimised by this mode of operation.

2.8 Project Costs

The Feasibility Consultant has made a cost estimate based on the quantities and unit rates for the main cost items.

The total direct costs excluding contingencies for the current project layout has been estimated at 705 million USD with the electro-mechanical works and equipment, including the switchyard, being the largest cost component amounting to around 188 million USD. The second most expensive project component is the dam and spillway with around 159 million USD.

In addition to the direct costs, there will be indirect costs for the following items and services:

- Technical Management Services;
- Client Administration and Project Management;
- Owner's Engineering and Site Supervision;
- Detailed Design Engineering;
- Lender's Engineer and Project Insurance;
- Land Acquisition and EIA Mitigation Costs.

2.9 Project Alternatives

2.9.1 Powerhouse location study

As a part of the technical Feasibility study, a preliminary comparison analysis for the choice of powerhouse type, i.e. in cavern in the bank or open air in dam toe, based on preliminary costs estimation and technical considerations was carried out.

As a result of this study, an underground powerhouse appears to be the most suitable option, provided that the geological conditions are favourable. Those conditions shall be checked by relevant geotechnical investigations carried out, at the future powerhouse location.

2.9.2 Grid connection point

The final connection point, and hence the transmission line corridor, will be decided at a later stage based on:

- Grid analysis to confirm capacity and flow in the grid;
- Land acquisition;
- Total costs.

3 APPROACH AND METHODOLOGY

3.1 Impact Zones and Study Area

The study area has been defined based on a preliminary analysis of the direct (primary) and indirect (secondary) impacts of the proposed project. Accordingly, it has been divided into a direct impact zone and an indirect impact zone. These zones constitute the project's area of influence where risks and impacts will be further analysed.

The *direct impact zone* covers all areas that will be physically affected by the construction and operation of the Middle Yeywa hydropower plant. It includes the following areas as well as an approximately 200 m buffer zone surrounding each project component:

- *Middle Yeywa reservoir*, i.e. the area that will be inundated by the Middle Yeywa dam up to the full supply level (FSL)
- *Infrastructure footprint*, including the Middle Yeywa dam (and coffer dams during construction phase), the power station and its ancillary structures, all access roads, boat landings, construction camps, office buildings, housing camps, etc.
- *Bypassed river reaches,* i.e. the river environment between the dam/intake and the outlet from the power station
- *Downstream river reaches between the power station outlet and the existing Yeywa reservoir,* which will be subject to modifications and flow alterations due to hydropower peaking
- *Extraction sites for construction materials*, such as quarries and borrow pits
- *Spoil disposal areas*
- *Off-site areas* required for resettlement or compensatory measures (e.g. tree planting, conservation areas)

It should be noted that, at the current stage of project development, the exact delineation of the direct impact zone beyond the dam and reservoir area is not known due to the preliminary nature of the project design. In particular, the siting of camps, quarries, spoil disposal areas and possible compensation areas will not be determined until the completion of the feasibility study or even at later stage (detailed design).

The *indirect impact zone* consists of an area beyond the direct impact zone where the construction and operation of the power plant may indirectly affect the physical, biological and human environment through, among others, changes in water quality characteristics, air pollution levels (in the "airshed"), long-distance wildlife and fish migrations, and livelihoods and cultural behaviour of neighbouring communities. This zone should be defined such that unplanned developments induced by the project can also be captured (e.g. spontaneous settlement and land use change). The exact size of this zone depends on the themes being studied but is generally assumed to include the south-eastern part of Nawnghkio Township, the southern part of Kyaukme Township and the north-western part of Lawksawk Township. The map presented in ( ) shows the project area and the identified impact zones.

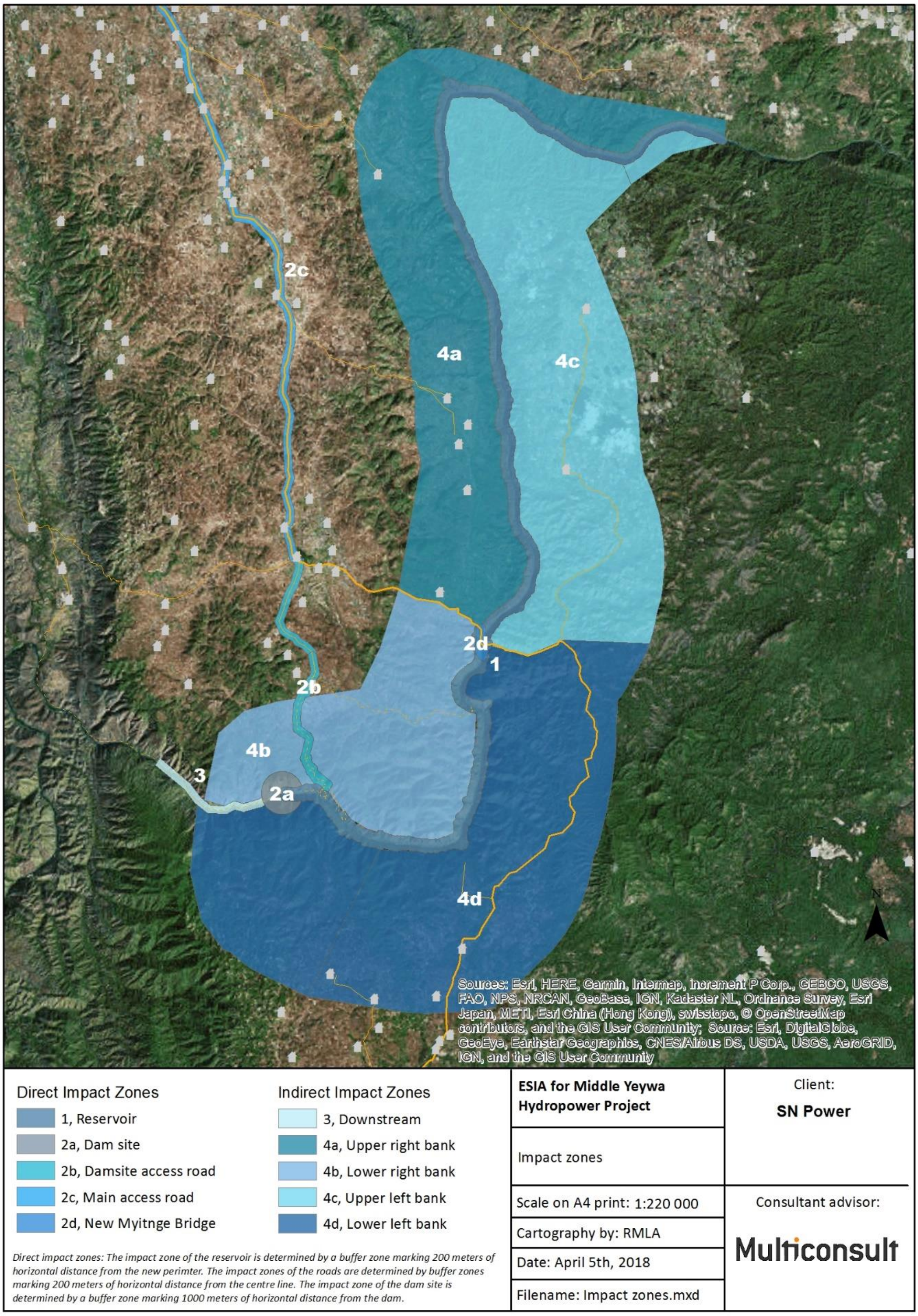


Figure 7-6: Map of Middle Yeywa HPP Impact Zones

3.2 General Approach

This EIA employs a standardised three-step approach to impact assessment in order to make the findings, conclusions and recommendations more objective and transparent. The key principle of the procedure is to combine the ‘value’ of the affected environment and the ‘magnitude’ of impacts to arrive at an overall assessment of impact.

- Step 1 attempts to attach a 'value', as judged from the baseline situation, for that specific issue or theme within the project area, giving a ranking on a scale from “low” to “high”. The setting of value is based on the absolute value, if applicable, and its value in the local, regional, national and international perspective. It also takes into account uniqueness and vulnerability.
- Step 2 consists of a description and an identification of the 'magnitude' of the potential impacts on that specific issue or theme. The magnitude is considered in terms of the extent (local, regional, national, international), duration, severity/intensity, reversibility, and probability/risk of the different impact sources. The magnitude is measures on a scale from ”large positive” to ”large negative” (see ***Table 7-2***).
- Step 3 combines the results from the two first steps based on the criteria illustrated in Figure 7-7. The outcome of this exercise is the final 'impact assessment' and results in a ranking of the impacts on a scale from “very large positive” to “very large negative”. In the summary tables, this ranking is illustrated by ”plusses” and ”minuses”. Uncertainty will be indicated with the symbol **?,** and no impact or irrelevant is marked with a **0**.

Table 7-2: Definitions of Different Levels of Impact Magnitude.

Impact		**Definition**
None or Minimal		No detectable change to the environment.
Positive and Negative	Low	A small but detectable and permanent change to the environment; or A larger short-term / temporary change to the environment.
	Medium	A larger, but non-fundamental permanent change to the environment; or A short-term / temporary large change to the environment.
	Large	A fundamental change to the environment.

Note: Fundamental changes are those which are permanent, detrimental and would result in widespread change to the baseline environment.

The three steps are reported in Chapters 6 and 7 (Baseline conditions) and Chapter 8 (Impact assessment):

- Baseline situation: The value is derived from an assessment of the existing environment (physical, biological and human) at the inception of the construction works. Given the nature of the proposed works and the likely short lead time, the baseline can be considered as the current environmental and social conditions. For themes that cannot easily be valued, such as parts of the physical environment (e.g. geology and soils) and the human environment (e.g. population, livelihoods and economic activities), the value is by default assumed to be high.
- Assessment of impacts: Based on available knowledge of hydropower projects in general and the proposed project in particular, potential impacts can be predicted for each theme under the physical, biological and human environment. Following the identification and description of each of these impacts, the magnitude of the impacts on each theme is determined (see ***Figure 7-7***). The final impact assessment is then summarised at the end of the chapter by combining the baseline value and the impact magnitude, as described above.

The assessment of impacts in Chapter 8 also includes the relevant mitigation measures, i.e. all actions that can eliminate, offset, or reduce potentially adverse environmental and social impacts to acceptable levels. The net impact remaining with mitigation measures in place is referred to as “residual impact”.

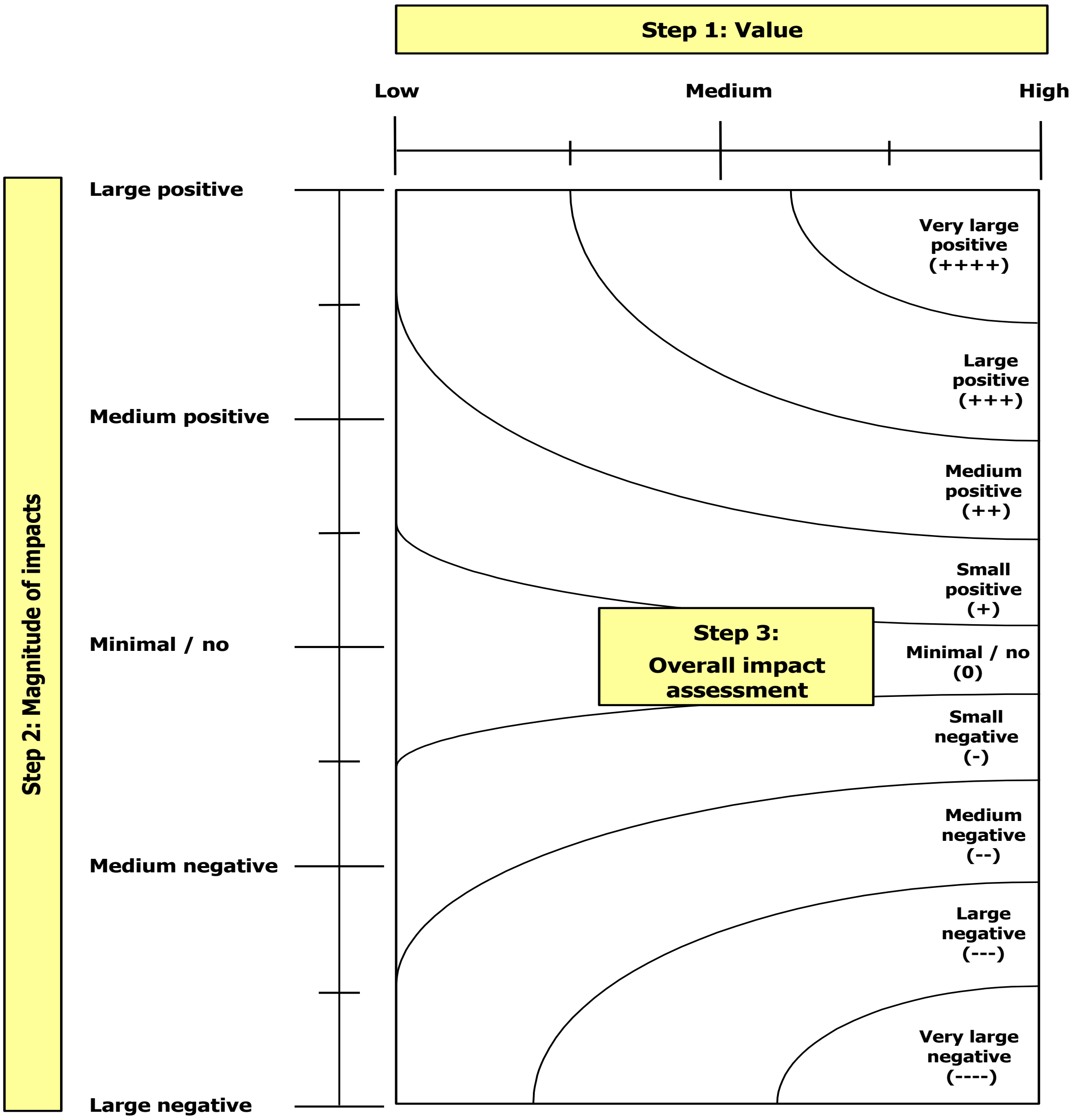


Figure 7-7: Impact Assessment Methodology.

3.3 Limitation and Data Quality

3.3.1 Limitations

The methodology for data collection and analysis is described in the respective sections and appendices. Limitations at the current stage of project planning are the lack of a detailed project description (technical feasibility studies are still at an early stage) and some gaps in the baseline data, first and foremost regarding the aquatic biodiversity. It is recommended that further studies of this environmental component is carried out.

Other limitations include:

- Some of the baseline data have been collected and analysed by other consultants than the current EIA consultant;
- Some groups residing in the wider project area may be sub-optimally represented in the socio-economic survey that was more focused on the villages located nearest to the reservoir and the dam site area.

3.3.2 Data Quality

The data quality for each of the main topics is evaluated in ***Table 7-3***. Further collection and studies will improve the data quality for a number of environmental and social components, most notably with respect to aquatic ecosystems and physical and economic displacement.

Table 7-3: Data Quality for Baseline Valuation.

Issue	Baseline Value
Environmental Baseline/Impacts	
Topography and landscape	High
Geology and soils	Medium-High
Climate	Medium
Air quality	Low
Noise	Low
Hydrology	Medium-High
Water quality	Medium
Protected areas	High
Vegetation	Medium-High
Terrestrial fauna	Medium
Aquatic ecosystems	Low
Social Baseline/Impacts	
Land use and land tenure	High
Natural resource use (river and forest resources)	Medium
Livelihoods and household income level	High
Vulnerable groups	Medium
Literacy and education status	Medium
Public infrastructure and services	Medium
Physical displacement	Low
Economic displacement	Low

4 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

4.1 Review of Existing Legislation on Hydropower in Myanmar

A number of laws, regulations and policies govern the power sector and hydropower development in Myanmar. In the following sections, these laws and regulations are briefly described, including laws and regulations that govern land acquisition, environmental conservation and the environmental assessment processes in Myanmar. Some of this legislation is relatively new and there may still be some lack of experience with the implementation and interpretation of the new laws.

4.1.1 Laws and Regulations

Myanmar Constitution (2008)

Sections of the Constitution that are especially relevant for hydropower development include:

- Section 37(a): The Union is the ultimate owner of all lands and all natural resources above and below the ground, above and beneath the water and in the atmosphere in the Union;
- Section 45 : The Union shall protect and conserve natural environment;
- Section 356: The Union shall protect according to law movable and immovable properties of every citizen that are lawfully acquired;
- Section 365: Every citizen shall, in accord with the law, have the right to freely develop literature, culture, arts, customs and traditions they cherish. In the process, they shall avoid any act detrimental to national solidarity. Moreover, any particular action which might adversely affect the interests of one or several other national races shall be taken only after coordinating with and obtaining the settlement of those affected;
- Section 371: The Union may assist the access to technology, investment, machinery, raw material, so forth, for national economic development.

Myanmar Electricity Law of 2014

The Myanmar Electricity Law of 2014 repeals the previous Electricity Law of 1984 and provides the legal basis for the establishment of the Electricity Regulatory Commission. The Commission is tasked with creating an environment conducive to investment in the power sector, and for overseeing compliance with electric power rules. The Electricity Law also authorises the Ministry of Electricity and Energy, region and state governments, and leading bodies of self-administrated zones and self-administrated divisions, to grant permits to entities to engage in electricity-related works such as generation, transmission, and distribution, thereby encouraging foreign and domestic investments in power projects.

The Electricity Law will be one of the key laws for SN Powers to consider as it is provides the legal basis for granting permits for development of energy projects.

Environmental Conservation Law (2012)

The Environmental Conservation Law has eight objectives, including:

- To provide the legal basis for implementation of the Myanmar National Environmental Policy;
- To provide the basic principles for systematic integration of environmental conservation considerations in the sustainable development process;
- To promote a healthy and clean environment and conserving natural and cultural heritage for the benefit of current and future generations;
- To reclaim ecosystems that have started to degenerate and disappear as far as possible;
- To reduce losses and promote sustainable use and management of natural resources;
- To promote public awareness and environmental education programmes;
- To promote international, regional and bilateral cooperation on environmental conservation;
- To promote cooperation among government departments, government organizations, international organizations, non-government organizations and individuals in matters of environmental conservation.

The Environmental Conservation Law enables the Union Government to form an Environment Conservation Committee with the Union Minister of President Office Ministry as Chairman (Chapter 3 paragraph 4). The other members are not specified, but it is stated that a Vice Chairman, Secretary and Joint Secretary shall be nominated among the members. The Committee is charged with promoting environmental conservation education, and guiding other government departments and agencies on conservation issues.

The Law further specifies the tasks and duties of the Ministry assigned by the Union Government to be responsible for environmental matters (Ministry of Natural Resources and Environmental Conservation). The most important tasks listed include:

- Implementing the environmental conservation policies;
- Preparation of national and regional plans for environmental management;
- Establishing monitoring programmes for the conservation and enhancement of the environment;
- Preparing and stipulating environmental quality standards (e.g. noise, water quality, solid waste);
- Give guidance related to mitigation and adaptation of climate change;
- Specifying categories and classes of hazardous wastes and prepare rules for safe management, treatment and storage;
- Promoting and carrying out the establishment of necessary factories and stations for the treatment of solid wastes, effluents and emissions which contain toxic and hazardous substances;
- Setting terms and conditions for discharge permits for effluents and air emissions for companies and factories;
- Implementation of the international, regional and bilateral agreements accepted by Myanmar for environmental conservation and enhancement of environmental quality;
- Preparation and implementation of a system of environmental impact assessment and social impact assessment for projects that may cause a significant impact on the environment to be undertaken by companies/persons and government organisations;
- Prepare guidelines for the management, conservation and enhancement of environment with respect to protection of ozone layer, conservation of biological diversity, conservation of coastal environment, mitigation and adaptation of global warming and climate change, combating desertification and management of non-depleting substances and management of other environmental matters.

Chapter 9 of the Law requires government departments and organisations to conserve and manage natural resources sustainably while in paragraph 19 it is stated that the Ministry (MONREC) shall be responsible for protecting and conserving cultural and natural heritage sites and cultural monuments in cooperation with other government departments and organisations.

The Environmental Conservation Law also establishes an Environmental Management Fund for implementation of conservation projects and programmes.

The Environmental Conservation Law requires sustainable development and systematic integration of environmental conservation considerations in project developments and is as such relevant for the Middle Yeywa HPP

Environmental Conservation Rules (2014)

The Environmental Conservation Rules provide more detailed descriptions of the duties and powers of the Environment Conservation Committee and the Ministry of Natural Resources and Environmental Conservation with regard to environmental conservation. Duties and functions of the departments under the Ministry are specified with the most important tasks being:

- Carrying out research and data collection regarding conservation and enhancement of the environment, as well as conducting training programs;
- Drawing up of plans for mitigation of climate change and climate adaptation;
- Dissemination of environmental information for raising environmental awareness;
- Promotion of environmental conservation education in schools and among the public;
- Environmental permitting and issuing of licenses for government organisation and businesses that operate factories and projects that has an impact on environmental quality;
- Regulating hazardous substances which can damage the environment and are restricted or prohibited by international agreements and local existing laws;
- Implementation of an Environmental Impact Assessment system;
- Preparation of environmental situation reports for the regions and for the country.

EIA Procedure (2015)

The Environmental Impact Assessment Procedure was adopted in December 2015 by the Ministry of Environmental Conservation and Forestry (superseded by the Ministry of Natural Resources and Environmental Conservation from April 2016). The procedure provides the practical framework for carrying out environmental assessment of projects that require an approval/licence or are regulated by any part of the Union Government of Myanmar.

Projects are divided into three categories according to their potential for causing adverse impacts to the natural or human environment:

- EIA Type Project (high risk of significant and adverse impacts)
- Initial Environmental Examination (IEE) Type Project (impacts that are local and temporary and can be mitigated)
- Projects that requires neither IEE nor EIA

Annex 1 of the EIA Procedure, *Categorization of Economic Activities for Assessment Purposes,* identifies hydropower projects with installed capacity from 15 MW and upwards or with a reservoir volume and reservoir area above 20 million m^3 and 400 ha (4 km^2) respectively, as EIA type of projects. The Middle Yeywa HPP qualifies as an EIA Type Project according to all these three criteria.

Chapter II of the EIA Procedure initially refers to the relevant sections and articles of the Environmental Conservation Law and the Environmental Conservation Rules and states in Article 3 that: *Pursuant to Section 21 of the Law and Articles 52, 53 and 55 of the Rules, all Projects and Project expansions undertaken by any ministry, government department, organization, corporation, board, development committee and organization, local government or authority, company, cooperative, institution, enterprise, firm, partnership or individual (and/or all Projects, field sites, factories and businesses including expansions of such Projects, field sites, factories and businesses identified by the Ministry, which may cause impact on environmental quality and are required to obtain Prior Permission in accordance with Section 21 of the Law, and Article 62 of the Rules) having the potential to cause Adverse Impacts, are required to undertake IEE or EIA or to develop an EMP, and to obtain an ECC in accordance with this Procedure.*

Most importantly, Article 7 requires project proponents to adhere to certain standards and practices if the project involves involuntary resettlement and indigenous peoples by stating that: *Projects that involve Involuntary Resettlement or which may potentially have an Adverse Impact on Indigenous People shall comply with specific procedures separately issued by the responsible ministries. Prior to the issuance of any such specific procedures, all such Projects shall adhere to international good practice (as accepted by international financial institutions including the World Bank Group and Asian Development Bank) on Involuntary Resettlement and Indigenous Peoples*.

Article 13 requires the project proponent to undertake an appropriate public consultation process and to disclose publically all relevant project-related information.

Chapter V describes and sets out the requirements for the EIA process, including the Scoping and the EIA Investigation phases. The project proponent is required to disclose information about the project and to hold public consultations during both phases (Articles 50 and 61).

Articles 55 to 61 describe the requirements for the EIA Investigation including baseline data collection (Article 57) and analysis of alternatives (Article 58). Most importantly, Article 60 requires that the EIA *investigations consider the views, concerns, and perceptions of stakeholders, communities and individuals that could be affected by the Project or who otherwise have an interest in the Project, and furthermore that the EIA shall include the results of consultations with the public, affected populations and other stakeholders on the environmental and social issues.*

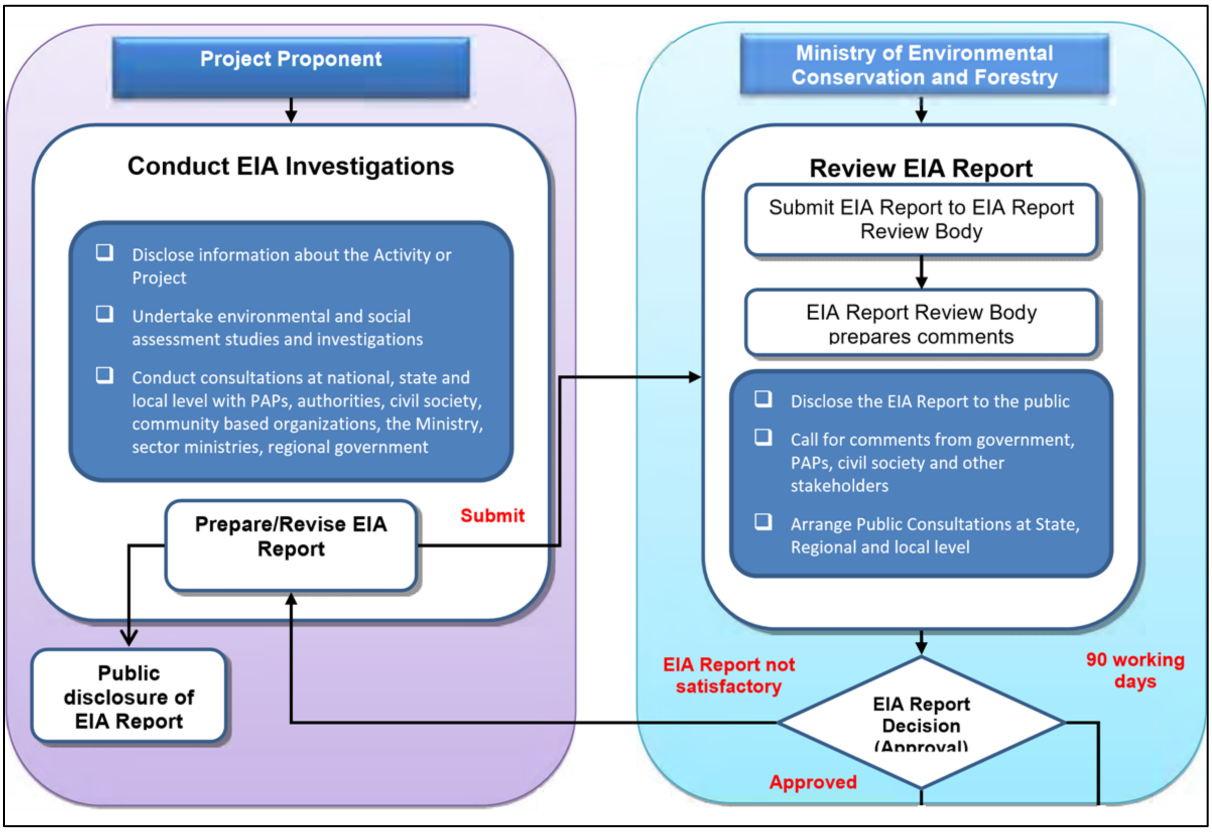


Figure 7-8: EIA investigation and review process in Myanmar (Source Environmental Impact Procedure, 2015).

The review and approval process for the EIA Report is described in Articles 67 to 70. After submission of the EIA Report, the Ministry appoints an EIA Report Review Body which invites comments from all stakeholders and relevant parties and arranges public consultation meetings at national, regional, state and local levels where the EIA Report is presented. The Review Body collects and reviews all submissions and comments and prepares a report for the Ministry with their recommendations. The Ministry subsequently takes the final decision within 90 days on whether to approve or reject the EIA Report. If rejected, the project proponent will have to amend the EIA Report before it is resubmitted, while if approved, the Ministry will issue an Environmental Compliance Certificate (ECC). The Ministry may attach conditions to the ECC obliging the project proponent to implement mitigation measures to eliminate or reduce the environmental impacts caused by the project.

The rejection or approval of the EIA Report by the Ministry may be appealed by the project proponent or any person or organisation that are negatively impacted by the project (Articles 71 - 75).

Chapter VIII describes the requirements for project approval and the award of the ECC. Article 83 requires the project proponent to obtain an ECC before any other permits can be granted by other ministries or authorities to proceed with implementation of a project.

After the ECC has been issued, the project proponent has to start the implementation of the project within the two years (Article 88). If implementations does not commence within the two year timeframe, a new EIA Report will have to be prepared and submitted to the Ministry, unless the project proponent has applied for an extension with an explanation of why the project is delayed and indicating the additional time needed before implementation can start (Article 89).

Article 102 places the full legal and financial responsibility on the project proponent for all of his actions and omissions, including those of his employees, contractors and consultants that have been hired for carrying out work on the project. Most importantly, Article 102 also requires the project proponent to restore the livelihoods of all project affected persons (PAPs) and support them until they have achieved socio-economic stability at a level not lower than that in effect prior to the commencement of the project.

Finally, Article 103 makes it clear that the project proponent is responsible for fully implementing the Environmental Management Plan (EMP) along with all project commitments and ECC conditions. Furthermore, the project proponent is responsible for ensuring that all contractors and subcontractors comply with all applicable environmental laws and regulations, project commitments and conditions.

For the SN Power the EIA Procedure is a key piece of legislation as it gives specifications for the EIA study requirements and the process for issuing an Environmental Compliance Certificate (ECC) for the Middle Yeywa HPP.

The Land Acquisition Act (1894)

The Land Acquisition Act of 1894 is the main legal instrument that presently governs the process of land acquisition in Myanmar. Part II sets out the procedures for initial investigation of the land that is considered for acquisition for public purposes, as well as procedures for how to raise objections to acquisition. Before any investigations and surveys can be made, Article 4(1) requires that *a notification to that effect shall be published in the Gazette, and the Collector shall cause public notice of the substance of such notification to be given at convenient places in the said locality.* Article 5A allows a thirty day period after the notification for any person who is entitled to claim compensation to object to the acquisition of the land. The objection must be made in writing to the Collector who is required to give the objector an opportunity of being heard. The Collector, after hearing the objections, makes a report summing up the objections and his recommendations regarding these and submits the case to the President of the Union for a final decision.

If the President of the Union decides to acquire the land a declaration of the acquisition is made and published in the *Gazette.*

Regarding valuation of the land, Article 11 states that the Collector is responsible for establishing the area of land to be acquired and for determining the compensation that shall be paid for the land. Article 12 stipulates that the award of compensation by the Collector is final while Article 15 requires the Collector to take into account the market value of the land (Article 23). If the awarded amount is not accepted by those who are entitled to compensation, Article 18 provides a possibility for referral to the Court. However, this has to be done through an application to the Collector within 6 weeks of the notification of the compensation award.

Part VII of the Act deals with acquisition of land for companies. Article 40(1)(b) allows for the acquisition of land for public purposes by a government agency from individual landowners when it is *likely to prove useful to the public.* Article 41 specifies that when the President of the Union has approved the company's plans and is satisfied that the project will prove useful to the public, the company is required to enter into an agreement with the Government for the acquisition of the land. After payment, the Government acquires the land and transfers it to the company. The Government has the responsibility for distributing the compensation to the owners or occupants of the land. The agreement between the company and the Government is to be disclosed in the National Gazette (Article 42).

It needs to be noted that land acquisition in Myanmar is an issue that is currently much debated due to the way land acquisition previously has been handled and implemented. The Myanmar Centre for Responsible Business notes the following regarding the legal framework for land acquisition[1]:

- *Myanmar does not have detailed procedures on land acquisition and appears primarily to be using outdated laws as the basis for land acquisition.*
- *The current legal framework, including even the more recent Farmland and VFV Laws, provides only general authorisations on expropriation "in the public interest" with no further procedural or substantive restrictions, leaving this process open to abuse. The Government has wide discretion to expropriate land "in the interests of the public" or even if "likely to prove useful to the public." The 1894 Land Acquisition Act permits expropriation because the Government "is or was bound" to provide land under an agreement with a company, without any additional requirement of public interest.*
- *The laws and rules provide limited specifications on the process of expropriation and as noted, limited safeguards for those whose property is being acquired. Only under the 1894 Act is there a process for objections. There are no procedures for objections to acquisitions or compensation for VFV land or farmland. Apart from these laws, there are no other laws on expropriation or resettlement.*

The Land Acquisition Act provides the legal basis for the land acquisition process and will therefore be an important piece of legislation for the Middle Yeywa HPP. However, the Project's need to acquire land for project purposes is expected to be relatively limited.

The Farmland Act (2012)

The 2012 Farmland Act provides the legal basis for land registration and provision of land use certificates (LUCs) that give farmers the right to sell, exchange, access credit, inherit and lease the land over which they hold user rights under customary law. Tenure rights awarded under the Farmland Act may be revoked by the Government if any of its conditions are not fully complied with. It also allows for the repossession of farmland in the interests of the State or the public but requires that the farmland rights holder must be fully compensated (Article 26).

The Farmland Act makes it clear that those who apply for registration of their land must be Myanmar citizens. Furthermore, it states that organisations are also permitted to apply, including government departments or organisations, nongovernmental organisations (NGOs) as well as companies.

Farmland rights granted under the Farmland Act are freely transferable except for the fact that there are restrictions on transfers to foreign investors.

The Farmland Act does not provide for any procedures for objections to be made to the acquisition or compensation awarded.

The Farmland Rules - Notification No. 62 (2012)

The Farmland Rules provides the procedures for applications for land use certificates under the Farmland Act as well as for applications for changes in land use. It also specifies procedures for dispute resolution and for leasing and mortgaging of land.

The Vacant Fallow and Virgin (VFV) Lands Management Law and Rules (2012)

The Vacant Fallow and Virgin (VFV) Lands Management Law and Rules provides a legal framework for implementing Government land policies to maximise the use of land as a resource for generating agricultural income and tax revenues. The law allows the Government the flexibility to do what they believe is needed for development.

[1] *Myanmar Centre for Responsible Business, 2015: Land, Briefing Paper, pages 12-13*

Article 55 gives the Central Committee for VFV Land Management the right to repossess VFV land that had been granted to others for, among other things, the *implementation of basic infrastructure projects or special projects required in the interests of the state*, and also where natural resources are discovered on VFV lands. Article 56 specifies that compensation shall be based on current values of the land.

The Farmland Act, the Farmland Rules and the VFV Lands Management Law and Rules will be important if the Project will be required to provide replacement land as a part of the compensation for loss of agricultural land.

4.1.2 Policies

National Land Use Policy (2016)

This new policy aims to harmonize existing laws and guide development of a new land law. The policy assures equitable land access for smallholders and landless people, with consideration of customary tenure and gender equality. Regarding projects that entails land use changes, it requires the proponent to carry out and pay for an independent environmental and social impact assessment out to identify and minimize the impacts of land use changes. The policy also aims at protecting common land resources shared by neighbouring communities.

Regarding resettlement, the policy specifies that involuntary resettlement shall be avoided as far as possible by amending and changing the plan for the project. However, it states that if the project is in the interest of the state and relocation is unavoidable, resettlement shall be negotiated and be carried out in a sustainable manner with sufficient resources to be provided for those who have to relocate. The policy also requires that project affected persons are consulted and involved in the relocation planning in a systematic manner. Finally, the policy requires that housing and infrastructure in the resettlement sites shall be in place before the actual relocation of the project affected persons. There is also a requirement that the housing and infrastructure facilities in the resettlement sites are at least of the same standard, preferable better, than the resettlers had before the relocation.

Section 46 of the policy deals with settling of land disputes and provides for establishment of local land dispute settlement bodies at the local administrative levels including at village-tract and community level. The policy also allows for appointment of monitors to oversee the settlement of disputes relating to land use.

The policy also requires that affected ethnic groups are duly consulted regarding traditional land use rights and that these shall be recognised irrespective of whether they are recorded and registered or not. Traditional land use rights may be registered according to existing laws.

4.2 Comparison with IFC Standards – Gap Analysis

Table 7-4: Gap analysis of Myanmar legal framework in relation to IFC performance standards.

IFC Performance Standards	Comments / Identified Gaps	Recommendations
Performance Standard 1: Assessment and Management of Environmental Risks and Impacts *Requires the project developer to carry out environmental and social assessment, and establish and maintain an Environmental and Social Management System to manage and minimise environmental and social risks and impacts.*	The Environmental Impact Assessment Procedures of December 2015 requires the EIA to cover social as well as environmental impacts. Although the Myanmar regulatory framework still has gaps when it comes to social safeguards, such as the rights for resettlers and indigenous peoples, the Procedure (Article 7) states that *projects that involve Involuntary Resettlement or which may potentially have an Adverse Impact on Indigenous People shall comply with specific procedures separately issued by the responsible ministries. Prior to the issuance of any such specific procedures, all such Projects shall adhere to international good practice (as accepted by international financial institutions including the World Bank Group and Asian Development Bank) on Involuntary Resettlement and Indigenous Peoples.*	It is recommended to adhere to IFC standards with respect to further assessment of and planning, especially with regard to consultations with project-affected persons, public disclosure and compensation process.
Performance Standard 2: Labour and Working Conditions *Requires the project developer to provide reasonable working conditions and terms of employment, treat migrant and non-migrant workers equally and allow workers to organise.*	Occupational health and safety and working conditions, including terms of employment, are relatively well covered in the Workman's Compensation Act, Leave and Holidays Act, Payment of Wages Act, Social Security Act and the Factory Act. However, issues and areas that are not sufficiently covered compared to the PS2 requirements include child labour, non-discrimination and equal opportunity. Child labour is not explicitly prohibited while legislation providing for equal opportunity was repealed in 1964 (*Law Defining the Fundamental Rights and Responsibilities of the People's Workers*).	As current labour legislation only provide basic principles and do not cover issues like child labour and non-discrimination and equal opportunity sufficiently, it is recommend that the Developer adheres strictly to the IFC Performance standard 2 as well as ILO's Labour Standards The Developer should also make sure that the contactor and sub-contractors comply with IFC and ILO labour requirements.
Performance Standard 3: Resource Efficiency and Pollution Prevention *Requires application of techniques that are adapted to the pollution hazards and risks specific for the project. The applied techniques shall be consistent with good international industry practices (GIIP) such*	Pollution control is addressed in the Environmental Policy of 1994 and in the National Environmental Quality Guidelines issued alongside the Environmental Impact Assessment Procedures. Energy efficiency is implicitly dealt with at policy level in the National Strategy for Sustainable Development (NSDS), as one of its goals is sustainable management of natural resources.	As high-level policy strategies on resource efficiency and pollution prevention are insufficiently backed up by legislation it is recommended that IFC General Health and Safety Guidelines on environmental standards (No.1) are strictly adhered to.

IFC Performance Standards	Comments / Identified Gaps	Recommendations
as those described in the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines). *For resource efficiency it is required that cost effective measures are applied for improving conservation of energy consumption, water and other resource inputs.*	With regard to resource efficiency, a gap exists as it is only expressed at the policy level and not backed up by enforceable legislation.	
Performance Standard 4: Community Health and Safety *Requires the project developer to minimize the risk that local communities are exposed to hazardous materials and substances. It is furthermore requires that measures are taken to avoid or minimize the risk for transmission of communicable diseases associated with influx of temporary or permanent project labor. Finally, measures shall be taken to prevent the loss of access to ecosystem services for the local population.*	Community health and safety is regulated by a number of laws and regulations focusing on food and drugs, transport, unsafe material and land resource utilization and negative environmental practices. In the Myanmar legal framework there are gaps with regard to design safety and hazardous materials management. There are also shortcomings with regard to wider community health legislation.	Because there are gaps with regard to legislation governing waste as well as requirements for consideration of wider community health and safety, it is recommended that IFC's General Health and Safety Guidelines for Community Health and Safety (No.3) with their waste management principles and emission standards are adopted by the Project.
Performance Standard 5: Land Acquisition and Involuntary Resettlement *Requires that the project developer seeks to avoid or minimize physical and economic displacement through alternative project designs. It is further required that a continuous consultation and stakeholder engagement process with affected communities is carried out. If physical displacement is unavoidable, a Resettlement Action Plan shall be prepared. Regarding compensation, it requires that*	Regarding physical displacement, there are no clauses in the present Myanmar legislation that requires a project developer to actively seek to avoid involuntary resettlement (although it is mentioned in the new Land Use Policy). There is no reference in the legal framework corresponding to the requirement that developers should be encouraged to use negotiated settlements to avoid expropriation and eliminate the need to use governmental authority to enforce relocation. There are no provisions in the laws and regulations that require consideration of feasible alternative designs to avoid or minimise physical and or economic displacement. However, in the National Land Use Policy, it	As there are gaps and uncertainties in the legislation with regard to compensation and resettlement it is recommend that the Developer follows the recommendations set out in IFC's PS 5 and Resettlement Handbook regarding full compensation and minimisation of displacement.

IFC Performance Standards	Comments / Identified Gaps	Recommendations
loss of land and other assets are compensated at full replacement cost and that a grievance mechanism is put in place.	is stated that that involuntary resettlement shall be avoided as far as possible by amending and changing the plan for the project. IFC PS 5 requires compensation for loss of assets at full replacement cost. The Land Acquisition Act provides for market value compensation (Article 9 and 23) but there are no references to full replacement cost except for in Article 26 of the Farmland Act that requires the farmland rights holder to be fully compensated. There are no references in the laws and regulations to the requirement that a resettlement action plan shall be developed apart from the statement in Article 7 of the EIA Procedures that project that involve resettlement should adhere to international good practice. In addition, the National Land Use Policy states that if the project is in the interest of the State and relocation is unavoidable, resettlement shall be negotiated and be carried out in a sustainable manner.	
Performance Standard 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources *Requires that the project developer seeks to avoid impacts on biodiversity and ecosystem services. If this is unavoidable, measures to minimize impacts and restore biodiversity and ecosystem services shall be implemented. In response to changes in conditions and monitoring outcomes, adaptive management of mitigation measures should be applied.* *Requires a project developer to put in place verification practices and a system for evaluation of primary suppliers in his supply chain to reduce the risk for significant conversion of natural and critical habitats.*	The main piece of legislation for biodiversity conservation in Myanmar is the Environmental Conservation Law of 2012. In addition, the Freshwater Fisheries Law of 1991 and the Conservation of Water Resources and Rivers Law of 2006 provide for the protection of fish biodiversity and riverine areas. However, the legislation only differentiates between critical and legally protected areas and not between natural and modified habitats as the PS 6 does. Regarding supply chain, the present legislation in Myanmar does not explicitly require companies to put in place verification systems to reduce risks for contributing to loss of natural and critical habitats in their supply chains and procurement process.	As requirements of distinguishing between natural and modified habitats as well as supply chain management are not covered in the Myanmar legislation, it is recommended that the Developer adheres and complies with the requirements set out in IFC's PS 6.

IFC Performance Standards	Comments / Identified Gaps	Recommendations
Performance Standard 7: Indigenous Peoples *Requires that adverse impacts on affected communities of Indigenous Peoples should be avoided where possible. If impacts are unavoidable, the project developer is required to minimize, mitigate and compensate for these impacts in a culturally appropriate manner.*	Article 7 of the EIA Procedure requires that *projects that involve Involuntary Resettlement or which may potentially have an Adverse Impact on Indigenous People shall comply with specific procedures separately issued by the responsible ministries. Prior to the issuance of any such specific procedures, all such Projects shall adhere to international good practice (as accepted by international financial institutions including the World Bank Group and Asian Development Bank) on Involuntary Resettlement and Indigenous Peoples.* In the absence of any specific procedures from other ministries, Article 7 would appear to ensure compliance with Performance Standard 7 requirements.	It is recommended that the Project adopts the recommendations in IFC's PS7 regarding carrying out consultations and compensation in a culturally appropriate manner on affected communities of Indigenous Peoples.
Performance Standard 8: Cultural Heritage *Requires the project developer to identify and protect cultural heritage by ensuring that internationally recognized practices for the protection, field-based study, and documentation of cultural heritage are implemented.* *Furthermore, if there is a risk of impacts to cultural heritage, it is required that competent professionals are engaged to assist in the identification and protection of cultural heritage.*	The Protection and Preservation of Cultural Heritage Region Law of 1998 is the main piece of cultural heritage legislation in Myanmar. It mainly focuses on protection of existing sites and largely lacks provisions for investigations at sites prior to commencement of project activities. Additionally, it does not specify requirements for 'chance finds' and procedures for how these should be handled. Finally, the Law does not explicitly mention any requirement for consultations in connection with project planning and potential impacts to cultural heritage sites.	It is recommended that the Developer adopts IFC PS 8 requirements for pre-survey and management of "chance finds" as this is not fully covered by Myanmar legislation.

4.3 Middle Yeywa Hydropower Project Policy Framework

The following section presents the Middle Yeywa Hydropower Policy Framework. The policy will be translated into Burmese and will be distributed to all villages in the project area and to Government organizations prior to the commencement of construction activities.

4.3.1 Objectives of the Policy

- Outline basic principles for resettlement and compensation for Project Affected Persons
- Ensure that Project Affected Persons participate in consultations, planning and preparation processes in a culturally-sensitive manner;
- Ensure that special measures are provided to vulnerable or disadvantaged groups so as to foster self-reliance;
- Provide compensation for all losses of production, land or assets;
- Provide for improved infrastructure in the project area in the best interests of the Project Affected Persons and in cooperation with government authorities.

4.3.2 Compensation Policy

- Cash compensation for losses of private land or production not exceeding 10% of total assets or production;
- Replacement of private land for losses exceeding 10% of land holdings or production value;
- Cost of removal of private structures (labour costs) and replacement of materials or cash compensation, as agreed with impacted households;
- Compensation based on the principle of replacement cost for the loss of immoveable private assets, including fruit trees and production trees;
- All Project Affected Persons will be entitled to fair and prompt compensation or replacement of lost assets;
- Development of social forestry and nurseries for indigenous tree species and Non-Timber Forest Production for the loss of community lands and resources in the reservoir area;
- Cash compensation and/or fishing equipment for households engaged in small-scale fishing activities along the affected reaches of the Myitnge River;
- Disturbance allowance (cash payment) for households living along access roads, construction sites, quarries and spoils areas (within 50 metres of project activities).

4.3.3 Other Provisions

- All Project Affected Persons will have the same basic rights, but specific entitlements may vary depending on the extent and duration of impacts in the different Project Zones;
- Proof of residency and use of agricultural land and natural resources from the village authorities is required in order to establish the right to compensation;
- The social and cultural aspects will be taken into consideration when planning and implementing programs, and special measures will be planned and implemented for vulnerable households;
- Traffic safety, dust control mechanisms and noise control mechanisms for all construction site activities in the vicinity of villages;
- All Project Affected Persons will have effective access to the grievance procedures that will deal with problems that may arise at the household or village level;
- Development programs in the form of infrastructure improvements and maintenance in cooperation with government authorities;

- The compensation and development programs will be linked to the Project construction program and the reservoir impoundment.

4.3.4 Implementation

- The Environmental and Social Unit of the Middle Yeywa Hydropower Project will be responsible for compensation and development activities in coordination with the government authorities;
- The Middle Yeywa Hydropower Project Policy will be approved by the Ministry of Energy and Electrical Power (MoEE) and Ministry of Natural Resources and Conservation (MoNREC) for effective implementation.

4.4 Middle Yeywa Hydropower Entitlements

This section presents the entitlements for all villages in Project Zones. The following Project Affected Persons (PAP) will be entitled to compensation under the Middle Yeywa Hydropower Project Policy:

- All households who will lose private lands, structures and production due to direct project impacts;
- All households who reside less than 200 metres from construction areas, access roads, quarries or spoil tips;
- All households engaged in small-scale fishing activities along the affected reaches of the Myitnge River;
- Communities adjacent to the future Middle Yeywa reservoir that will lose community lands and resources.

Entitlements are described in detail in the Concession Agreement and summarised in the table below.

Table 7-5: Summary of entitlements.

Impact / Issue	Entitlements
Permanent loss of agricultural land	• Cash compensation for the loss of land or production of less than 10% of land or production of the household; • Replacement land of at least the same size and equal productive value at a location acceptable to the Project Affected Person (PAP) for loss of more than 10% of land or production; • Replacement land will be cleared, fenced and prepared by the PAP at project cost; • In cases where replacement land is not available in sufficient quantities, the PAP will be given an option of a cash payment.
Permanent loss of commercial land	• Replacement land of at least equal value at a location that will be acceptable to the PAP in order to continue viable commercial activities; OR • Cash payment for the value of land if commercial activities cannot be continued or PAP does not wish to do so.
Loss of structures	• Labour costs for dismantling of structure and cost for transporting materials to new location; • Provision for new materials and construction of new house (of at least the same standard) or the cost of labour for construction; OR • Cash payment for the value of land if commercial activities cannot be continued or PAP does not wish to relocate the structure.

Impact / Issue	Entitlements
Loss of fruit trees and production trees	• Cash compensation based on 5 years of production or estimated return on investment (based on professional studies and agreed by government authorities); • Replacement seedlings at a new location in agreement with the PAP.
Loss of common property resources	• Development of social forestry and reforestation program in areas allocated by authorities adjacent to the reservoir; • Establishment of village nurseries for indigenous tree species and Non-Timber Forest Products.
Loss of community infrastructure and infrastructure improvements	• Replacement of all community infrastructure of at least the same value and function if directly impacted by construction activities or access road construction; • All-weather road to selected villages closest to the project on the right and left bank (villages adjacent to the reservoir in Zone 4a, 4b, 4c and 4d); • Expansion of electricity grid and connections to selected villages closest to the project on the right and left bank (villages adjacent to the reservoir in Zone 4a, 4b, 4c and 4d).
Training and support	• Priority for labour opportunities on project construction sites; • Skill training programs in preparation for construction for villages in right and left bank (villages adjacent to the reservoir in Zone 4a, 4b, 4c and 4d).
Vulnerable households	• Households with insufficient labour force will receive special assistance in relation to compensation and replacement programs; • Vulnerable households will receive special attention to ensure their participation in development programs and initiatives in relation to their needs and capacity.
Grievance	• All household to have access to Grievance Committee for complaints; • Prompt and fair handling of all complaints in a transparent manner.

5 STAKEHOLDER ANALYSIS AND CONSULTATIONS

5.1 Consultation Requirements and Benefits

Requirements for stakeholder engagement and consultations are set out in IFC Performance Standard 1, paragraph 25 to 33. Briefly summarised, a project developer is required to:

- Identify all stakeholders that may have an interest in the project and in particular communities that will be adversely affected by the project;
- Prepare and implement a Stakeholder Engagement Plan that is adapted to the risks and potential impacts of the project, as well as to the characteristics and interests of affected communities;
- Disclose relevant project information that will help affected communities and other stakeholders understand the risks, impacts and opportunities of the project. Important information will include nature and scale of the project, potential social and environmental impacts and possible mitigation measures, the planned stakeholder process and envisioned the grievance mechanism;
- The project developer shall undertake a consultation process that allows affected communities to express their concerns and views regarding potential impacts and possible mitigation. For projects with potentially significant adverse impacts the developer is required to carry out an Informed Consultation and Participation (ICP) which involves a more in-depth process that will allows for taking the affected communities concerns and views into the project planning process;
- The consultation process should be conducted in a gender sensitive way so that the views and concerns of both women and men are noted and taken into account;
- When indigenous peoples are adversely impacted by the project the project developer is required to conduct an ICP process and in certain circumstances also to obtain their Free, Prior, and Informed Consent (FPIC) as described in Performance Standard 7.

The benefits of conducting consultations with stakeholders are many, and the consultation process is essential for ensuring the successful planning, construction and operation of a project. Important benefits include:

- It provides a means of taking into account the views and perceptions of people who may be affected or have an interest in a development project;
- Project impacts may be avoided or minimised through stakeholder inputs through improved project design and implementation;
- Data obtained from other sources can be verified and complemented, thereby improving the quality of environmental and social impact assessments;
- Affected people and communities are enabled to understand their rights in relation to a project so that they are aware of their entitlements and can claim them through the specified grievance mechanism;
- Involvement of stakeholders and directly affected communities provides greater transparency and enhances project sustainability through creating project acceptance and local ownership.

IFC and other international financial institutions require that the stakeholder consultations should be meaningful and this means that the process in general needs to meet several criteria. Important requirements for the process to be considered meaningful are:

- The stakeholder consultation process should not be a “one off” event but should start as early as possible and continue throughout all phases of the project;
- All interested and/or affected groups should be included in the process with special care taken to ensure that vulnerable groups are given the opportunity to raise their concerns;

- The consultations should be conducted in a non-threatening manner that it is understandable for all stakeholders while stakeholders who express concerns or criticism against the project or authorities should be protected from retaliation;
- The consultation process should be systematically documented, and relevant aspects of it should be disclosed publicly.

5.2 Stakeholder Mapping and Analysis

The IFC's Stakeholder Engagement Handbook (IFC 2007) identifies stakeholders as *persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively*.

Stakeholders comprise different groups such as project affected persons/people (PAPs), locally affected communities, government authorities and civil society organizations, including non-governmental organisations (NGOs) and individuals with special interests in a project.

Through the consultation process, stakeholders are invited to make inputs into the planning and decision making process of a project so that their concerns and points of view can be taken into consideration.

The stakeholder groups for the Middle Yeywa Hydropower Project have been identified through an analysis of the Project's geographic sphere of influence and impact zones. In addition, interest based analysis have been applied in order to identify stakeholders outside of the project area that are not directly or indirectly affected but who have an interest in the Project that determines them as stakeholders such as different central and local government ministries and departments.

The table below lists the main stakeholder groups that have been identified for the Middle Yeywa Hydropower Project.

Table 7-6: Main Stakeholder Groups for the Middle Yeywa HPP

Stakeholder	Role	Concern / Expectations	Interest	Influence
Union Government				
Ministry of Electricity and Energy (MOEE) with its Departments of Electric Power Hydropower Planning and Hydropower Implementation	Awards MOUs for studies and planning of hydropower projects Awards Concessions for construction and operation of hydropower projects	Project completed on time providing reliable supply electricity to the national grid	High	High
Ministry of Natural Resources and Environmental Conservation (MONREC)	Screens and decides on EIA study requirement Reviews and approves the EIA reports for the Project	Compliance with environmental regulations and capacity building for local agencies	High	High

Stakeholder	Role	Concern / Expectations	Interest	Influence
State and Township Government				
Shan State Government: Ministries of Road and Communications; Natural Resources and Environment; Electricity, Energy and Technology; and Planning and Economy	Responsible for infrastructure planning (roads and rural electrification), local natural resource management and protected areas / forest reserves	Improvement of local road and electricity distribution network	High	High
Nawnghkio Township Kyaukme Township Lawksawk Township	Participation in the consultation and public disclosure process Provides statistics and information on local conditions Participates in ESMP implementation	Improved local roads infrastructure Increased economic activity and employment opportunities and opportunities for local businesses Increased tax incomes and revenue for the township government	High	Medium
Villages				
Villages along the reservoir – right and left bank	Village population likely affected by changes in access to natural resources (fish and forest products) as well as indirect social impacts	Benefits to villagers in the form of employment and market opportunities Improved road access and local electricity supply	High	Low
Yae Twin Gyi – dam site and camp area	Likely to be affected in terms of temporary or permanent loss of land, changes in access to natural resources and changes in the social environment	Negative social impacts due to influx of construction workers Compensation for loss of assets Benefits to villagers in the form of employment and market opportunities Improved road access and local electricity supply	High	Low
Villages along main access roads	Village population likely to be affected by increased dust and noise emissions as well as increased risks for traffic accidents	Injuries and fatalities resulting from increased heavy traffic	High	Low

Stakeholder	Role	Concern / Expectations	Interest	Influence
Other Stakeholders				
Local business and local contractors	Offering services that will be required by the Project	Opportunities for providing services and supplies during construction	Medium	Low
Lenders and Funding Agencies	Provision of project financing	Compliance with international standards (IFC).	High	High
Local NGOs	Represents interests of national civil society	Concerns about sustainability, benefits to impacted communities and implementation of international standards.	Medium	Medium
International NGOs	Represents interests of the international civil society	Concerns about sustainability, benefits to impacted communities and implementation of international standards.	Medium	Low
Advocacy Groups	Hinder or restrict hydropower development	Concerns about political reform, human rights and	Medium	Low

5.2.1 Directly and Indirectly Affected People

People that will be directly affected by the Middle Yeywa HPP will include the persons and households that directly utilize the resource base in the reservoir area and at the sites where project infrastructure, such as contractors'' camps and project access roads, will be located.

There are a number of villages located along the prospective project access roads (Zone 2b and 2c) whose inhabitants will experience impacts in terms of increased dust and noise emissions due increased traffic loads, most notably by heavy trucks carrying construction material and equipment. Those who live closest to the road will experience the greatest exposures but the increased noise and dust emissions are likely to be noticeable in a wider corridor zone adjacent to both sides of the roads. In addition to noise and dust impacts, upgrading and widening of access roads will most probably cause both physical and economic displacement for some households and individuals who reside and operate businesses within the existing right-of-way or the new expanded corridor of the roads.

Another group of people that will experience direct impacts will be a limited number of individuals and households in the right and left bank villages located along the reach of the Myitnge River that will be converted into a reservoir (Zone 4a, 4b and 4d). Among the village population, only those who still practise fishing for food supplementation, income generation or for recreational purposes will be directly impacted. As indicated in the socio-economic survey results, this is a relatively small group in terms of numbers. Another potentially directly affected group among the village population will be those who collect forest products or utilize wood and timber resources in the lower valley that will be submerged. However, all indications from village consultations suggest that this will also be a very restricted group of people in terms of numbers because forest products are normally not collected and, while the timber resources are indeed utilized, the logging is mainly done in the forested zone above the steep lower valley, and some activities are carried out with proper permits.

5.3 Vulnerable Groups

The vulnerable groups in the project area include: 1) households with disabled persons, 2) poor households (income below the national poverty line), 3) female headed households, 4) and landless households (no residential land). The household surveys carried out in 2105 and 2017 sampled only 30 percent of the total number of households in the villages and hence the table below only gives the number of vulnerable households in the sampled group, not for the whole village. However, the figures should give an indication of the prevalence of vulnerable households in project area villages

Table 7-7: Vulnerable households in the surveyed project area villages.

Village	Zone	Sample %	Disabled Persons	Poor HHs	Female-Headed	Landless	Total
Nawng Lin	4a	33	6	0	7	3	16
Yae Maung Tan	4a	33	0	0	1	0	1
Me Poke	4a	33	4	3	2	1	10
Nawnghkio Kone	4a	33	2	2	0	0	4
Ma Gyi Yae	4a	41	0	4	0	0	4
Yae Twin Gyi	4a	33	5	0	3	1	9
Nawnghkio Gyi	4a	33	0	4	4	0	8
Kone Nyaung	4c	33	1	5	7	1	14
Pin Ping	4c	33	7	19	11	4	41
Thar Si	4c	33	2	10	4	2	18
Hpet Yin Kone	4d	33	1	8	3	1	13
Kyauk Hson	4d	33	0	1	5	1	7
Tawng Hkan	4d	33	1	4	1	3	9
Total			**29**	**60**	**48**	**17**	**154**

The total number of persons/households in the villages indicate that the largest vulnerable group in the area is poor households followed by female-headed households, while there are relatively few landless households. In the case of resettlement, vulnerable groups would be prone to be disproportionally impacted by the stress and disruption to their lives that that relocation would represent.

5.4 Overview of Consultation Issues and Concerns

In the following, an overview of consultations that have been conducted so far in the project planning process is provided.

5.4.1 Scoping Phase / Pre-feasibility Consultations

February - March 2015

Initial community meetings were held in the six right bank villages where socio-economic surveys were also conducted. The consultations took place from 26th of February to 1st of March 2015 and were well attended with good participation by women and youths. The average attendance was around 50% of the village households except for one village (Ma Gyi Yae) where only 5 % of the households attended because the meeting day coincided with the market day. The consultation meetings took place in the following villages:

1. Nawng Lin
2. Yae Maung Tan
3. Me Poke
4. Nawnghkio Kone
5. Ma Gyi Yae
6. Yae Twin Gyi

The general reactions to the proposed hydropower project of all the six villages were generally positive and nobody expressed opposition to the project. The most common questions and issues raised during the meetings were:

- Will they (village) get electric power from the project (connection to the grid)?
- Will there be other benefits such as village road, village water supply; and will these be provided by the project as well?
- Will land be taken from the villagers by the project?
- What kind of compensation for loss of properties will be offered?
- Will there be support for infrastructure development of community facilities and social services?
- Will the dam cause flooding to the villages?
- What areas will be flooded/affected?
- Will the villages/households get free electricity?

Regarding the questions concerning what type of benefits the villages would be receiving, no definite answers could be provided but the villagers were assured that different types of support were being considered, including road construction and support for rural electrification.

With regard to flooding and loss of land, the villagers were assured that no farmland would be lost due to creation of the reservoir but that some limited land could be taken for access roads and camps in Yae Twin Gyi, the village nearest to the dam site.

Figure 7-9: Village Consultations

May 2016

Consultation continued in selected villages surrounding the reservoir and the dam site in May 2016 with consultation conducted in the following villages:

1. Me Huong (10 May)
2. Nawnghkio Gyi (11 May)
3. Yae Twin Gyi and Ma Gyi Yae Village with representatives from Taung Shay and Tawng Hkam (11 May)
4. Me Poke with representatives from Yae Maung Tan and Nawnghkio Kone (13 May)
5. Thar Si and Pin Ping (14 May)
6. Tawng Hkan with representatives from Hpet Yin Kone and Kyauk Ku with representatives from Kyauk Hson Village (15 May)
7. Nawng Lin Village (16 May)

Overall, the consultations were well received by communities, and participants expressed thanks for keeping them informed. During the consultations, participants posed several questions about the Project in general. These were similar to the questions posed in previous meetings with the villagers. They were mostly interested in whether or not they would receive electricity and what other benefits the project could give the communities (i.e. funding and support for community projects). Some villages were also concerned about the Myitnge Bridge and whether it would be flooded.

The consultation moderators stated that it is not yet known whether the villages will receive electric power and that this would depend on the decision of the government. It was also explained that there may be funding for community development projects but the nature and extent of these projects are not yet decided. Furthermore, the extent of village support would be proportionate to the impact of the project on the villages and will be used to offset negative impacts. Villagers also asked about employment opportunities. The moderators stated that there is potential for employment but this is not yet certain and would need to be handled carefully so as not to distort local labour prices and agricultural production.

Figure 7-10: Village Consultations in Nawng Lin in May 2016

In Pin Ping, the villagers were particularly concerned about forced labour, as this has been a common practice in government projects in the past. The villagers became more open and relaxed after being repeatedly assured that this would not be the case in this project, and it was entirely their decision whether to participate in the project or not.

In addition to providing general information about the project, villagers were also informed about the various surveys that were to be undertaken by geo-technical teams along the reservoir and around the potential dam sites. All villages along the reservoir were consulted about these surveys and provided information about how to contact project staff and report any grievances. This was an opportunity to introduce elements of a transparent grievance mechanism that should be further elaborated prior to construction. Information posters were distributed to all villages after consultations.

Figure 7-11: Village Information regarding Geotechnical Surveys, showing appropriate behaviour and a simplified grievance mechanism

5.4.2 Feasibility / EIA Phase 2017 -2018

April 2017

The EIA Consultant undertook an initial site visit in April 2017 during which meetings were held in seven right and left bank villages. These meetings with the village leadership focused more on the local population's resource use in the reservoir area and were not set up and conducted as public consultation meetings. However, the meetings provided a good opportunity to inform the village leadership about the project planning process and to take note of any concerns they might have with regard to the Project. Since consultation meetings had been held once or twice in all of the villages already (except for in Hpet Yin Kone), few concerns were raised in the meetings. Again, the main interest was more focused on what kind of benefits the villages could expect to receive. No definite answers regarding benefits could be provided at that stage other than indicating that some of the most likely benefits would involve local road infrastructure and possibly also rural electrification and connecting villages to the grid.

The table below lists the visited villages and the main information on livelihoods and natural resource dependency collected in the meetings.

Table 7-8: Villages visited and consulted in April 2017.

Village	Date Visited	Ethnic Group	Livelihoods and Natural Resource Use
Nawnghkio Gyi Zone 4a	3 April 2017	50% Shan50% Danu	Limited timber extraction, some fishing for household consumption; Agriculture based livelihoods with sugar cane (contract farming) and maize as the main cash crops.
Nawng Lin Zone 4a	3 April, 2017	Danu	Collecting bamboo, fishing for household consumption; Sugar cane (contact farming) and maize main sources of cash income.
Me Poke Zone 4a	3 April, 2017	Danu	Extracting timber from the lower river valley for house building, Fishing for household consumption in the off agricultural season; Harvesting of wild bee honey from beehives placed in the forest; Sugar cane (contact farming) and maize main sources of cash income.
Pin Ping **Zone 4c**	4 April 2017	Danu	Around 15 households fish for household consumption; A number of crops are cultivated with maize as the most important cash crop; Sugar cane not commonly cultivated; Each family has around 10 acres of cropping land.
Thar Si Zone 4c	4 April; 2017	Danu	15 – 20 persons fish for household consumption at the start of the rainy season; Largest fishes caught are around 1.5 kg; Fish migration in middle of March; A variety of crops is cultivated with maize as the main cash crop; Expects benefits such as improved road access, grid connection and improved water supply.
Hpet Yin Kone Zone 4d	5 April; 2017	Danu	Around 10 people go for fishing in March and April; Rotational cropping with maize, sesame and peanuts; Shifting cultivation with 8 years of fallow, maize is the main cash crop; Upland rice cultivated for household consumption; Around 30 households keep large livestock; Expects support for improving village access road.
Yae Twin Gyi Zone 4d	6 April, 2017	Danu	No timber extraction by villagers as there is no valuable timber left; Around 10–15 people go for fishing in the river, staying for to up to 5 days and getting catches of 20-30 kg for each trip; Cultivates sugar cane (contract farming) and maize as cash crops; Fruit trees such as mango and papaya are common.

Figure 7-12: Meeting with villager leaders and elders at Pin Ping in April 2017

5.4.3 Consultations and Meetings with Government Conducted by SN Power

Representatives for SN Power have since the project planning started held regular meetings with Central Government and State Ministries to inform them about the project and to collect information about the Government's infrastructure development plans within the project area which the project potentially could link up with in terms of impact mitigation and benefit sharing.

There have also been regular meetings and follow-up by the SN Power's local representative on a range of issues including field investigations. SN Power has also participated in regional meetings organized by various parties, including recently a Workshop on the finalization of the Sector Environmental Assessment (SEA) report and the Planning of Cumulative Impact Assessment (CIA) for the Myitnge Basin Workshop, both of which were organized by IFC in August 2017.

SN Power has had a series of coordination and update meetings with the Ministry of Natural Resources and Conservation (MoNREC) during the Pre-Feasibility and Feasibility Studies. Representatives from the Department of Forestry and Environmental Conservation Departments have attended regional and union meetings and provided input and comments.

Meetings have also been held with NGOs and various members of Civil Society for insights into the EIA process and to register concerns. These include meetings with World Wildlife Fund (WWF), World Conservation Society (WCS) and Myanmar Centre for Responsible Business in May 2017, among others.

The table below summarises the issues discussed in the meetings held with Shan State officials.

Table 7-9: Overview of issues discussed with Shan State officials.

Date and Venue	Officials Met With	Issues Discussed
11 and 14 September 2017, Ministry of Electricity and Energy, Taunggyi	Chief Engineer, Superintendent	• Government standards and requirements for the construction of electricity lines and rural distribution networks; • Rates for compensation; • Extension of grid connection system from Yak Sauk to Kyauk Ku (Phase 1 – 2019-20) and Kyauk Ku to Naung O (Phase 2 – 2020-21); • Government practice for house connections; • Priority classification for project area villages; • Government practises regarding contracts, tendering and construction of transmission lines.
12 September, 2017; Taunggyi	Director of Department of Border Affairs and Development of National Races	• Prioritization of infrastructure plans in the project area; • Division of responsibilities between Department of Border Affairs and Development of National Races and Department of Rural Development; • Possibilities and costs for improvement of village access roads; • Possibilities for engaging the Department's mobile team to carry out training and capacity building (vocational and technical training).
12 September, 2017; Taunggyi	Director of Forestry and Environmental Conservation Departments	• Naung Lon Reserve Forest on left bank (Zone 4d) and possibilities for implementation of programmes; • Possibilities for enforcement of regulations and better protection of the reserve forest; • Training activities carried out under the present Community Forestry Program; • Ongoing programs to relieve pressure on the forests through the introduction of more efficient charcoal ovens and solar panels.
12 September, 2017; Taunggyi; 14 September, 2017 Nawnghkio	Staff from Ministry of Construction; Kyaukme District representative in Nawnghkio	• Requirements and load limitations on the on access roads; • Plan to upgrade of the Nawnghkio-Lawksawk section of Route 41; • The Government procedures for selection of local suppliers for construction materials such as sand, gravel and rocks; • The Right of Way (ROW) that was fixed during the construction of the original road and the Highway Law's stipulation of 150 foot ROW for rural roads. • Compensation in connection with access road improvement if the current ROW is exceeded
13 September, 2017; Taunggyi;	Chief Minister and Cabinet (including other ministers and directors of departments)	• The technical planning and progress and EIA progress; • Establishment of a protected area downstream of the dam site and the establishment of a forestry research centre; • The possibility of including the protected forest initiatives as a part of the Environmental Management Plan of the Middle Yeywa HPP; • The design and schedule for the construction of the new bridge across the Myitnge River;

Date and Venue	Officials Met With	Issues Discussed
		• The need for seismic studies and surveys of the geological conditions of the reservoir and the risks of landslides into the reservoir; • Tender document specifications in terms of access road widths and other details that should be included in Tender Documents for construction of the access roads; • The power supply needs for construction activities.
7 June, 2018; Taunggyi	Chief Minister and Cabinet (including other ministers and directors of departments)	• Update on the status of the EIA studies and main recommendations • Discussion at the Dept. of Forestry on proposed Reserve Forest Area (Mehon DokeHta Wady River RFA) being established using new procedures for public announcement and approvals. This RFA is located near our dam site and as Multi recommends, we should work with this initiative. An extension of this area to around the dam site where the best forest is located would be a practical solution from a conservation perspective.

5.4.4 Assessment of Local Government Capacity

In connection with the first round of consultations held in 2015, several Nawnghkio Township offices were visited by the consultant team from MIID. The purpose of the visits was to find out how the villages in the project area interact with the government and to collect information for an assessment of local government capacity. The majority of the interviews were with government offices whose roles and function are related to the economic activities of the population of the villages. These include the offices of Land Settlement and Registration, Irrigation, and Planning and Economic Development. Part of the purpose of the visits was also to introduce the proposed hydropower project, to hear their opinions about it and what kind of role they could have during project implementation.

In addition to the local government offices, private sector businesses, hospitals and markets were also visited to understand the interaction between the villagers and these institutions.

The table below summarises the collected information about the roles and the capacity of the government offices visited.

Table 7-10: Collected information on roles and capacities of Local Government Offices.

Organization	Initial Assessment of the Organization's Capacity
Land Settlement & Records (LSR) Office	LSR is responsible in registering: (i) farmland, virgin land and vacant land. It takes around 3 months to register land. The LSR Office covers 35 village tracts and has only 18 staff, something that limits their capacity to process land registrations.
Department of Agriculture	The Department of Agriculture are tasked with extension services and provision of agricultural inputs (seeds) to farmers. Together with the Township Management Committee, the Township Development Support Committee and the Municipal Committee they determine compensation rates for different types of land.

Organization	Initial Assessment of the Organization's Capacity
Township Office of Ministry of Cooperatives	The Ministry of Cooperatives organises and provides support for the 58 Agricultural Cooperatives with 7,261 farmer members in Nawnghkio Township. Each cooperative is entitled to a credit loan from the Ministry at an interest rate of 1.5% per month and payable after 6 months.
Myanmar Agricultural Development Bank (MADB)	MADB is one of the 9 departments under the Ministry of Agriculture and provides farmers with loans ranging from Myanmar Kyats (MMK) 20,000 to 100,000 per acre at an interest of 5% per year. Because of the limitation on loan amounts farmers go to local moneylenders to get bigger loans but has to pay higher interest rates. MADB has a bank agent in each village to facilitate processing of loan application of farmers.
Township Office of Ministry of Natural Resources and Environmental Conservation (MONREC)	MONREC's role and responsibilities include management of nurseries for the township from which villagers can receive seedlings for planting (20 trees per household) MONREC also conducts resource usage surveys and monitors and control usage of forest resources.
Township Office of Department of Planning	The office is responsible for development plans for village tracts, townships and districts. Development plans for the project area include: • Meh Poke village tract (education, bridge, electrification, and drinking water, budget MMK 58,500,000); • Yae Twin Gyi village tract (schools and roads, budget MMK 4,000,000); • 5-year plan for Kyaukme District (the expansion of Nawnghkio Township and a bridge on the road between Nawnghkio and Kyaukme).
General Administration Department, Ministry of Home Affairs	Manages land in villages and towns
Nawnghkio Hospital	Has 25 beds and a medical staff consisting of 2 doctors, 12 nurses and 8 health workers.
Taung Shae Hospital	Serves 13 village tracts and is under the management of Nawnghkio Central Hospital. Medical staff consists of 2 doctors, 6 nurses and 3 health workers. The hospital has sub-health centres in 4 villages with 1 midwife and 1 public health staff for each sub-health centre.

6 ENVIRONMENTAL BASELINE CONDITIONS

6.1 Topography and Landscape

The project area covers 70 km of river reach in a deeply incised valley with steep slopes in the range of 30° to 60° and no significant widening. The river valley cuts through the Shan Plateau to a depth of 900 m (on average) with a bottom width of around 70 m. The minimum width of the valley at river level is approximately 25 m and the maximum width approaches 160 m.

The Myitnge River originates from the northern Shan State mountain ranges and flows from east to west in the upper reaches of the proposed reservoir area before turning south near Nawnghkio Gyi village. The river then turns again in a westerly direction about 9 km upstream of the proposed dam site.

The river valley is generally V-shaped but with several near vertical cliffs creating a canyon-like topography. Several tributaries join the main Myitnge River downstream of the Upper Yeywa dam (under construction), including Gohteik River (at the river bend near Nawnghkio Gyi village) and another river about 4 km downstream of the Myitnge Bridge which forms a small alluvial fan at the confluence point where the river valley is widening. There are, however, no floodplains or alluvial terraces along the riverbanks because of the steep topography and the generally high water velocity.

From a landscape perspective, the most interesting tributary is the Nam-kam River which empties into the main river at the bend near Thar Si village (left bank). The Myitnge flows down a cascade of waterfalls, some of which create small spray zones at the foot of the falls (***Figure 7-15***, right). This location is the only one that is visited by people from outside the villages for recreational purposes, while the rest of the river valley is either inaccessible (due to topography) or only visited by local fishermen or hunters. The Myitnge Bridge is the only crossing point along the affected reaches of the Myitnge River (***Figure 7-14***, left).

The Myitnge River has a regular slope between a succession of smaller rapids of a few metres in height in the upper and middle reaches. However, in the downstream reaches the river profile is steeper with a drop in elevation of 50-55 m over a 1.5 km distance. This section is characterised by a series of fast-flowing rapids (***Figure 7-13***, right). Local fishermen are taking advantage of these rapids by catching fish at the downstream end of the rapids.

Figure 7-13: Myitnge River at Me Poke (left) and the rapids in the downstream reaches (right).

Figure 7-14: Myitnge Bridge (left) and Myitnge River immediately downstream of the bridge (right).

Figure 7-15: Myitnge River downstream of the rapids (left) and waterfall at Nam-kam River (right).

6.2 Geology and Soils

6.2.1 Regional Geology of Myanmar

The Myanmar region originates from[2]:

- lifting caused by the subduction of the northward moving Indian Plate below the Euro-Asian Plate in the East along the Andaman Megathrust Zone, and
- sea floor spreading centred in the Andaman Sea (see ***Figure 7-16***)[3].

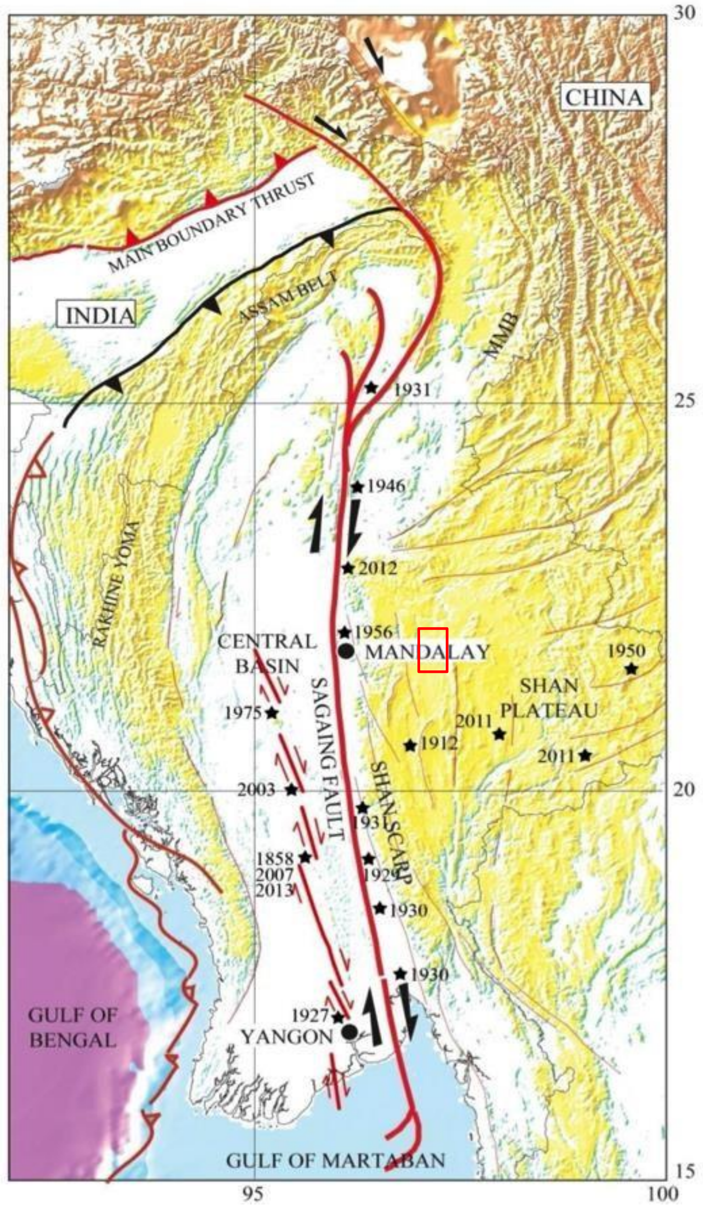


Figure 7-16: Generalised seismo-tectonic map of Myanmar with project area marked in red frame.

[2] Report on Regional Geology of Myanmar; Department of Geological Engineering, Faculty of Engineering, Gadjah Mada University, Jogjakarta, Indonesia, April 2010.

[3] Bender, F.: Geology of Burma; Beiträge zur regionalen Geologie der Erde, Band 16; Gebr. Bornträger, Berlin Stuttgart, 1983. Geology and Mineral Resources of Myanmar: Atlas of Mineral Resources of the ESCAP Region, Volume 12; Economic and Social Commission for Asia and the Pacific, United Nations, New York, 1996.

The north-south trending Sagaing Fault forms the major fault system of Central Myanmar and runs close to the west of the city of Mandalay. The same fault is often referred to as the Shan Boundary Fault. Close to the east of Mandalay, the Panlaung Fault approaches the Sagaing Fault from the SSE, and in the north the Lashio Fault approaches from the NE.

The Middle Yeywa project area is located to the east of Mandalay and to the east of the above-mentioned main fault zones, and to the south of the Lashio Fault within the Shan Plateau (Northern Shan State of the Sino-Burman Ranges).

Litho-stratigraphically, the Shan Plateau is built up of a sequence of dolomites, limestones, and some shales, referred to as Plateau Limestones (Group) or the Shan Dolomite Group and has a thickness of more than 3,000 m. The age of these sedimentary bedrock units ranges from Devonian (approximately 410 million years old) to Middle Triassic (approximately 230 million years old).

Small-scale geological maps of Myanmar also indicate that the Middle Yeywa project area has a uniform covering of the above-mentioned Plateau Limestones or Shan Dolomite Group (***Figure 7-17***).

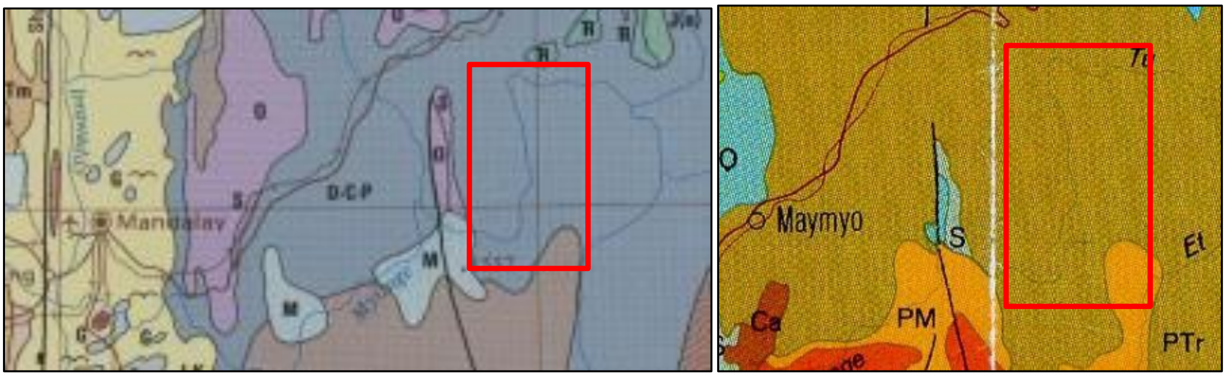


Figure 7-17: Extract from the geological map of 1977 (left) and 1980 (right). The project area is indicated by the red frame.

6.2.2 Geological Features of the Project Area

Geomorphology

The geomorphology of the relief of the Myitnge valley is the combined result of the lithological characteristics of the area, the geo-structural control and the effects of erosion.

The Myitnge River intersects and erodes the Shan Plateau in different phases which easily can be recognised in the middle section of the right river bank (***Figure 7-18***):

- The rim of the highest plateau level (between elevation 800 to 1100 masl) is clearly marked in the central part to the west (right bank) of the river, but far away from the current river path (red line) in the left bank;
- Below this uppermost plateau level a smaller intermediate plateau level (700 to 800 masl) with a less pronounced rim can be observed (blue line);
- The third level is marked with a wide plateau (500 to 700 masl.) ending in a rim to the narrow, deep and V-shaped gorge of the current Myitnge flow path (green).

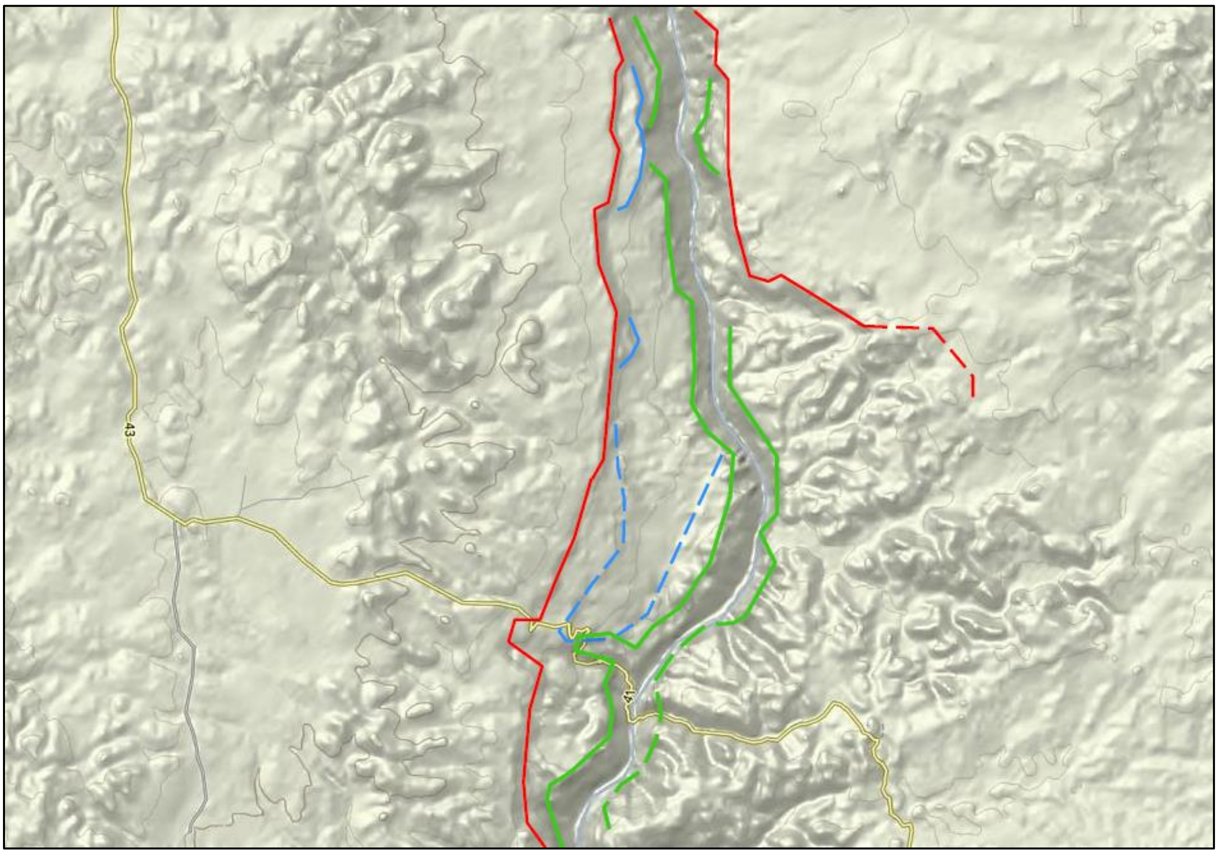


Figure 7-18: Main geomorphological features in the middle section of the project area.

In the area several karst phenomena (dissolution of carbonate bedrock by running water) were observed. On the uppermost plateau, limited by the red line in ***Figure 7-18***, no single karst-feature was observed. This is due to the thick cover by residual soils and agricultural land. In the cliffs of the dolomitic limestone below the red line, widespread caves of a few centimetres to several metres in width/ depth are observable. These caves are formed from the karst dissolution of limestone.

The caves observed within the dolomite (below the green line in ***Figure 7-18***) are solely a result of mechanical erosion of heavily brecciated areas by river water. In some areas the surface of the dolomite shows small karrens of only a few millimetres to a few centimetres in depth (***Figure 7-19***, left).

On the widely outcropping dolomite area along the Myitnge River valley, numerous vertical pots in the dolomite are present (***Figure 7-19***, right). They have a diameter and depth of several tens of centimetres, up to around one metre. These features are not of karst origin, but of mechanical erosion by cobbles and small boulders due to turbulent water flow.

Figure 7-19: Karren bedrock surface due to surface water corrosion (left) and mechanically excavated pots in hard dolomite due to turbulent flowing river water with cobble/boulders (right).

Litho-Stratigraphy

From the top of the plateau to the river bottom, four main geological units can be briefly described as follows:

Dolomitic Limestone: (***Figure 7-20***, left): A bedrock with varying shades of grey and texture. The limestone ($CaCO_3$) is partly dolomitized ($CaMg\ (CO_3)_2$), and brecciated with a heterogeneous distribution, and has widely spread cavities of several metres in size. This unit, which is several tens of metres in thickness, forms the uppermost cliff and rim of the geomorphology (red line in ***Figure 7-18***). Its base is probably widespread, brecciated and easily erodible, and forms the intermediate level of the middle platform and less prominent rim (blue line in ***Figure 7-18***) well above the project footprint and the future reservoir level (400 to 500 masl.).

Red Residual Soil: Layer covering the surface of the dolomitic limestone except on steep cliffs (***Figure 7-20***, right). This clayey material derives from tropical weathering of the bedrock and its thickness varies widely.

Dolomite: (***Figure 7-21***, left): Very thick (>100 m), mainly massy, partly moderately bedded bedrock of varying shades of grey and heterogeneously affected by tectonic impact. It can be moderately to densely jointed, with the joints being tight or healed by white thin calcite. As is the case with the dolomitic limestone, the dolomite is also partly heterogeneously brecciated and thus partly weakened from its usually high strength. Such zones or pots of a few centimetres to few metres in size are easily eroded by flowing (river) water and can form caves. All high cliffs and the V-shaped river valley below the green line in ***Figure 7-18*** are formed of this carbonatic rock.

Travertine: (***Figure 7-21***, right): This material can cover the three geological units described above from below the top cliff down to the Myitnge River. When ground water, oversaturated with dissolved calcite, dissipates or flows out of the bedrock, pressure and temperature conditions suddenly change and calcite precipitates at the surface, either on rock or on the vegetation, and forms the typical appearance of travertine sediments, which are varying considerably.

Figure 7-20: Dolomitic limestone with karst caves on left bank of Myitnge River (left) and red residual soil on top of the dolomitic limestone (right).

Figure 7-21: Massive dolomite with no signs of karst (left) and travertine outcropping along the Myitnge River close to the proposed dam site (right).

Hydrogeology

According to villagers, there are two different (and probably independent) groundwater levels in the Shan Plateau. The **shallow wells** are only a few metres deep (the well in ***Figure 7-22*** is 3 m deep) and end in the red residual soil. Some interconnected channels with gravelly material might collect rainwater penetrating the ground and feed the wells with young groundwater. During the rainy season, the groundwater level is reported to be higher than during dry season, but there is generally only a small fluctuation. The **deeper wells** (one well was reported to be approx. 50 m deep) are assumed to end in the dolomitic limestone underneath the residual soil and represent the karst groundwater in the rock unit.

Figure 7-22: Shallow water well ending in the residual soil.

The water supply for the villages on the Shan Plateau is secured by the following different sources:

- Collecting rainwater from the house roofs;
- From classical water wells only few metres deep;
- Collecting the groundwater in the residual soil and from boreholes several tens of metres deep by pumping groundwater from the dolomitic limestone.

According to Pöyry (2015), the hydrogeological features of the Shan Plateu and Myitnge valley are characterised by the following phenomena:

- There are two, probably independent, groundwater levels. The lower one is on a relatively high level within the Shan Plateau and within the dolomitic limestone;
- Running rivers with travertine deposits are observable from elevations at the level of the dolomitic limestone and thus most probably derive from karst springs within the dolomitic limestone;
- The main volume of bedrock eroded by the Myitnge River consists of dolomite, not showing typical karst phenomena (except some very superficial and small karrens due to thin joints healed with calcite). The only weak areas within this very strong bedrock are brecciated zones, prone to mechanical erosion;
- The extent and role of the brecciated layer between the dolomitic limestone and the dolomite are yet not clearly understood. Their geometry and impact on the karstification process, its presence, if it is a horizon prone for karstification or a barrier to karstification, are unknown at this moment. The current depth/base of karstification seems to be located somewhere inside the dolomitic limestone or directly above the upper limit of the dolomite, at the level of the groundwater level; and
- The dolomite seems not to be affected by the karstification process.

6.2.3 Seismicity

Myanmar is located within a tectonically complex and active region. ***Figure 7-23*** represents a structural interpretation of the Central Myanmar Basin and adjacent Shan Plateau from various satellite images. The figure shows that the Shan Plateau, where the Middle Yeywa Project is located, forms an island of considerably lower fault density than the surrounding areas.

Between the tail of the existing Yeywa reservoir and the Upper Yeywa dam site, only eight potential tectonic lineaments less than 1 km long could be identified. These lineaments are probably correlated with major local joints or faults but as far as observable, these lineaments could not be linked to the known active earthquake lineaments.

In Northern Myanmar most earthquakes occur to the west of and along the Shan Sagaing Fault (SSF) (***Figure 7-25***). The strongest historically recorded earthquake (Ms 7.8, 1946) was located on the Shan Sagaing Fault north of Mandalay. The reason for this concentration of earthquakes is the subduction of the Indian Plate underneath the Burma Sub-Plate (***Figure 7-24***).

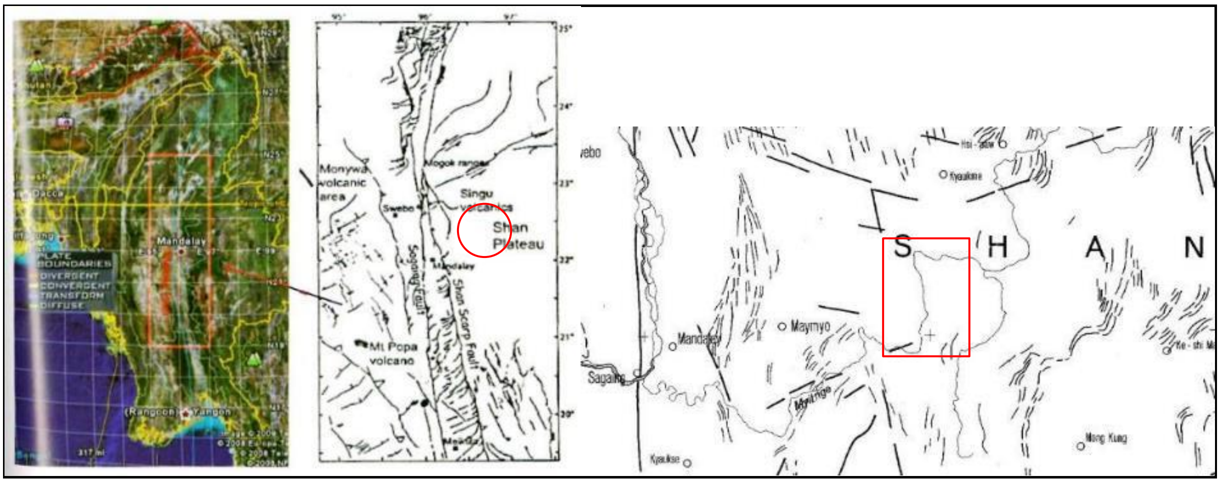


Figure 7-23: Left: Structural interpretation of the Central Myanmar Basin and adjacent Shan Plateau from various satellite images; Right: Extract from the Structural Map of Burma.

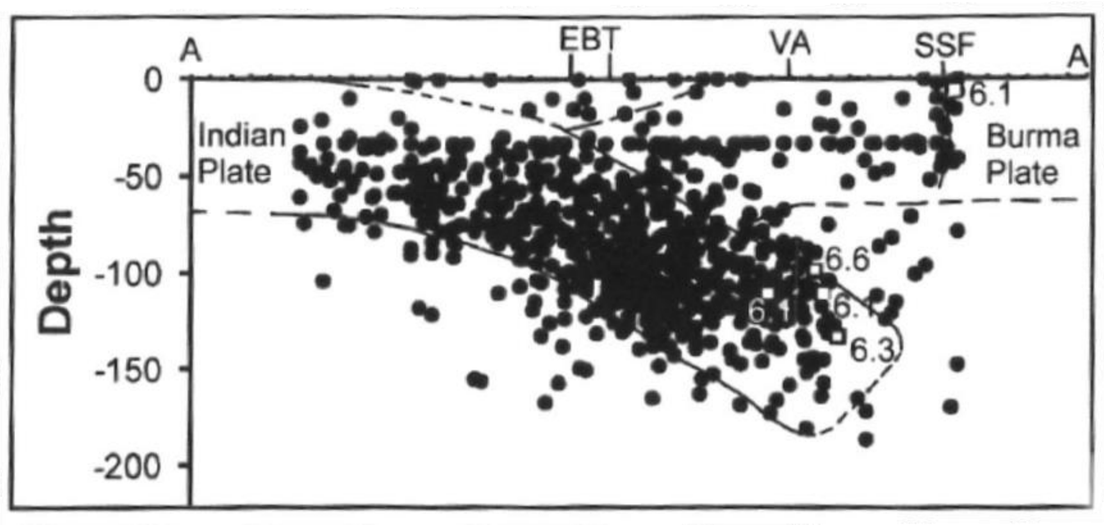


Figure 7-24: Seismic cross section along a W-E traverse; SSF = Shan Sagaing Fault.

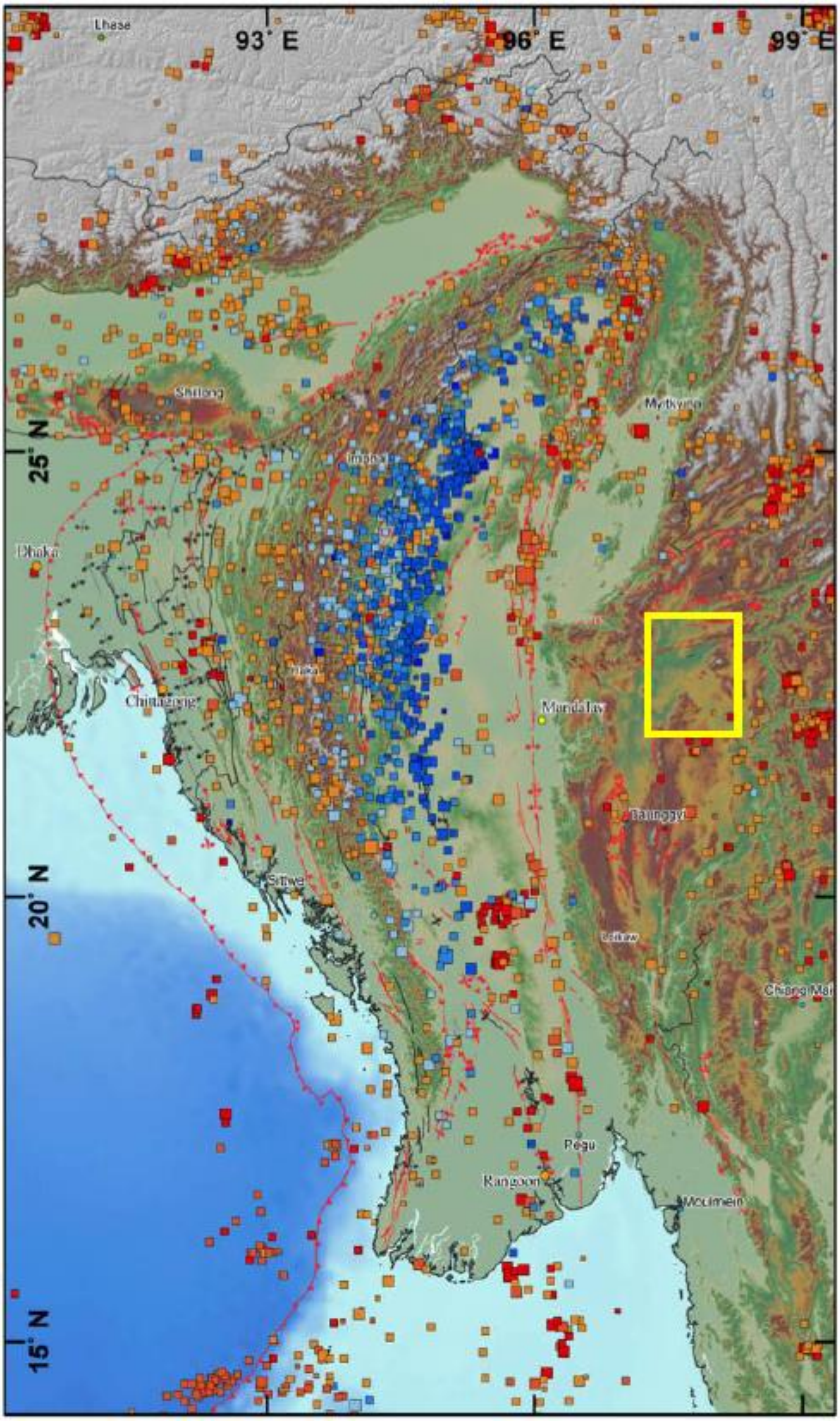


Figure 7-25: USGS/NEIC catalogue 1973-2008 showing earthquakes recorded in Myanmar. The project area is located within the yellow rectangle.

According to the Seismic Zone Map of Myanmar (revised version, 2012), the Middle Yeywa project area is located in the Seismic Zones III, near to Zones IV and V (Seismic Zone V is the maximum).

The Zone III indicates area of high damages, equivalent to MMI VII, and indicating PGA from 0.1g to 0.2g.

The Probabilistic Seismic Hazard Map of Myanmar (2012) for 10% probability of exceedance in 50 years (475 years recurrent interval) indicates for the Middle Yeywa project area peak ground acceleration (PGA) between <0.11g and 0.2g.

6.2.4 *Mineral Resources*

There are no known mineral deposits in the impact zone of the Middle Yeywa project (***Figure 7-26***). According to SN Power, the project will seek a waiver from the Department of Mines.

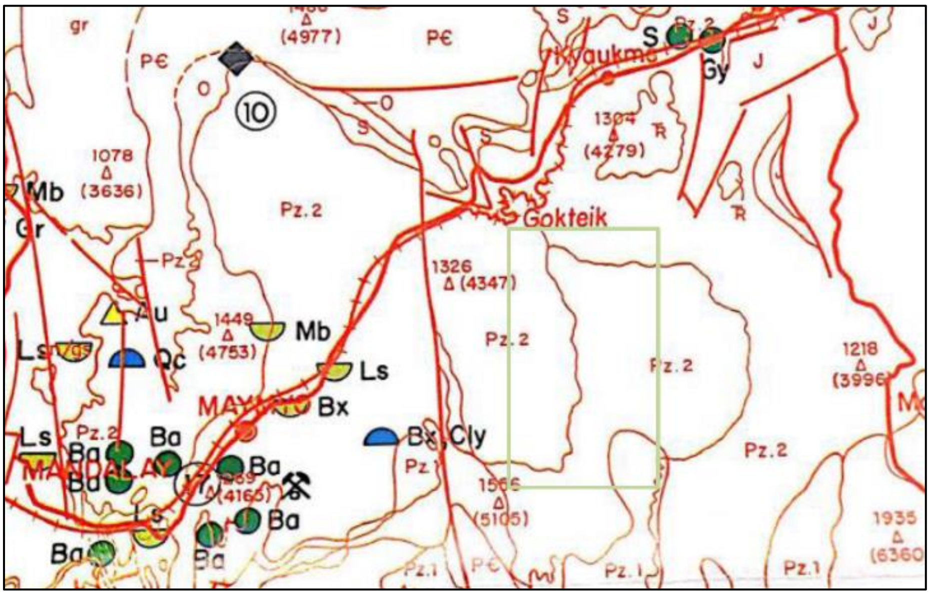


Figure 7-26: Extract from the Mineral Resource Map of Myanmar (scale 1:1,500,000). The project area is marked with a green rectangle.

6.2.5 *Soils*

Based on the FAO soil map (***Figure 7-27***), the dominant soils in the project area belong to the acrisol group. Such kind of soils is clay-rich and is associated with humid, tropical climate and often supports forested areas.

Acrisols have little weatherable minerals left. The contents of Fe-, Al- and Ti-oxides are comparable to those of Ferralsols or somewhat lower; the SiO_2/Al_2O_3 ratio is 2 or less. The clay fraction consists almost entirely of well-crystallized kaolinite and some gibbsite.

Acrisols under a protective forest cover have porous surface soils. If the forest is cleared, the valuable A-horizon degrades and slakes to form a hard surface crust. The crust allows insufficient penetration of water during rain showers with devastating surface erosion as an inevitable consequence. Many Acrisols in low landscape positions show signs of periodic water saturation.

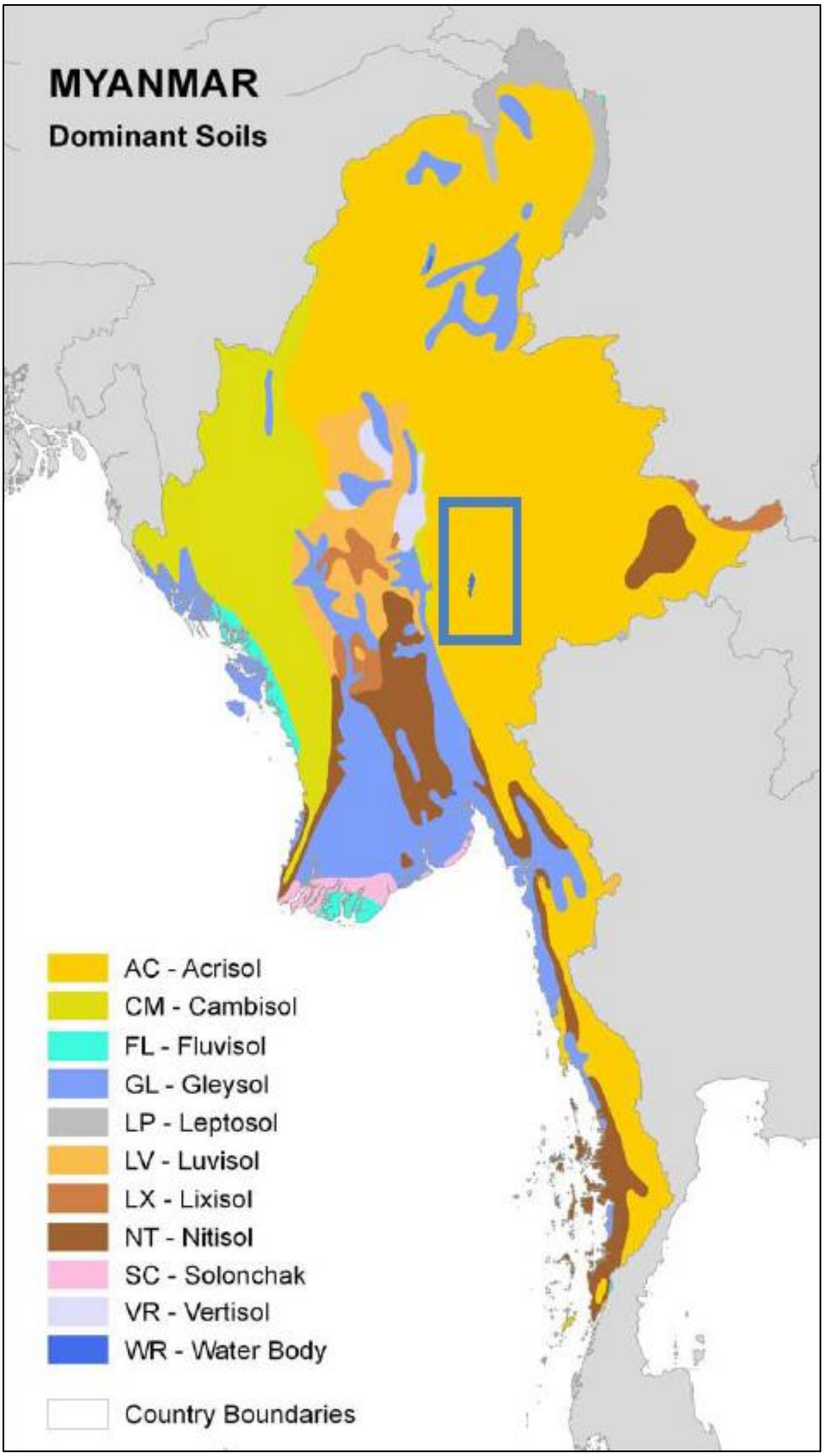


Figure 7-27: FAO soil map of Myanmar. The project area is shown by the blue rectangle.

Preservation of the surface soil with its important organic matter is a precondition for farming on Acrisols. Mechanical clearing of natural forest by extraction of roots and filling of the holes with surrounding surface soil produces land that is largely sterile because toxic levels of aluminium (the former subsoil) kill any seedlings planted outside the filled-in spots.

Adapted cropping systems with complete fertilization and careful management are required if sedentary farming is to be practiced on Acrisols. The widely used ‘slash and burn’ agriculture (‘shifting cultivation’) may seem primitive at first sight but is really a well-adapted form of land use, developed over centuries of trial and error. If cropping periods are short (one or a few years only) and followed by a sufficiently long regeneration fallow period (up to several decades), this system is a sustainable way of making use of resources of Acrisols.

Low-input farming on Acrisols is not very rewarding. Undemanding, acidity-tolerant cash crops such as pineapple, cashew or rubber can be grown with some success. Large areas of Acrisols are (still) under forest, ranging from high, dense rain forest to open woodland. Most of the tree roots are concentrated in the humus surface horizon with only few tap roots extending down into the subsoil.

Acrisols are suitable for production of rain-fed and irrigated crops only after liming (as practiced in the project area) and full fertilization. Rotation of annual crops with improved pasture maintains the organic matter content.

According to the Myanmar agricultural atlas, the project area is covered with mountainous red forest soil, mountainous brown forest soil and red earth and yellow soil (***Figure 7-28***):

- **Red-brown forest soils** develop under tropical evergreen forests and wet tropical monsoon forests mostly at altitudes between 300 m and 1,300 masl. These soils have the average humus content of 2% and the pH value is between 5.5 and 6.5.
- **Red earths** occur at altitudes around 1,000 masl. and mountain red earths are found at relatively higher altitudes. These soils cover the area from eastern Mandalay division, eastern Kayin, Kayah to, large parts of Shan Plateau. The humus content is between 2 and 4% in the light red earths and may be up to 8% in dark red earths. The pH value is between 6 and 7. Such soils are suitable for diversified agriculture. **Yellow earths** occur on level surfaces or slopes at lower altitudes on the Shan limestone plateau. They are less suited for agriculture when compared to red earths.

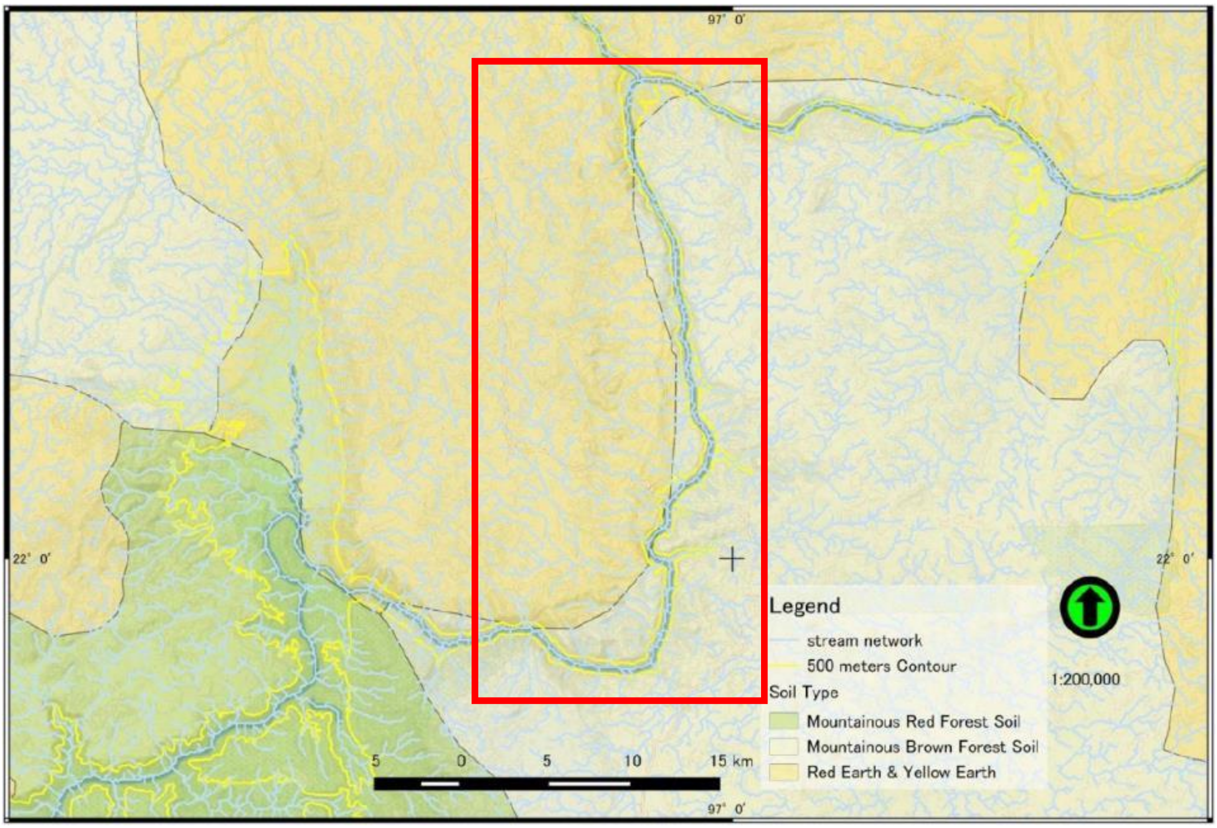


Figure 7-28: Myanmar agricultural atlas map. The project area is shown by the red rectangle.

6.3 Climate

6.3.1 Metrological Conditions

The Myitnge River basin has a subtropical monsoon climate. It is characterised by two seasons:

- A rainy season from mid-May to October where the monsoon of the Indian Ocean leads to overcast and rainy conditions, and
- A dry season from November to mid-May where continental dry west wind is prevailing in the upper air, with many sunny days and limited rain.

The period from November to February is cold and the period from March to April is hot. The southwest and the northeast monsoons distinguish the climate of the basin between dry and wet seasons. The southwest monsoon brings most rainfall (about 90% of the total annual rainfall) from mid-May until October.

The meteorological data at the Upper Yeywa Dam site is considered as the most representative for the Middle Yeywa project's impact zone thought the data only cover the period from 2010. Other metrological data exist from the Kyaukme station, north of Upper Yeywa, for the period 1985-1997. Mean monthly rainfall, temperature, evaporation and relative humidity for these two stations have been summarised in Tractebel (2017) and are detailed in ***Table 7-11***. Rainfall and evaporation for the Upper Yeywa station are illustrated in ***Figure 7-29***.

Table 7-11: Meteorological data near the Middle Yeywa dam site.

Parameters	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Annual
Upper Yeywa													
Rainfall (mm)	8	2	14	33	135	191	261	360	164	121	27	10	1,327
Temp. (°C)	15	16	19	24	25	25	24	24	24	22	20	16	21
Evap. (mm)	78	97	138	174	152	115	100	98	105	107	97	81	1,343
Humidity (%)	90	86	82	77	86	90	90	91	90	79	92	90	87
Kyaukme													
Rainfall (mm)	3	8	12	60	173	179	205	241	147	138	48	8	1,223
Temp. (°C)mean daily max	25.6	27.9	32.4	33.9	32.7	29.9	30.2	30.1	30.5	29.3	27.2	24.2	29.5
Temp. (°C)mean daily min	4.9	6.5	9.8	13.7	17.7	21.0	20.0	20.5	19.7	15.7	11.2	6.5	13.9
Evap. (mm)	96	118	181	194	176	145	148	144	137	131	98	80	1,648

Source: Tractebel (2017)

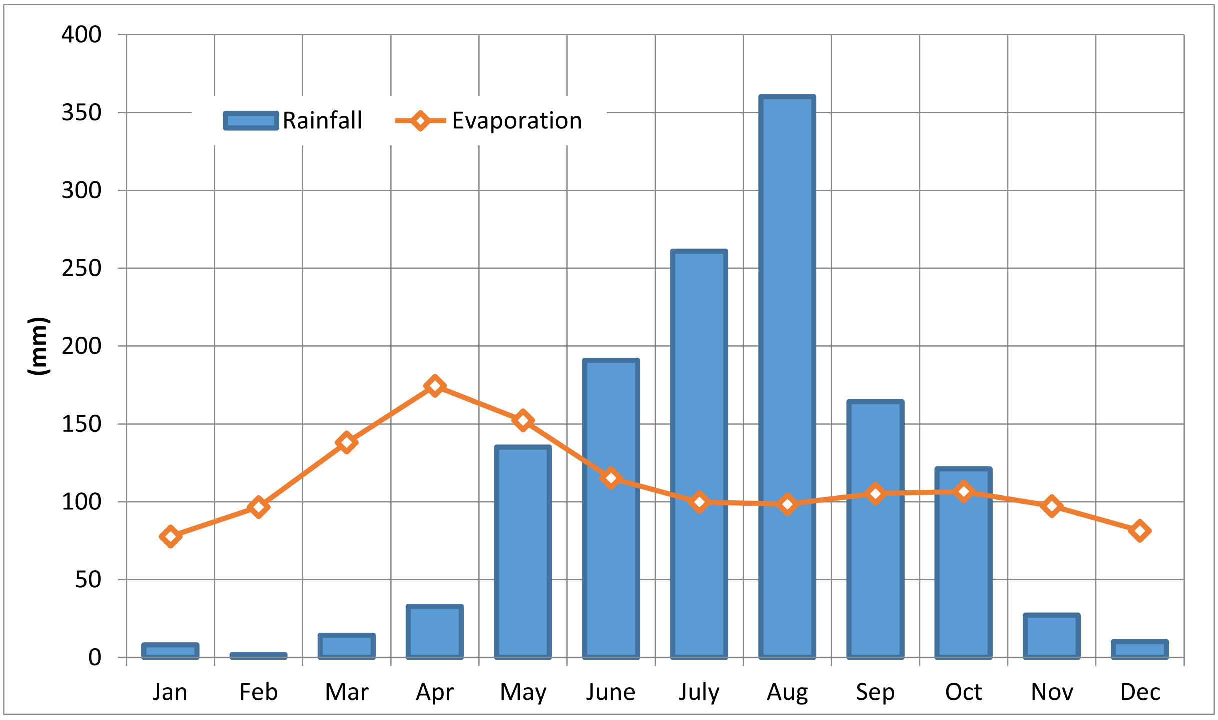


Figure 7-29: Rainfall and evaporation at the Upper Yeywa dam site.
Source: DHPI (in Tractebel 2017)

The distribution of mean annual precipitation within the Myitnge River basin is shown in ***Figure 7-30***. Mean annual precipitation ranges from 1,000 mm in the south-eastern part of the basin to 1,800 mm in the north-western part. Average basin precipitation is in the order of 1,300 mm.

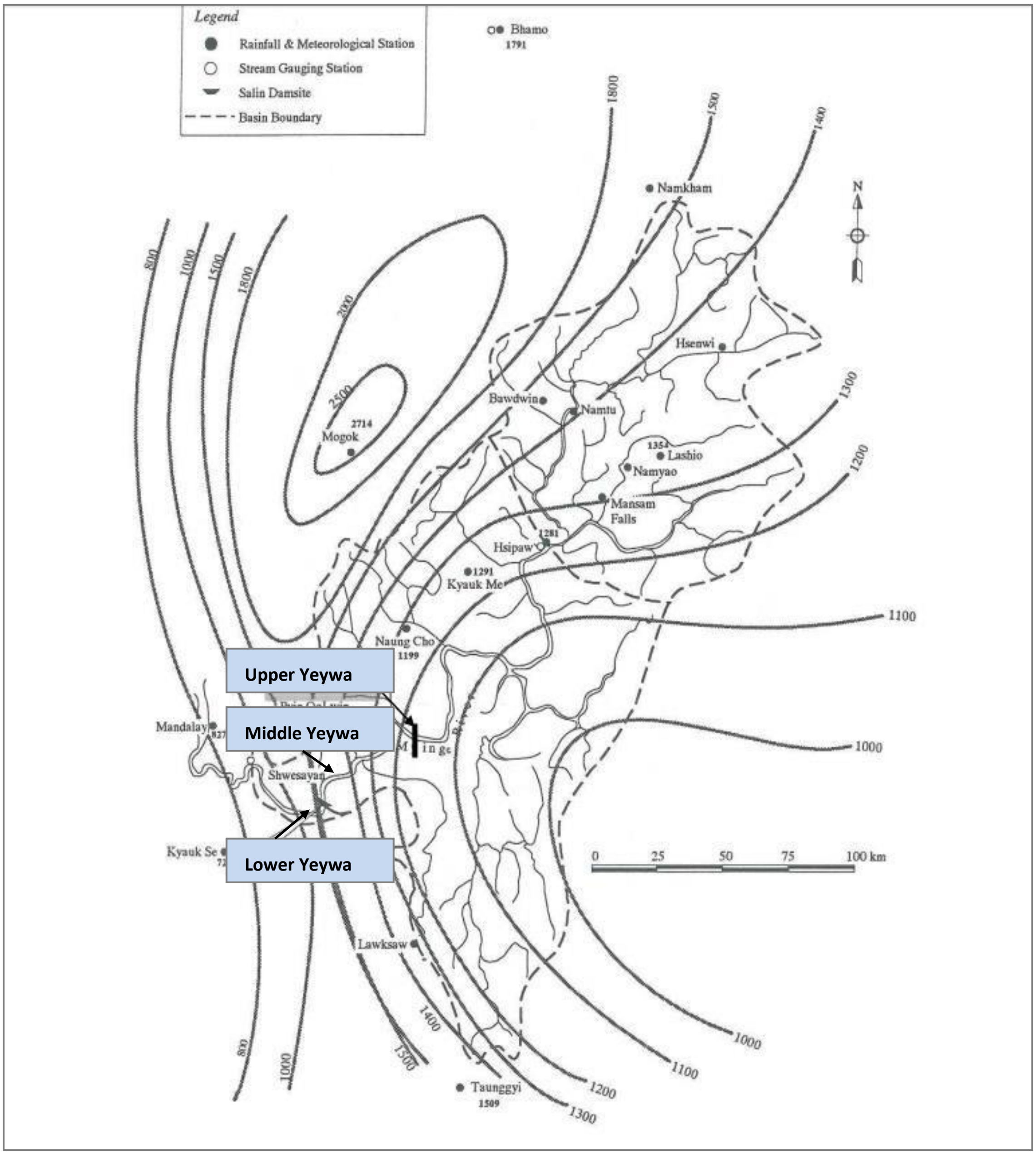


Figure 7-30: Isohyetal map of the project area.
Source: Colenco (2007)

6.3.2 Climate Change Projections

The salient features of the observed climate change in Southeast Asia are presented by the Intergovernmental Panel on Climate Change (IPCC 2014) as follows:

- It is very likely that mean annual temperature has increased over the past century over most of the Asia region.
- Across Southeast Asia, temperature has been increasing at a rate of 0.14°C to 0.20°C per decade since the 1960s, coupled with a rising number of hot days and warm nights, and a decline in cooler weather;
- In Southeast Asia, annual total wet-day rainfall has increased by 22 mm per decade, while rainfall from extreme rain days has increased by 10 mm per decade, but climate variability and trends differ vastly across the region and between seasons;

- In Southeast Asia, between 1955 and 2005 the ratio of rainfall in the wet to the dry seasons increased.

Projected climate change in Southeast Asia is forecasted by the IPPC (2014) as follows:

- Warming is very likely in the mid- and late-21st century. Ensemble-mean changes in mean annual temperature exceed 2°C above the late 20th-century baseline over most land areas in the mid-21st century under the worst case scenario (RCP8.5), and exceed 3°C over Southeast Asia in the late 21st-century.
- Precipitation increases are likely by the mid-21st century and very likely by the late-21st century under the RCP8.5 worst case scenario over southern areas.
- Future increases in precipitation extremes related to monsoon are very likely in Southeast Asia. More than 85% of the CMIP5[4] models show an increase in mean precipitation in the East Asian summer monsoons, while 95% of models project an increase in heavy precipitation events.
- The future influence of climate change on tropical cyclones is likely to vary by region, but there is low confidence in region-specific projections of frequency and intensity.

The observed and projected climate change more specific in Myanmar is presented in the Myanmar Climate Change Strategy and Action Plan (Ministry of Natural Resources and Environmental Conservation, 2016). The main features are as follows:

- Over the last six decades there was overall an increase in mean temperature of 0.08°C per decade while the observed increase in temperature during the last three decades was 0.35°C per decade for inland region.
- The annual total precipitation increased slightly between 1981 and 2010 with a rate of 37 mm/decade in inland according to some authors (Center for Climate Systems Research at Columbia University, WWF-Us and WWF-Myanmar, 2017) while recent DMH study showed on the contrary a decrease on annual precipitation with increase in average intensity.
- There was an increase in the intensity and frequency of cyclones and strong winds. Mala (2006), Nargis (2008) and Giri (2010) were the most severe and damaging cyclones experienced in Myanmar.
- In general, the duration of the monsoon has decreased with 125 day today against the previous 144 days resulting from a late on-set and early withdraw.

The more recent climate change projections for Myanmar revealed:

- A general increase in temperature with more extremely hot days.
- The Eastern and Northern Hilly Regions are likely to see the most dramatic warning among all regions of Myanmar, with hot season average temperatures rising by up to 3°C.
- An increase in rainfall variability during the rainy season including a most likely increase across the whole country from March-November, and a probable decrease between December and February.
- An increase in the occurrence and intensity of extreme weather events; including cyclones/strong winds, flood/storm surge, intense rains, extreme high temperatures and droughts.

The results of the climate projections for the Myitnge River basin are detailed in ***Table 7-12*** and ***Table 7-13***.

Overall, it can be observed that the increase in temperature is virtually certain since the climate projections for temperature are consistent. The magnitude of the increase in temperature is more uncertain as it depends on the RCP (Representative Concentration Pathway).

In contrast, the level of confidence regarding the change in rainfall is medium since the climate projections are not consistent except for the long term time horizon. Overall, an increase in

[4] Coupled Model Intercomparison Project Phase 5

precipitation is more likely than a decrease in precipitation whatever the time horizon. The results are thus consistent with the AR5 Report which states that "the increase in seasonal mean precipitation is pronounced in the East and South Asian summer monsoons" and that "there is medium confidence that monsoon-related inter-annual rainfall variability will increase in the future".

Table 7-12: Change in seasonal temperature with respect to 1986-2005.

Horizon		2016-2035			2046-2065			2081-2100		
		near term			mid term			long term		
	RCPs	25%	50%	75%	25%	50%	75%	25%	50%	75%
		Change in temperature (˚C) with respect to 1986-2005								
DJF	RCP4.5	1.00	1.25	1.50	1.50	2.00	2.50	2.00	2.50	3.00
	RCP8.5	1.00	1.25	1.50	2.50	3.00	3.50	3.50	4.50	6.00
MAM	RCP4.5	0.75	1.00	1.50	1.50	2.00	2.50	1.75	2.50	3.00
	RCP8.5	0.75	1.25	1.50	2.50	2.75	3.25	3.75	4.50	6.00
JJA	RCP4.5	0.75	1.25	1.50	1.50	1.75	2.25	1.75	2.00	2.50
	RCP8.5	0.75	1.25	1.50	2.25	2.75	3.00	3.75	4.50	5.50
SON	RCP4.5	0.75	1.25	1.50	1.50	1.75	2.25	1.75	2.25	2.75
	RCP8.5	0.75	1.25	1.50	2.25	2.75	3.00	3.75	5.00	6.00

Source: Tractebel (2017);
DJF = December, January, February; MAM = March, April, May; JJA = June, July, August; SON = September, October, November.

Table 7-13: Change in seasonal precipitation with respect to 1986-2005.

Horizon		2016-2035			2046-2065			2081-2100		
		near term			mid term			long term		
	RCPs	25%	50%	75%	25%	50%	75%	25%	50%	75%
		Change in precipitation (%) with respect to 1986-2005								
Oct-Mar	RCP4.5	-5%	-5%	5%	-5%	0%	5%	-5%	5%	15%
	RCP8.5	-5%	5%	5%	-5%	5%	10%	-5%	5%	15%
Apr-Sep	RCP4.5	-5%	5%	5%	5%	5%	15%	5%	5%	10%
	RCP8.5	-5%	5%	5%	5%	5%	15%	5%	15%	20%

Source: Tractebel (2017)

6.4 Air Quality

There are no industrial air pollution sources in the project's impact zone, and the traffic and transportation density on the local roads is relatively low with no significant dust pollution. Forest fires occur in the dry season, creating localised air pollution where the burning is taking place (away from settled areas). Background air quality measurements have been undertaken, but it is highly unlikely that the airshed is degraded under present conditions.

6.5 Noise and Vibration

No data exist on the present noise situation. However, due to the remoteness of the proposed construction sites, the low traffic volumes on the local roads, and the absence of major industrial activities in the direct impact zone, noise levels are considered insignificant and/or within the normal range of natural sounds.

6.6 Hydrology

6.6.1 Basin Characteristics

The Myitnge River, one of the tributaries of the Ayeyarwady River, originates from Mount Loi Swang at an elevation of 1,460 m on the northern Shah Plateau. The total drainage area is 34,800 km^2 and the river is about 530 km long. ***Table 7-14*** gives an overview of the areal dimension of the various catchments (see also ***Figure 7-31***).

Table 7-14: Estimation of the areal extension of the different sub-catchments.

Location	Catchment Area (km^2)
Hsipaw Gauging Station	12,289
Dam axis – Upper Yeywa	22,671
Dam axis – Middle Yeywa Alt. 1	24,585
Dam axis – Middle Yeywa Alt. 2	24,931
Dam axis – Middle Yeywa Alt. 4.2&5.2	25,490
Dam axis – Middle Yeywa Alt. 3,4.1&5.1	25,518
Dam axis – Lower Yeywa	28,710
Shwesayan Gauging Station	29,197
Confluence with Ayeyarwady River	34,800

Source: Pöyry (2015)

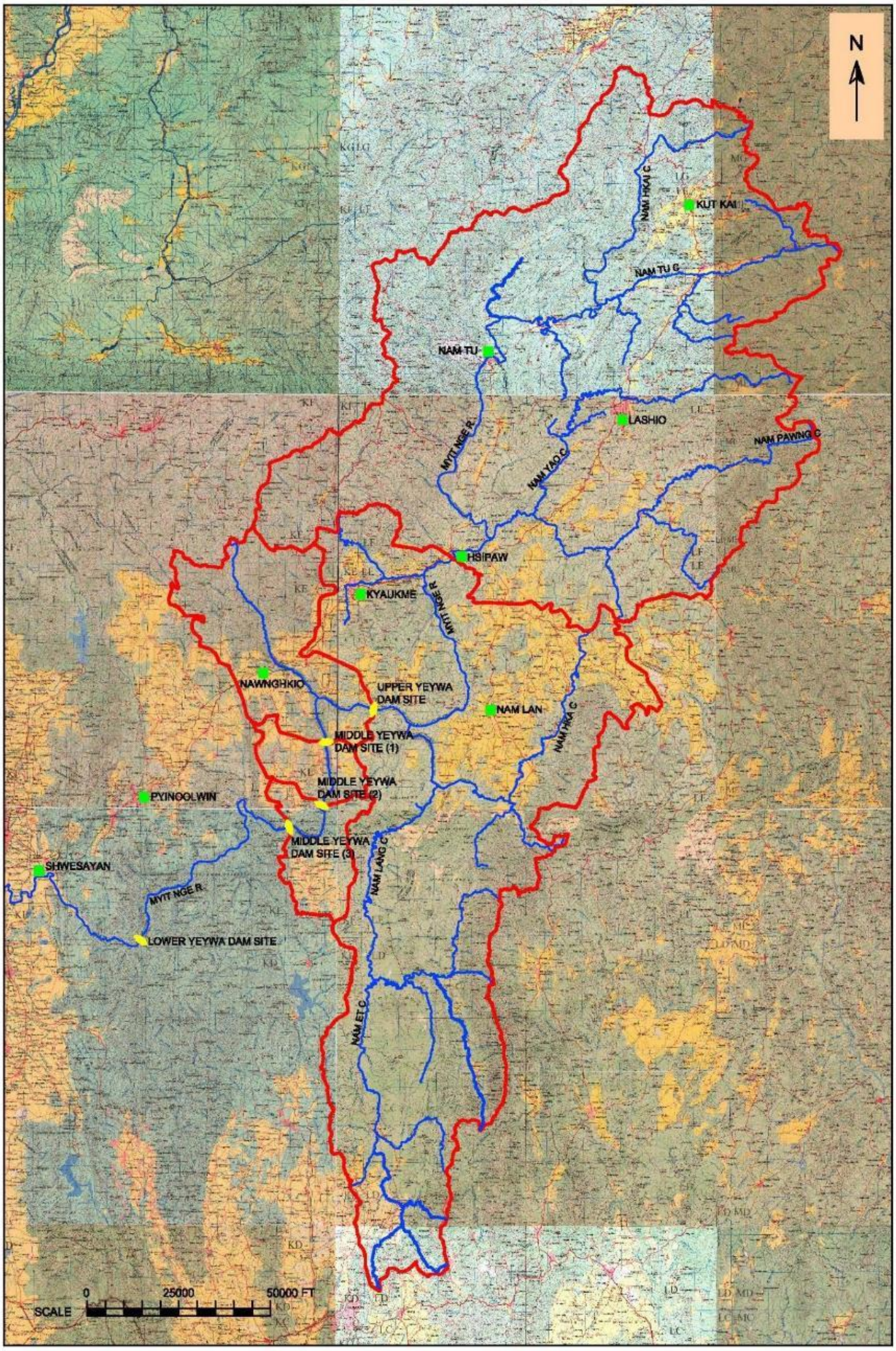


Figure 7-31: Myitnge river basin at the Middle Yeywa most downstream dam location.

6.6.2 Inflows

<u>Seasonal Variability</u>

The daily natural inflow series at Middle Yeywa (1984-2016) was obtained through hydrological modelling (Tractebel 2017). The inflows are characterised by a marked seasonal variability with low flows of about 100-150 m^3/s in March to May and high flows of about 950 m^3/s in August to September. The mean annual inflow is 458 m^3/s and the 95% exceedance frequency inflow is near 100 m^3/s.

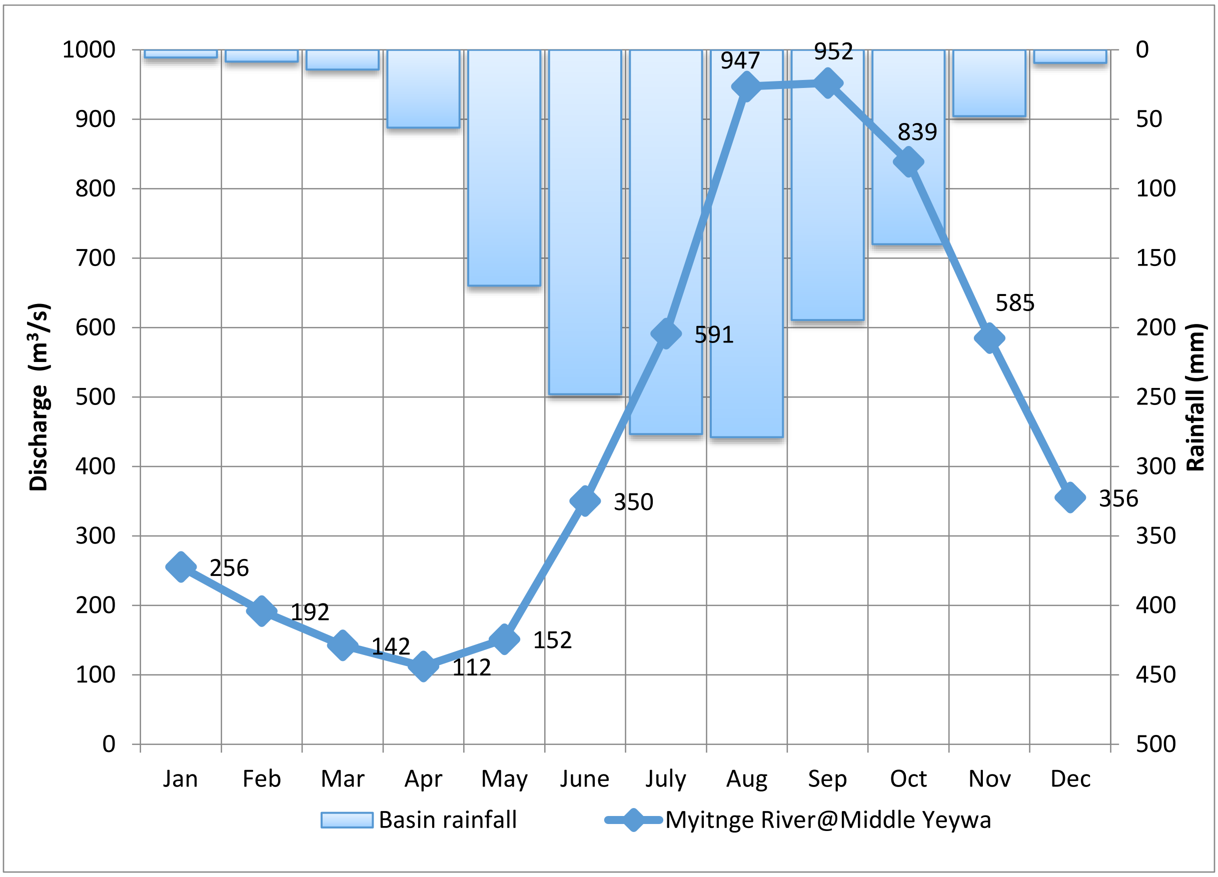


Figure 7-32: Mean monthly discharge and rainfall at Middle Yeywa.
Source: Tractebel (2017)

Table 7-15: Monthly series of inflows at Middle Yeywa (1984-2017).

	Monthly series of inflows at Middle Yeywa (25,400 km²) (m³/s)												
	Jan	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Q5%	188	142	108	85	86	169	360	573	616	548	349	247	**356**
Avg	256	192	142	112	152	350	591	947	952	839	585	356	**458**
Q95%	329	235	176	161	243	676	979	1377	1327	1247	845	465	**571**

Source: Tractebel (2017)

The daily inflow series at Middle Yeywa is represented in ***Figure 7-33***. Individual years are represented by a thin grey line. The daily inflows associated with an exceedance frequency of 5%, 50% and 95% are also represented by red color lines.

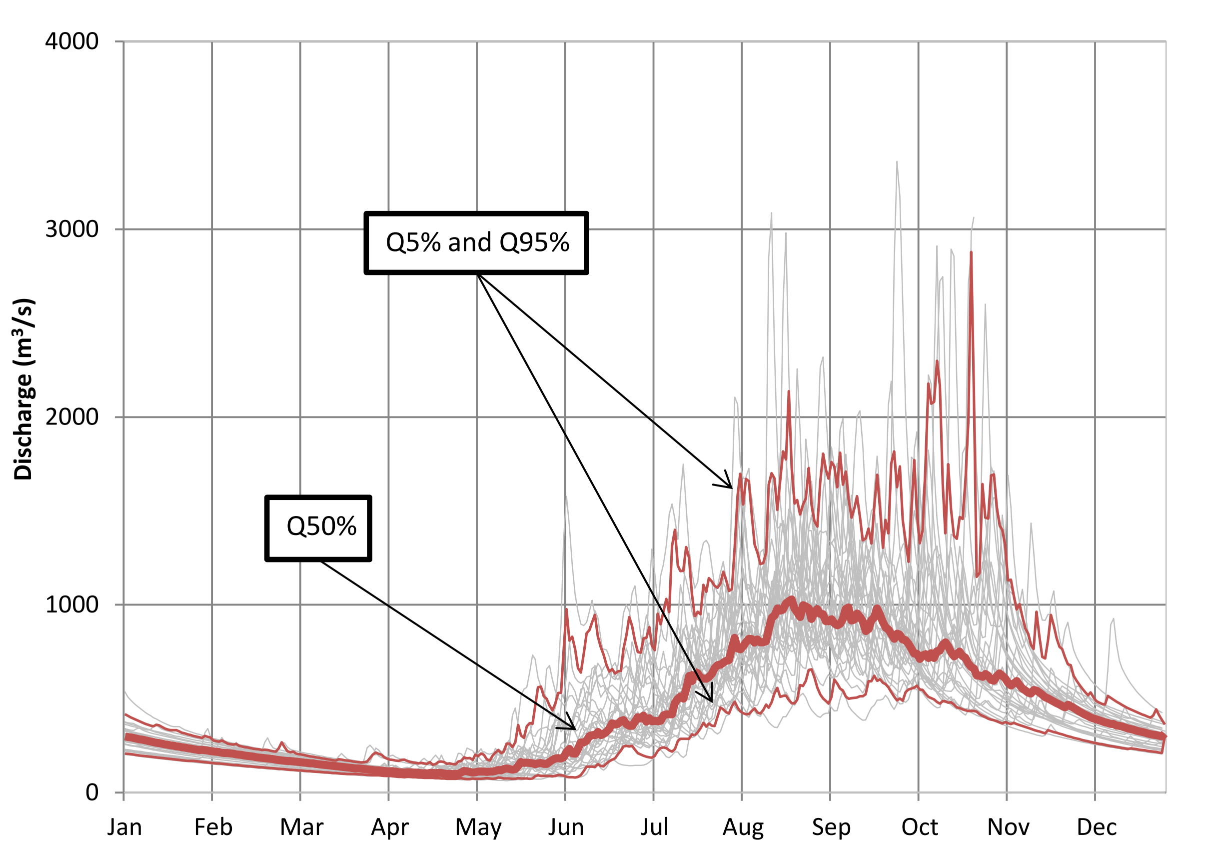


Figure 7-33: Daily inflow series at Middle Yeywa.
Source: Tractebel (2017)

<u>Flow Duration Curve</u>

The flow duration curve is calculated from the daily series of inflows at Middle Yeywa (Tractebel 2017). The results are given in ***Table 7-16*** hereafter.

Table 7-16: Daily inflows at Middle Yeywa - flow duration curve. Source: Tractebel (2017).

Exceedance frequency (%)	Daily inflow (m^3/s)	Exceedance frequency (%)	Daily inflow (m^3/s)	Exceedance frequency (%)	Daily inflow (m^3/s)
0	3,360	35	490	70	192
5	1,163	40	425	75	168
10	967	45	375	80	150
15	839	50	325	85	130
20	742	55	283	90	115
25	650	60	247	95	97
30	567	65	218	100	65

Source: Tractebel (2017)

The flow duration curves at Middle Yeywa are illustrated in ***Figure 7-34***. Individual years are represented by thin grey lines. The flow duration curve calculated for the entire period is represented by the marked red curve.

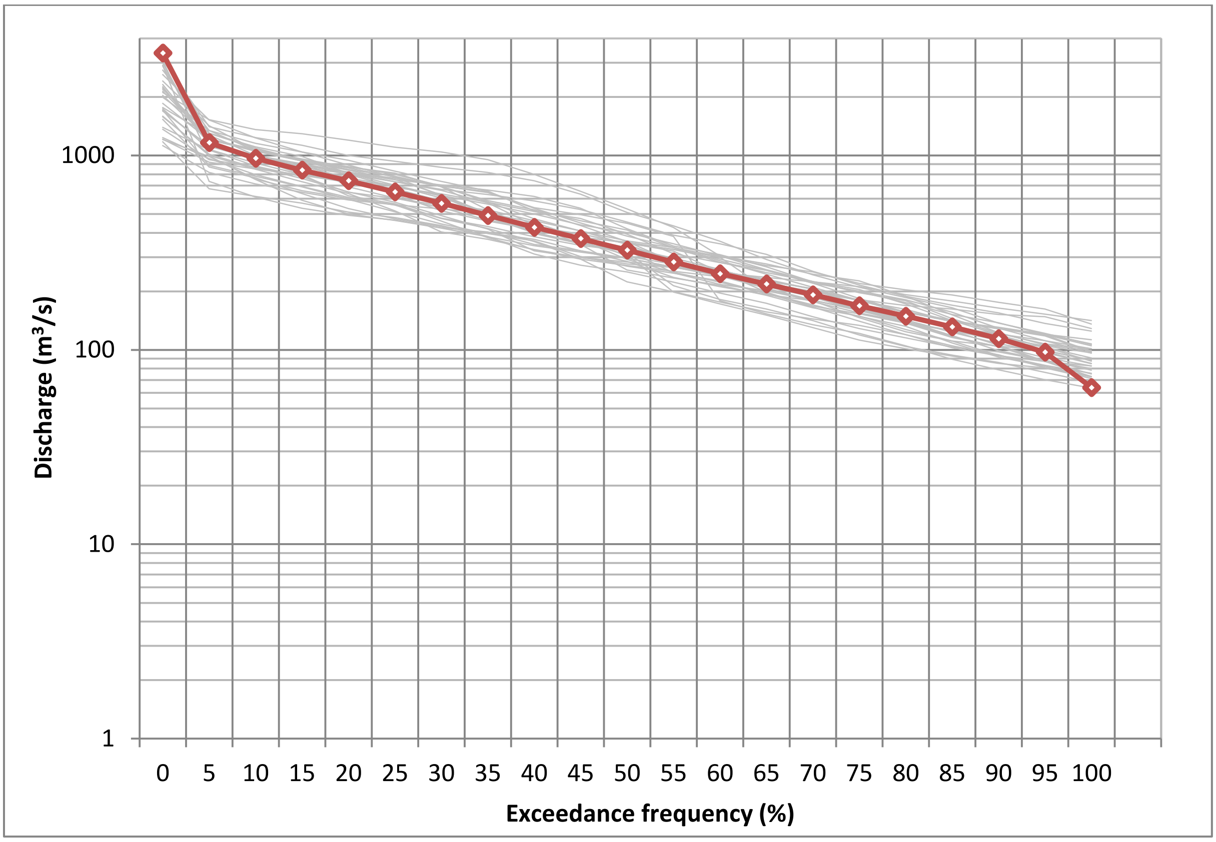


Figure 7-34: Daily inflows at Middle Yeywa – Flow duration curves.
Source: Tractebel (2017)

6.6.3 Floods

The flood assessment relies on both observed flood discharge statistical analysis and rainfall-runoff approach (Tractebel 2017). The major flood events in the Myitnge River are caused by long and spatially extended rainfalls. In addition, the soil moisture conditions (affecting the retention capacity) as well as the base flow play a major role. The analysis of the major flood events shows that the relevant duration for flood calculations is 7 days.

The hydrographs of the major flood events observed at Shwesayan Gauging Station (downstream of the existing Yeywa dam) reveal that more than 95% of the annual maximum flood events occur between August and November, with the majority occurring in September (37%) and August (33%). The modelled flood hydrographs for some selected return periods and for the Probable Maximum Flood (PMF) at Middle Yeywa are illustrated in ***Figure 7-35***. The PMF is estimated at 15,000 m^3/s.

Table 7-17: Flood volumes at Middle Yeywa for 7, 15 and 31 days.

Return period (years)	7 days flood volume at Middle Yeywa (million m^3)	15 days flood volume at Middle Yeywa (million m^3)	31 days flood volume at Middle Yeywa (million m^3)
10	1,350	2,200	3,400
100	2,140	3,300	4,900
1,000	3,540	5,300	7,450
10,000	4,930	7,300	10,050
PMF	7,750	11,300	15,250

Source: Tractebel (2017)

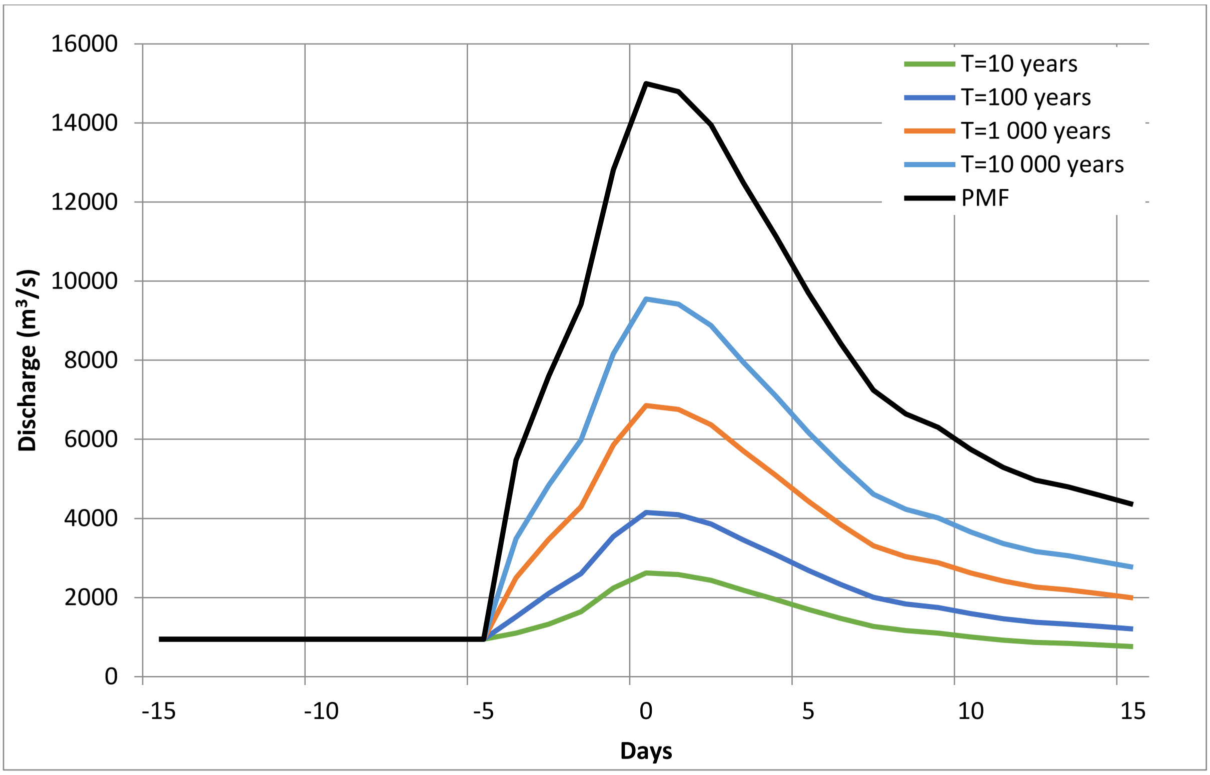


Figure 7-35: Flood hydrographs at Middle Yeywa.
Source: Tractebel (2017)

6.7 Sediment Transport

Sediment transport consists of suspended sediments and bedload. Unfortunately, few data are available on the sediment transport in the Myitnge River, but Tractebel (2017) has reviewed the existing documentation and conducted modelling of sediment loads. The total specific sediment yield has been estimated at 773 m^3/km/year. The assumed grain size distribution is 13% sand, 42% silt and 45% clay. In addition, it has been assumed that the bed load is 20% of the suspended load, i.e. 16.7% of the total load.

6.8 Water Quality

The sampling sites for water quality are shown in ***Figure 7-36*** and the recorded water quality data are presented in Table 7-18, Table 7-19 and

Table ***7-20***. For comparison, the classification of river water adopted by ASEAN is given in Table 7-21.

The water quality in the affected reaches of Myitnge River is generally favourable to aquatic life although it does not meet all drinking water quality standards.

Dissolved oxygen (DO) values ranged from 4.7 to 8.4 mg/l with the majority of samples having a DO level of 5-6 mg/l. The DO values were consistently higher during the monsoon season at peak river flow, and the highest DO values were recorded in the rapids (MYS 1-3 and MYS 1-4) and at MYS 1-8 near Me Poke. Generally, DO levels less than 4 mg/l can be detrimental to fish and other aquatic animals.

The only parameters that consistently exceeded national and international standards for potable water quality is nitrogen (NH_3-N) and turbidity, while some samples also had elevated levels of biological oxygen demand (BOD) and chemical oxygen demand (COD). The nitrogen level is not severely high but could be due to decomposition of animal wastes or chemical fertilizers (however, the recorded phosphorus level is insignificant).

BOD and especially COD are considered as effluent parameters showing if the river is polluted by human activities (e.g. industrial, agriculture or sewage). BOD levels ranged from 3.0 to 22.0 mg/l, while COD levels ranged from 6.2 to 55.9 mg/l. These values give evidence of some effluent inputs, probably from upstream cultivation and human settlements (including the only settlement at Myitnge Bridge), although not severe as compared to rivers with higher population densities. Indeed, the recorded values are within the limit values for treated wastewater (cf. World Bank / IFC EHS guidelines) and there is no evidence of faecal contamination (faecal coliforms and E. coli) in the water samples.

As expected, turbidity levels are higher in the high flow period (monsoon season) with values ranging from 69 to 115 NTU, compared to less than 50 NTU in the wet/hot season and less than about 20 NTU in the cold/dry season. Turbidity levels were however insignificant (2 NTU) immediately upstream (LYS1) and downstream of the Yeywa dam (LYS-2 and LYS-3), indicating that sediments are trapped in the reservoir.

It should be noted that additional water quality samples are planned to be collected from the Yeywa reservoir (downstream of the planned Middle Yeywa dam). These data will be reported in the final EIA report and could serve as an indication as to how the water quality characteristics of the Myitnge River will change after the filling of the reservoir.

Table 7-18: Water quality data for cold/dry season (February/March 2015) in Myitnge River.

Sample	Unit	MYS1-1	MYS1-2	MYS1-3	MYS1-4	MYS1-5	MYS1-6	MYS1-7	MYS1-8	MYS1-9
pH		7.95	7.99	7.76	7.77	7.93	8.0	8.3	7.78	7.91
BOD	mg/l	4.0	3.4	3.0	3.5	4.2	6.5	4.2	6.5	6.2
COD	mg/l	8.3	6.2	14.8	6.4	8.8	14.8	6.2	14.8	14.8
TSS	mg/l	0.04	0.04	0.08	0.08	0.32	0.64	0.72	0.68	0.32
Copper	mg/l	0.000	0.002	0	0.012	0	0	0.007	0	0.005
Iron	mg/l	0.03	0.02	0.01	0.01	0.02	0.03	0.03	0.01	0.03
Zinc	mg/l	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NH_3-N	mg/l	6.9	11.04	2.76	4.83	6.21	6.21	4.83	4.15	3.45
Phosphorus	mg/l	0.02	0.01	0.02	0.04	0.01	0.01	0.02	0.03	0.01
EC	µS/cm	472	416	422	420	417	410	410	417	418
Turbidity	NTU	17	14	20	19	20	20	10	21	20
DO	mg/l	5.2	5	5	5.2	4.7	4.7	4.7	5	5.2
Salinity	%	0.02	0.01	0.01	0.01	0	0	0	0.01	0.01
Tot. Coliform	N.	>16	>16	>16	>16	>16	>16	>16	>16	>16
Faecal Coliform	N.	0	0	0	0	0	0	0	0	0
E. coli	N.	0	0	0	0	0	0	0	0	0

Table 7-19: Water quality data for wet/hot season (May 2015) in Myitnge River.

Sample	Unit	MYS1-1	MYS1-2	MYS1-3	MYS1-4	MYS1-5	MYS1-6	MYS1-7	MYS1-8	MYS1-9
pH		7.39	7.46	7.35	7.46	7.49	7.49	7.47	7.41	7.38
BOD	mg/l	5.0	4.1	4.0	3.7	5.0	6.7	4.3	4.5	4.2
COD	mg/l	9.7	7.6	7.5	7.1	10.5	15.0	6.4	6.8	11.5
TSS	mg/l	0.28	0.52	0.60	0.52	0.35	0.48	0.80	0.64	0.04
Copper	mg/l	0.000	0.000	0.208	0.005	0.001	0.000	0.000	0.006	0.003
Iron	mg/l	0.15	0.10	0.05	0.04	0.05	0.06	0.10	0.40	0.10
Zinc	mg/l	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NH_3-N	mg/l	5.60	16.80	9.10	9.80	11.20	9.10	12.60	13.30	11.20
Phosphorus	mg/l	0.01	0.06	0.03	0.02	0.02	0.04	0.01	0.05	0.01
EC	µS/cm	400	420	426	425	443	410	410	434	421
Turbidity	NTU	45	47	50	47	37	42	45	37	27
DO	mg/l	5.2	5.3	5.2	5.3	5.1	5.2	5.2	5.3	5.3
Salinity	%	-	-	-	-	-	-	-	-	-
Tot. Coliform	N.	>16	>16	>16	>16	>16	>16	>16	>16	>16
Faecal Coliform	N.	0	0	0	0	0	0	0	0	0
E. coli	N.	0	0	0	0	0	0	0	0	0

Table 7-20: Water quality data for late monsoon season (September/October 2015) in Myitnge River.

Sample	Unit	MYS1-1	MYS1-2	MYS1-3	MYS1-4	MYS1-5	MYS1-6	MYS1-7	MYS1-8	MYS1-9	LYS-1	LYS-2	LYS-3
pH		7.31	7.51	7.34	7.26	7.26	7.20	7.44	7.25	7.28	8.06	7.64	7.94
BOD	mg/l	4.4	7.0	14.5	22.0	10.6	3.0	5.3	17.0	4.2	5.0	3.1	3.0
COD	mg/l	8.8	17.6	36.3	55.9	26.4	7.1	13.2	44.7	10.5	11.9	7.3	7.3
TSS	mg/l	0.48	1.12	0.20	0.40	0.52	0.44	0.60	0.96	0.68	0.52	0.44	0.64
Copper	mg/l	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Iron	mg/l	0.50	0.30	0.20	0.50	0.20	0.15	0.10	0.20	0.45	0.05	0.10	0.05
Zinc	mg/l	0.036	0.016	0.012	0.008	0.027	0.004	0.004	0.019	0.003	0.003	0.017	0.000
NH_3-N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Phosphorus	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
EC	µS/c	-	-	-	-	-	-	-	-	-	-	-	-
Turbidity	NTU	69	95	115	113	105	91	96	114	112	2	2	2
DO	mg/l	5.7	5.7	7.5	7.5	6.5	5.6	7.5	8.4	6.9	5.6	5.6	5.8
Salinity	%	-	-	-	-	-	-	-	-	-	-	-	-
Tot. Coliform	N.	>16	>16	>16	>16	>16	>16	>16	>16	>16	>16	>16	>16
Faecal Coliform	N.	0	0	0	0	0	0	0	0	0	0	0	0
E. coli	N.	0	0	0	0	0	0	0	0	0	0	0	0

Table 7-21: Classification of river water (adopted by ASEAN).

Parameter	Class I: Potable water	Class II: Recreation	Class III: Commercial Fisheries	Class IV: Irrigation
pH	6-9	6-9	5-9	5-9
BOD (mg/l)	5	5	10	10
COD (mg/l)	30	30	100	100
Amm – N (mg/l)	0.3	0.3	1	3
TSS (mg/l)	50	50	150	300
DO (mg/l)	5	5	3-5	3
Faecal Coliform (counts/100) ml)	-	1000	-	-

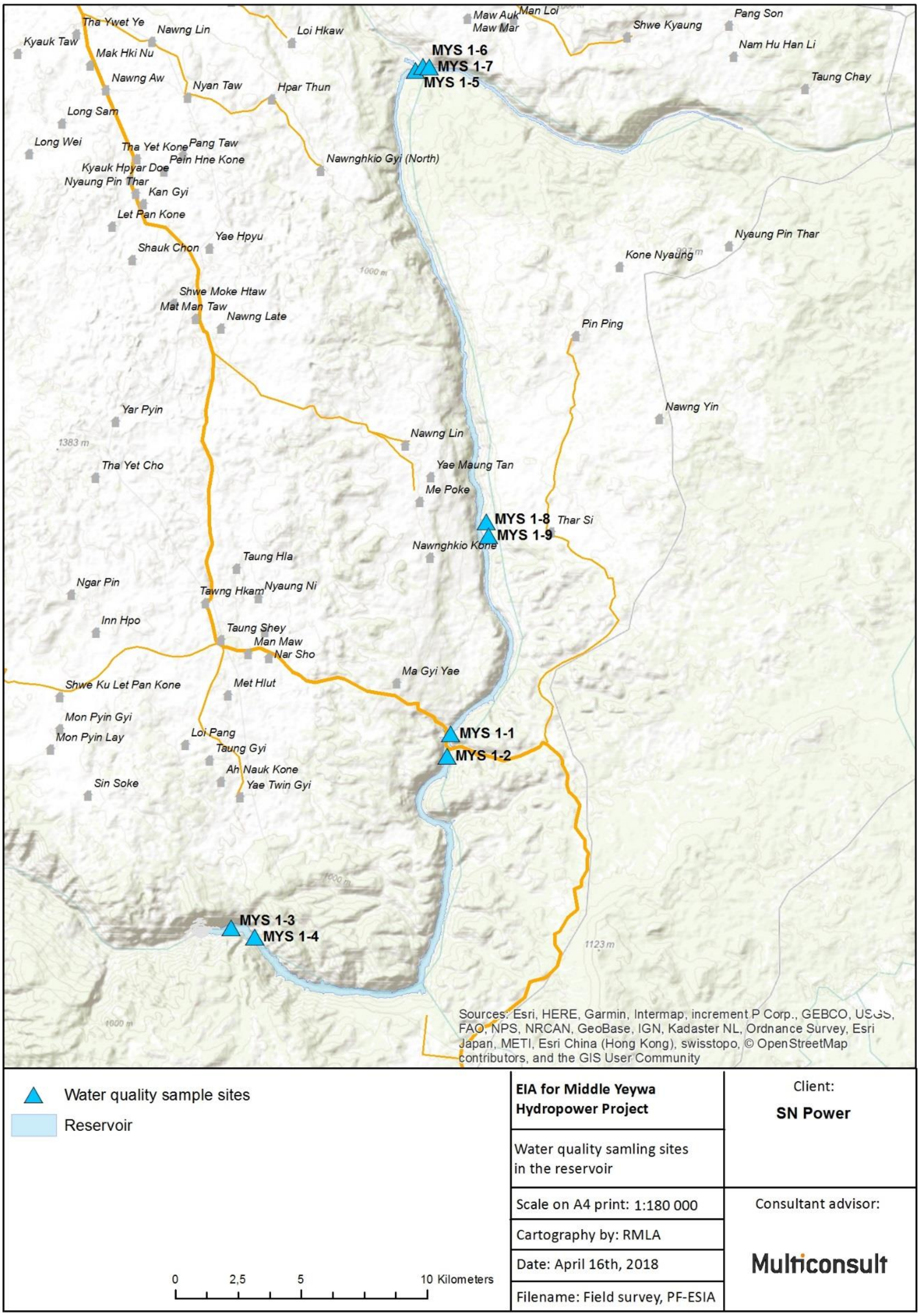


Figure 7-36: Sampling sites for water quality.

6.9 Biodiversity and Protected Areas

6.9.1 The Biodiversity Context

The Project is located within the Indo Burma Biodiversity Hotspot (Mittermeier *et al.*, 2004). This is one of the world's 35 biodiversity hotspots. The Indo Burma Biodiversity Hotspot originally covered an area of 2,373,000 km^2 (see ***Figure 7-37***). Biodiversity hotspots are the world's biologically richest and most threatened regions. The Indo Burma Biodiversity Hotspot covers a range of forest types with high diversity and limestone karst that supports distinctive vegetation formations with high levels of endemism particularly among plants, reptiles, and molluscs.

Less than five percent of the natural habitat in the Indo Burma hotspot remain, and the hotspot has more people than any other biodiversity hotspot globally. Hydropower development is acknowledged as one of the threats to biodiversity in the hotspot.

The Indo-Burma hotspot encompasses all or parts of seven Endemic Bird Areas defined by BirdLife International (Stattersfield *et al*., 1998, as updated by http://www.birdlife.org/datazone/), twelve of the Global 200 Ecoregions defined by WWF (Olson *et al*., 2000) and 28 Centres of Plant Diversity defined by the International Union for Conservation of Nature, IUCN (Davis *et al*., 1995).

Recognising the biodiversity importance of the larger region, the project developer has placed emphasis on analysing and understanding whether the project area is unique and undertaking field work to confirm desk review findings.

The Middle Yeywa project area is not located in any of these Endemic Bird Areas or centres of plant diversity. The project area is not located in any of the montane areas or the lowland evergreen forest areas that in geological and evolutionary time have been isolated and consequently developed high levels of localised endemism. The project is therefore not located in one of the areas within the larger biodiversity area that is of particularly high conservation value.

Figure 7-37: The boundaries of the Indo-Burma Biodiversity Hotspot defined by Mittermeier et al., (2004), which includes most of Myanmar except areas in the north of the country.

Overall, the biodiversity recorded in the Project's direct and indirect impact zones was not found to be unique. The ecosystems, habitats and species documented are relatively widespread. Sections 6.10 - 6.12 below provide further information, including on the ecosystems, habitats and species considered most important from a conservation perspective.

The terrestrial biodiversity has been and continues to be substantially negatively impacted by human disturbance, for instance logging of high value timber species, conversion of forest areas to agriculture, and hunting (see Figures 6-26 to 6-28). Some of the steep and less accessible areas towards the river have been less impacted by habitat conversion but hunting tends to be concentrated in these areas. The aquatic biodiversity is particularly impacted by hydropower development downstream and upstream of the Middle Yeywa Project.

Very likely, the project area will be subject to further pressures from human activities. The likely future scenario without the Project is therefore one with continued negative impacts on biodiversity, and this scenario provide the basis for comparison when considering likely project impacts.

Figure 7-38: Recent conversion of forest to agriculture on the left bank near Tar Si Village

Figure 7-39: Small-scale logging of selected hard wood species using chain saw in very steep slopes towards the Myitnge River near Nawnghkio Gyi Village. Wood is carried up the steep slopes.

Figure 7-40: Hunting for mammals and birds is practiced by local people using very simple technologies such as home-made guns using gun powder and small balls from bearings as ammunition. Hunting using dogs is also common.

6.9.2 Protected Areas

As can be seen in Figure 6-29, there are no confirmed protected areas in the Project's impact zones. The nearest protected area recorded in the World Database on Protected Areas is Pyin Oo Lwin Wildlife Sanctuary and is located approximately 35 km west of the dam site. This wildlife sanctuary appears to be a 'paper park' as the natural habitats have been largely converted to agricultural land and partly residential areas of Pyin Oo Lwin.

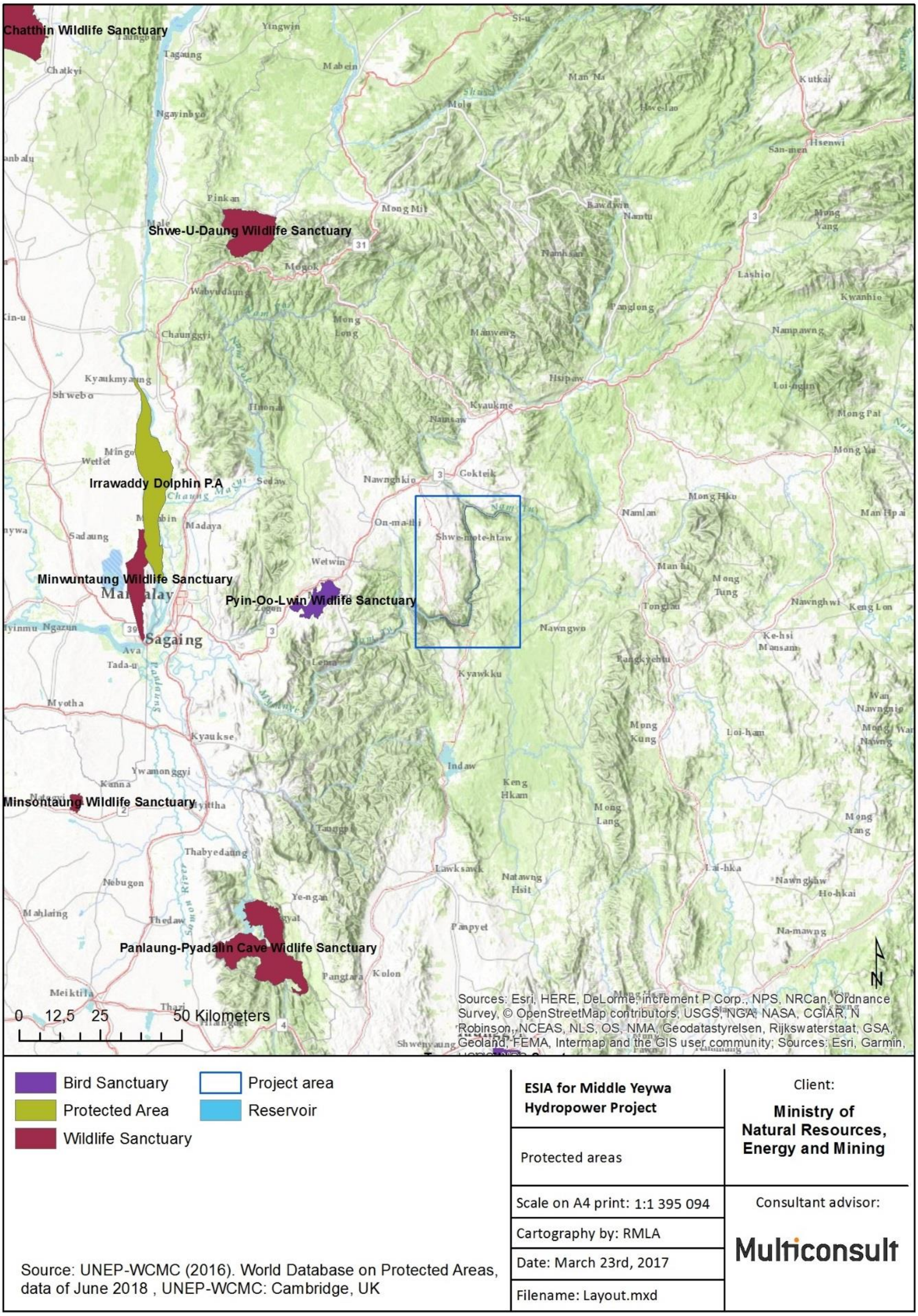


Figure 7-41: The Protected Areas closest to the project.

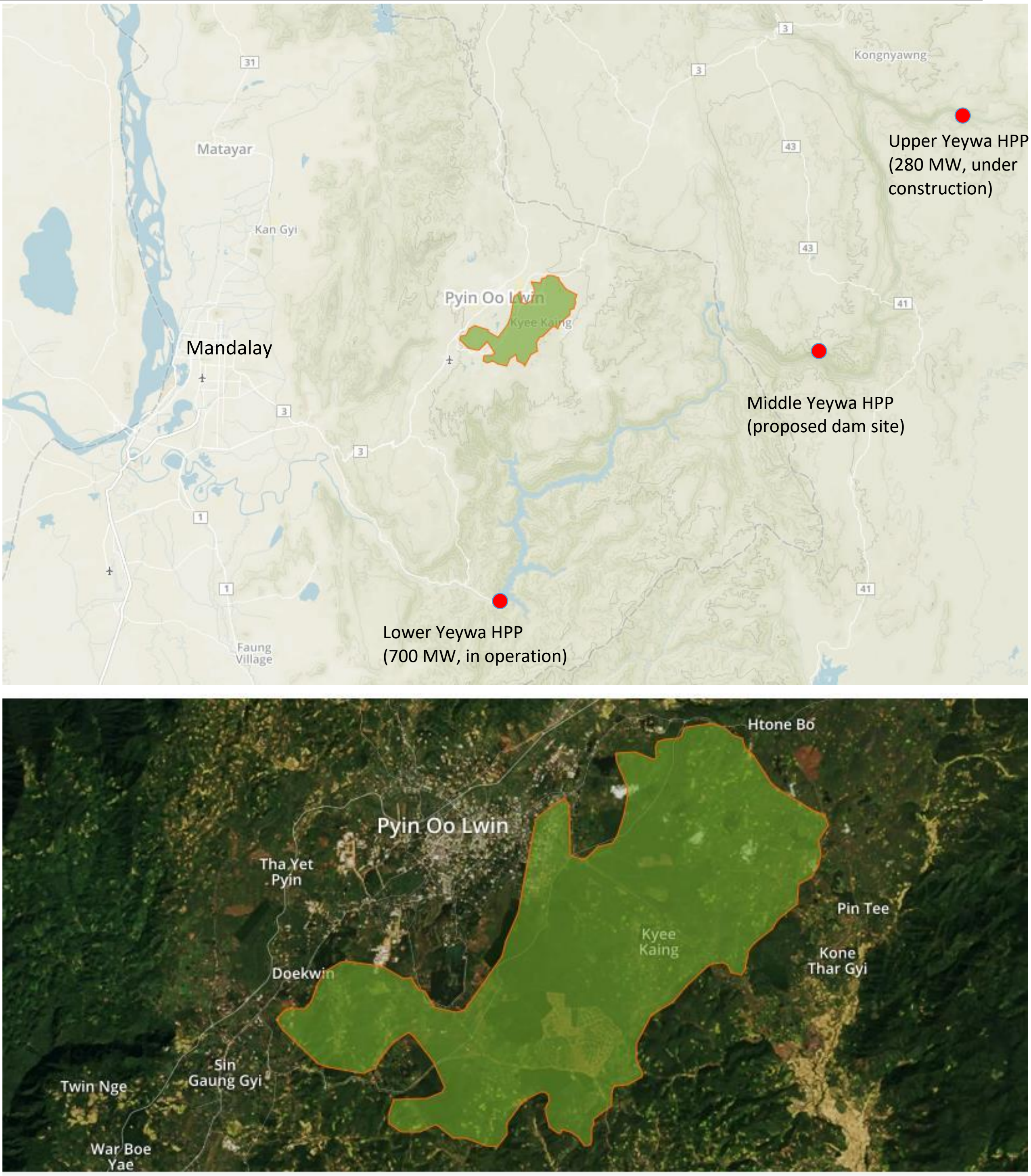


Figure 7-42: Upper map showing the location of the Pyin Oo Lwin Wildlife Sanctuary approximately 35 km west of the proposed Middle Yeywa dam site. Lower satellite image showing land conversion within the Pyin Oo Lwin Wildlife Sanctuary.
Source: www.protectedplanet.net

There is potentially a forest reserve in parts of the project area on the left bank upstream of the Nam-kam River to the upper end of the reservoir. The World Database on Protected Areas and publications on protected areas in Myanmar do not reflect any protected area along the river's left bank, but the potential existence or previous proposal for protection of an area on the left bank requires further clarifications from authorities in Myanmar. The area on the left bank proposed for the Naung Lon Forest Reserve is shown on the map in **Error! Reference source not found.**.

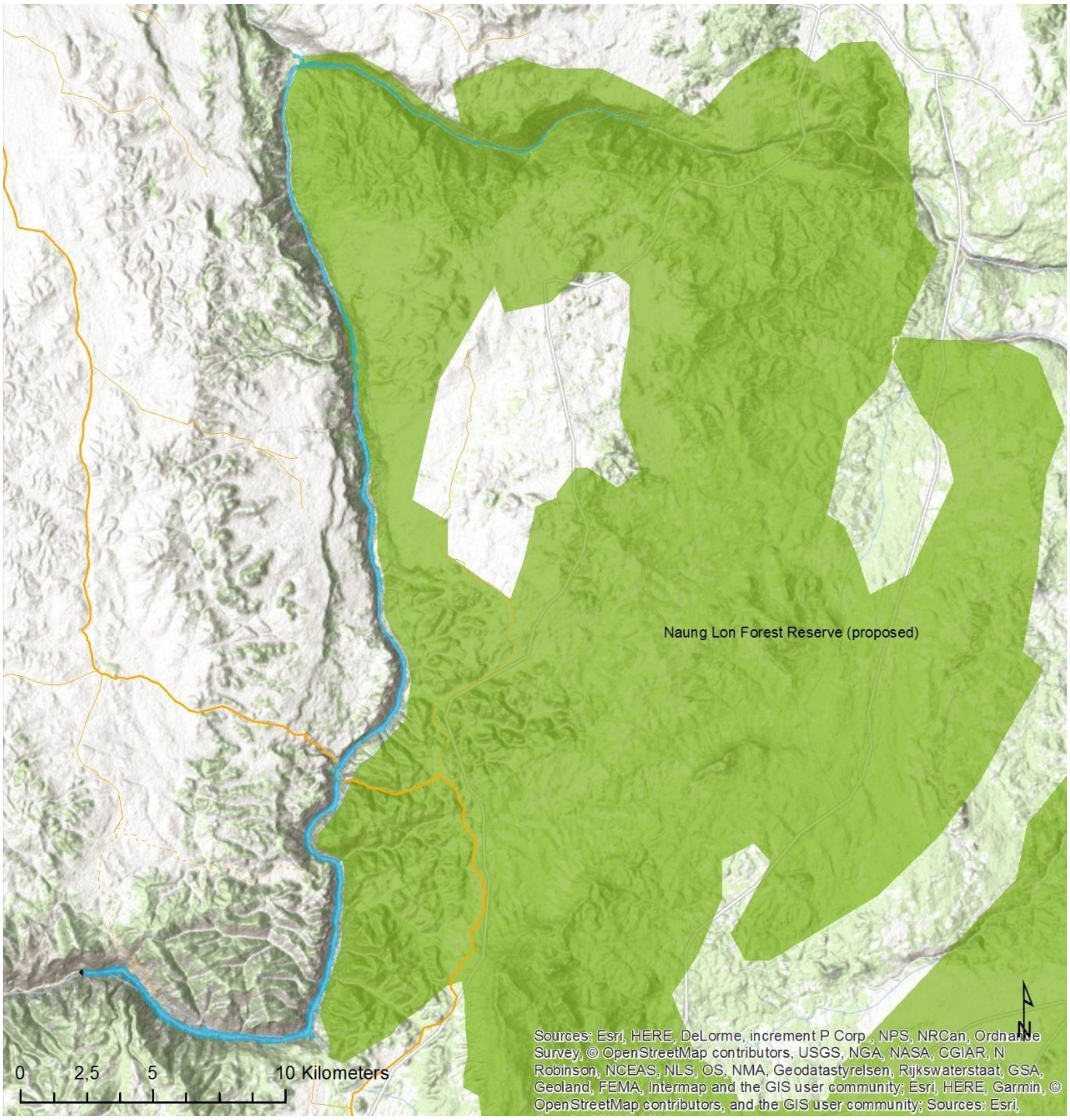


Figure 7-43: The unconfirmed forest reserve on the left bank.

The closest recognised area of particular biodiversity importance is the Mehon - Doke-hta Wady River key biodiversity area (KBA). This KBA is found between the Pyin Oo Lwin Wildlife Sanctuary and the dam site (see ***Figure 7-44***). The area does not have any legal status but is considered an International Bird Area by Birdlife International (IBA MM023), which was the basis for the KBA status. The delineation of this key biodiversity area is not unequivocal and is based on the presence of a bird species, the endangered Green Peafowl (*Pavo muticus*). This species was recorded within the project direct impact zone towards the dam site using wildlife camera traps, but the project direct impact zone or indirect impact zone are not considered key habitats for this species due the human pressures in the area.

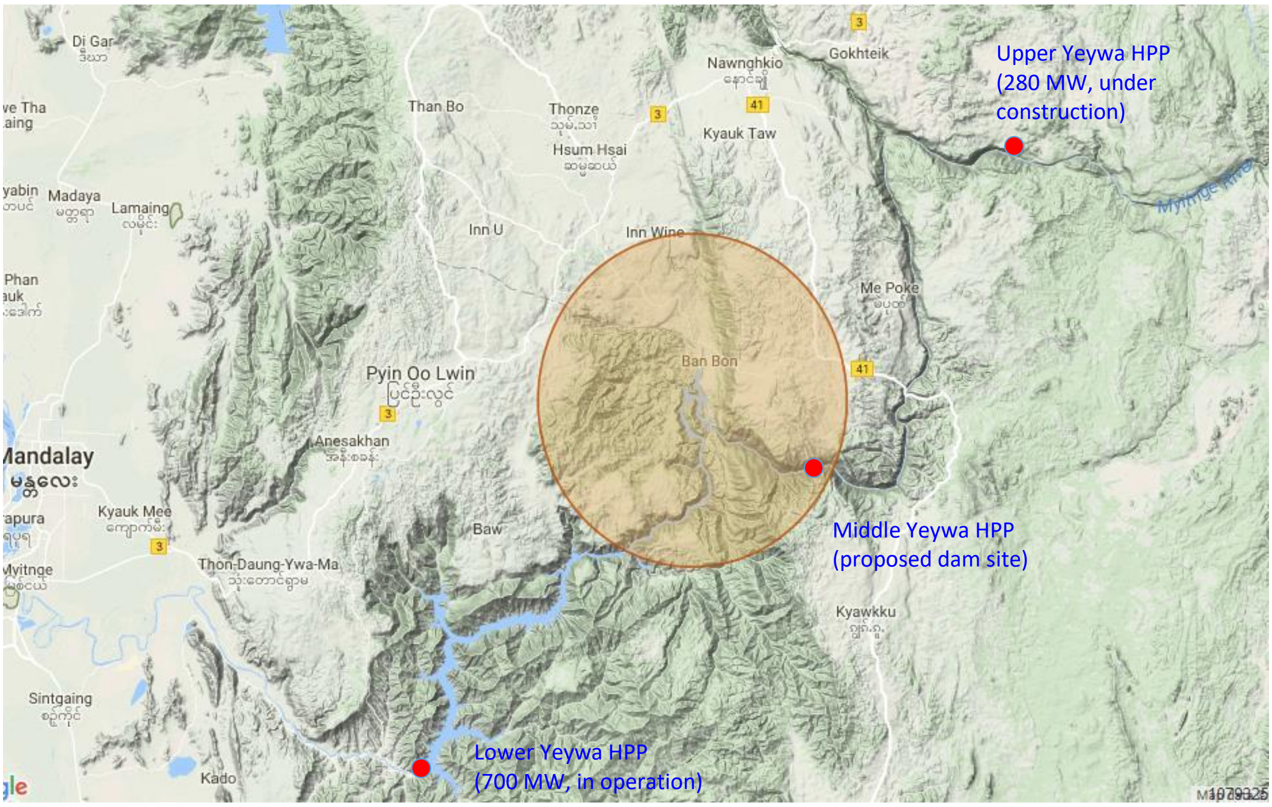


Figure 7-44: Map showing the location of the Mehon - Doke-hta Wady River key biodiversity area west of the Middle Yeywa project area.

Protected areas, key biodiversity areas and biodiversity hotspots are primarily defined based on terrestrial biodiversity rather than freshwater biodiversity. Available information about aquatic ecology in the project area is characterised by uncertainties, and further studies are therefore recommended to confirm the aquatic biodiversity values. Available information on aquatic ecology does not indicate unique biodiversity but this should be confirmed through further field surveys. The fact that Yeywa Hydropower Project was constructed several years back and that the Upper Yeywa Hydropower Project is under construction has important implications for aquatic biodiversity, including lateral connectivity between areas downstream and upstream of the Middle Yeywa Hydropower Project (see Section 8.2.12).

6.10 Vegetation

6.10.1 Materials and Methods

Vegetation data were collected over several sampling seasons, including:

- March-May 2015 (right bank, dry season)
- September-October 2015 (right bank, transition period after the rainy season)
- July-August 2016 (left bank, rainy season)
- December 2017 (both banks, dry season)

Plots of 20x20 m and 30x30 m were distributed along strategically placed transects. Plant species identification was carried out by using key to families of flowering plants and appropriate literature and confirmed by matching with herbarium specimens of Department of Botany, University of Yangon.

To get representative checklists of the plant species, collection and identification was also carried out by random transect lines along the roadsides and between one plot and another wherever possible.

The plant species were checked for their conservation status according to the IUCN Red List and threatened species were flagged, that is, species in the categories ‘near threatened’ (NT), ‘vulnerable’ (VU), ‘endangered’ (EN), and ‘critically endangered’ (CR).

Further details of the sampling methodology are provided in the respective field reports (see Appendices).

6.10.2 Vegetation Types

The vegetation in the project’s direct and indirect impact zones is predominantly deciduous Indaing (*Dipterocarp*) forest characterised by trees in the *Shorea* and *Dipterocarpus* genera, in particular *Shorea siamensis, S. obtusa* and *Dipterocarpus tuberculatus*. Other common species with a wide occurrence include *Sterculia foetida, Terminalia alata, Erythrina stricta, Schleichera oleosa, Syzygium grande, Dalbergia oliveri* and *Phyllanthus emblica.*

The Indaing forest may be further divided into several sub-types, but those are not clearly distinguishable at a landscape level expect for patches of bamboo especially on land that has previously been logged or disturbed. The bamboo species recorded in the Myitnge valley (and beyond) are *Dendrocalamus membranaceus, D. latiflorus, Gigantochloa albociliata* (syn. *Oxytenanthera albociliata), Bambusa tulda* and *Thyrsostachys oliveri.*

Figure 7-45: Bamboo forest.

Other sub-types include mixed deciduous forest dominated by the dipterocarp *Shorea siamensis* together with *Chukrasia velutina, Pterocarpus indicus, Eugenia operculata, Atalantia monopyhlla* and the teak tree *Tectona grandis.* Teak is sometimes also associated with bamboo, forming deciduous teak and bamboo forest characterised by the typical Indaing species (e.g. *Shorea siamensis, Shorea obtusa, Terminalia alata*, *Schleichera oleosa*, *Dalbergia oliveri*) together with *Tectona grandis* and one or several of the bamboo species mentioned above. Mixed evergreen forest also occurs within the wider Indaing forest with species such as *Polyalthia viridis, Mesua nervosa, Mangifera indica* and *Anthocephalus morindaefolius.*

Figure 7-46: Mixed deciduous forest.

The forest and shrubs growing along the Myitnge River do not form a true riparian or riverine vegetation type, as the dominant species are similar to those growing at higher elevation and there is no distinct riverine zone due to the steep topography. Thus, the Indaing forest generally extends all the way down to the edge of the river. The common trees found along the riverbanks include *Shorea siamensis*, *Shorea obtusa, Sterculia villosa, Terminalia alata, Schleichera oleosa, Tetrameles nudiflora, Xylia xylocarpa, Crateva magna, Acer oblongum*, *Bombax ceiba* and *Ficus* spp*.* However, one species that is largely restricted to the river flood zone (i.e. the zone between dry and wet season river water level) and is thus a true riparian species is the flood tolerant shrub *Homonoia riparia.* This species grows on the alluvial deposits along the entire length of the Myitnge River.

Figure 7-47: Riverbank vegetation.

Figure 7-48: **Homomia riparia.**

Aquatic plants are not widespread, probably due to the high water velocity, but some aquatic species were recorded in the slow flowing reaches of the river, including *Equisetum hyemale, Najas minor, Potamogeton crispus, Utricularia* sp. and *Echinodorus quadricostatus.* In addition, the green algae *Spirogyra* sp. can survive in small ponds between stones along the riverbanks, while some bryophytes and lichens were found growing on rocks and cliffs (e.g. *Racomitrium aciculare, Schistostega pennata, Grimmia trichophylla, Marchantia berteroana, Plagiochila obscura, Dichodontium pellucidum* and D. *hirsuta* ssp. *nepalensi*s). According to IFC *et al*. (2017), there are no threatened aquatic plant species recorded in the IBAT freshwater database for the Ayeyarwady river basin.

There are some small spray wetlands along tributaries, all of which appear to be seasonal spray zones. The most interesting of these are on the Nam-kam River which flows down a cascade of waterfalls before emptying into the main river on the left bank near Thar Si village. The spray zones at the foot of the falls were investigated for any threatened or endemic flora, but no such species were found other than some of the moisture dependent plants also recorded elsewhere along the Myitnge River (e.g. the liverwort *Dumortiera hirsuta* ssp. *nepalensi*s).

Overall, the Indaing forest and other vegetation sub-types in the Myitnge valley are common and widespread not only in the project's impact zone but also in other regions of Myanmar, including in other parts of Shan State, Mon State and Bagoyo Mountain Range.

6.10.3 Threatened Plant Species

A total of 462 species of flora (including some fungus species) were identified within the project's direct and indirect impact zones (see Appendices). Of these, five (5) species are classified as threatened according to the IUCN Red List, that is, species in the categories 'near threatened' (NT), 'vulnerable' (VU) and 'endangered' (EN) (but no 'critically endangered' (CR) species were recorded). It should be noted, however, that many of the recorded species have not yet been assessed for the IUCN Red List or are classified as 'data deficient' (DD). The globally threatened species are described below.

Dalbergia oliveri Gamble ex Prain is endangered (EN) according to the IUCN Red List version 2.3 (EN A1cd). The species occurs within a restricted distribution and is native to Myanmar, Thailand and Viet Nam. It was assessed in 1998 and listed as endangered due to overexploitation of its valuable red wood. The listing is in need of updating. In the Middle Yeywa project area, *D. oliveri* is a common species occurring both within the proposed inundation zone and at higher elevation.

Pterocarpus indicus Willd. is vulnerable (VU) according to the IUCN Red List version 2.3 (VU A1d). It is a widespread forest tree native to south-eastern Asia, northern Australasia, and the western Pacific Ocean islands. Many populations are seriously threatened and it has been confirmed as regionally extinct in Viet Nam. The observed decline is because of overexploitation (sometimes illegal exploitation) of timber, as well as from increasing general habitat loss. Cultivated sub-populations are widely distributed throughout the tropics. *P. indicus* is a relatively common tree species in the Myitnge valley (below and above the planned reservoir level).

Figure 7-49: **Dalbergia oliveri** ***(left) and*** **Pterocarpus indicus** ***(right).***

Cycas siamensis Miq. is vulnerable (VU) according to the IUCN Red List version 3.1 (VU A2cd). It is native to Myanmar, Thailand and Viet Nam, but also occurs in Cambodia and probably in Lao PDR. The species is widespread and locally extremely abundant, hence not under any immediate threat of extinction. However, the global population of *C. siamensis* is estimated to have declined by more than 30% over the past century, mainly due to forest clearing for agricultural purposes, forest fires, and over-collection for ornamental trade. In the project area, it is a rare species only found on the left bank of the river.

Dalbergia cultrata Graham ex Benth. is near threatened (NT) according to the IUCN Red List version 3.1. The species occurs within its native range of Cambodia, China (Yunnan), Lao PDR, Myanmar, Thailand and Viet Nam, as well as in India where it has been introduced. Thus, the distribution range extends over a wide area, but the species has been described as decreasing due to overexploitation of the timber (including illegal logging) and the severe reduction of forest areas in the countries where it occurs (i.e. conversion of forests to agricultural land and settlements). *D. cultrata* grows on both sides of the Myitnge River, mainly above the proposed impoundment zone.


Figure 7-50: **Cycas siamensis *(left) and* Dalbergia cultrata *(right).***

Curcuma alismatifolia Gagnep. is near threatened (NT) according to the IUCN Red List version 3.1. It is a herb species native to Cambodia, Lao PDR, Thailand, Viet Nam and presumably Myanmar (it was recorded on the left bank of the Myitnge River). While this is one of the fairly common species in the Indochinese floristic region, it is one of the commercially most exploited ginger species for cut flower industry in Thailand. It has been the target of commercial collectors for many years and this collection combined with the loss of habitat due to other threats has resulted in a population reduction in the last 60 years which comes close to 30%. Wild populations are exploited to gather new phenotypes for tissue culture propagation and introduction of new cultivars in the market. Over-collecting in the wild poses a threat to the wild populations of this species. *C. alismatifolia* is a rare species in the Myitnge valley.

Figure 7-51: Curcuma alismatifolia.

In addition to the IUCN Red List, the Forest Department has published a list of nationally protected plant species. Among the species recorded in the project's impact zone, three of them appear on this list, namely *Tectona grandis, Acacia catechu*, and *Dalbergia oliveri.* As explained above, both the teak tree (*T. grandis*) and *D. oliveri* are common species in the Myitnge River valley, while *A. catechu* was observed only on the left bank and with occasional occurrence. On a global scale, it has a wide distribution in East Asia including China, India and the Indian Ocean area.

6.10.4 Invasive Plant Species

Two of the recorded plant species are non-native to Myanmar and classified as invasive plants. These are *Mikania micrantha* Kunth. and *Mimosa pudica* L., both of which are widespread in the country as a whole and beyond. *Mikania micrantha* is native to the sub-tropical zones of North, Central, and South America and is a vigorously growing perennial creeper growing as a tropical weed, while *Mimosa pudica* is a pantropical weed native to South and Central America. In addition, the invasive grass *Neyraudia reynaudiana* (Kunth) Keng ex Hitchc. was also recorded, but this species is native to subtropical Asia (including Myanmar) and only known as a weed in southern Florida in the United States.

6.10.5 Baseline Threats

There is a clear distinction between the right and left bank of the Myitnge River. Human disturbance is significantly higher on the right bank of the river and especially on the plateau where the forest has been cleared for agriculture and settlements. In contrast, the population is much lower on the left bank where the forest is largely intact in many places. This pattern is, however, less pronounced on the steep slopes in the bottom of the valley where access is restricted by topography and there is less human interference on both sides of the river.

Apart from land clearing for agriculture, the Indaing forest in the Myitnge valley has been – and continues to be – affected by timber extraction. Most of the teak forest has already been cleared, at least on the right bank of the river, but other hardwood species are still being extracted for timber. In some places, the valuable trees have been taken by MTE (Myanma Timber Enterprise) and then later the local villagers have continued to extract and sell timber to merchants who come to the villages for buying logs. The illegal logging mainly occurs above the proposed inundation zone, due to topography and access, but the river is often used for transporting the logs by boat down the river to locations that can be accessed by timber lorries. The clear-cut areas are typically replaced by pure stands of bamboo forest.

The forest in the Myitnge valley is also heavily influenced by bush fires in the dry season. Local informants explained that the forest is burnt in order to keep it open for access by people and livestock as well as to replenish the soil nutrients for better pasture. This is a traditional and common practice throughout the project area, even on the steep slopes and valley bottom where there is virtually no grazing by cattle or buffalos but where burning of vegetation aids hunting for wildlife. According to the local people, the fires do little harm to the forest because they are localised and short lasting (typically a day or two before they die out) and the trees are adapted to the fire regime (e.g. teak is known to be fire resistant). Some tree species may also depend on fires for seed germination.

Figure 7-52: Bush fire.

Bush fires are also traditionally used when clearing land for shifting cultivation (slash and burn), especially on the plateau and upper valley slopes, although agricultural practices are currently changing from shifting cultivation into permanently cultivated relying on fertilizers and other inputs. This shift has already been completed in the right bank villages, where maize, sugarcane, paddy and other crops are grown over wide areas uphill from the river valley, and evidence of the same is also observed on the left bank. A striking example is Pin Ping village where large areas of forest have been cleared, initially for timber extraction and later for commercial maize cultivation.

6.11 Terrestrial Fauna

Fauna surveys were undertaken in the period 2015-2018 and identified more than 350 species across several groups. A number of these were not confirmed through visual observations but identified through interviews with local people, which introduces several uncertainties (e.g. interviewed persons not able to correctly identify species or providing information that reflects historical presence of species rather than current presence). The main findings are summarised below after a brief description of materials and methods. Further details can be found in the Appendices.

6.11.1 Materials and Methods

Comprehensive fauna surveys covered several groups of species, including:

- Mammals
- Amphibians and reptiles (herpetofauna)
- Birds
- Insects

Data were collected over several sampling sessions covering different seasons and considerable sampling effort, including:

- March-May 2015 (right bank, dry season): Covered mammals, amphibians, reptiles, birds, and insects.
- September-October 2015 (right bank, transition period after the rainy season):
- July-August 2016 (left bank, rainy season) Covered mammals, amphibians, reptiles, birds, and insects.
- December 2017 (both banks, dry season): Covered mammals, amphibians, reptiles, birds, and insects.
- December 2017 – April 2018 (both banks, dry season): Wildlife camera traps covering mammals and to a lesser extent birds.

A variety of methods were applied in collection data including:

- Transect walks for direct observations, that is, visual observations of species, sound recognition (e.g. bird calls) and traces of species (e.g. footprints, markings on trees). Voucher specimens were also taken for subsequent identification.
- Interviews with local people (e.g. hunters).
- Local market surveys to identify species caught and sold.
- Wildlife camera traps targeting mainly mammals but also resulting in observations of birds and hunters (see map in ***Figure 7-55***).

Species identified were checked for their conservation status according to the IUCN Red List and threatened species were flagged, that is, species in the categories ‘near threatened’ (NT), ‘vulnerable’ (VU), ‘endangered’ (EN), and ‘critically endangered’ (CR).

The previous studies in some instances used different scientific or common names compared to this ESIA. This report consistently uses the internationally accepted names as provided in the IUCN Red List (http://www.iucnredlist.org/) or alternatively Catalogue of Life (http://www.catalogueoflife.org/).

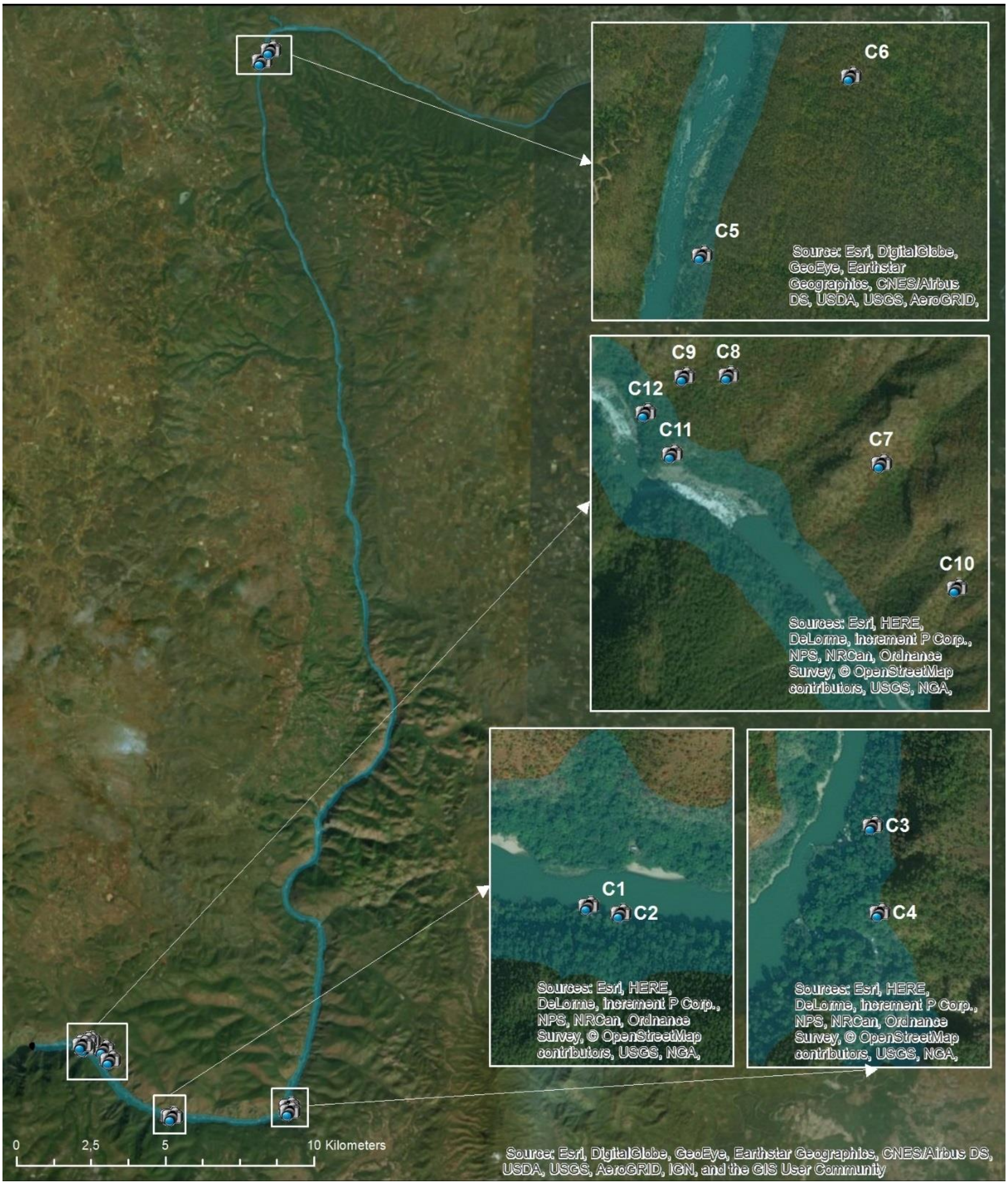


Figure 7-53: Map of camera survey sites

6.11.2 Main Habitat Types

The main habitat types for terrestrial fauna in the direct impact zone are the main river, small tributaries, riverine forest along the main river and tributaries, and dry deciduous forest (Indaing forest) above the riverine forest. Areas that will be used for camps and other associated infrastructure may also include cultivated areas, though the locations of such infrastructure have not yet been determined. There are some small spray wetlands along tributaries, most of which are seasonal spray wetlands. These small habitats are briefly described in Section 6.10.3 above). The direct impact zone is dominated by the main river and riverine forest and Indaing forest. The indirect impact zone is dominated by dry deciduous forest (Indaing forest) and agricultural areas.

The riverine forest and the spray wetlands have not been subject to disturbance that have changed the primary ecological functions and species composition. These habitats maintain viable populations of species found and are considered 'natural habitats' according to the IFC Performance Standard 6 on biodiversity. The dry deciduous forests have a larger degree of disturbance due to logging of high value timber species, fire, hunting and grazing. The ecological functionality of the habitat is largely maintained but the hunting and tree cutting have substantially impacted a number of species, in some cases also resulted in local extinction of some wildlife species.

Figure 7-54: Indaing forest above the dam site area showing strong seasonal variation. Upper photo from dry season in April 2017. Lower photo in December 2017 after the rainy season.

6.11.3 Mammals

More than 45 mammal species were identified, most of them in the indirect impact zone. For complete list of mammals identified, see Appendices. A considerable proportion of the species were only identified through interviews with local people and not confirmed by visual observations. It is difficult to ascertain whether all species reported by local people are within the project area at present. Some of the species reported by local people are certainly unlikely to maintain resident populations (e.g. Tiger, *Panthera tigris*) and may not be in the area at all even if they may have been observed there in the past due to the major habitat loss that has taken place. None of the mammal species identified were limited to the direct impact zone.

Mammal species' abundance, particularly for larger mammals, was greatly reduced by human disturbance and the negative trend continued with persistent forest conversion. Given the major conversion of forest to agriculture in recent years, a process still ongoing at high speed in parts of the left bank, several of the species identified are unlikely to maintain populations in the project area in the future and will become locally extinct unless current forest conversion is substantially reduced or stopped.

Among the identified species, several are categorised as threatened[5] on the IUCN Red List and these are included in Table 6-12 below. One species (1) identified in the surveys was categorised as critically endangered, the Chinese pangolin (*Manis pentadactyla*). This species was not observed and only reported through an interview survey. A total of six (6) mammals identified in the surveys were categorised as endangered on the IUCN Red List: Tiger (*Panthera tigris*), Dhole/Asiatic wild dog (*Cuon alpinus*), Banteng (*Bos javanicus*), Pharyre's langur (*Trochypithecus phayrei*), Cappet langur (*Trochypithecus pileatus*), and White handed gibbon (*Hylo bateslor*). Except *Cuon alpinus*, none of these were confirmed through direct observation during the surveys, which may indicate that the species are not in the area anymore or that these were incorrectly identified by local persons reporting their presence. Based on habitat characteristics and human pressures in the project area, it is

[5] The term 'threatened' in the context of the IUCN Red List includes the Red List categories 'near threatened', 'vulnerable', 'endangered', and 'critically endangered'.

considered unlikely that any of these species maintain resident populations in the direct impact zone or the indirect impact zone.

Twelve species (12) were categorised as vulnerable by IUCN. Several of these species were identified through camera traps (Leopard, *Panthera pardus*), skin found locally (Clouded leopard, *Pardofelis nebulosa*), or foot prints (Long-tailed macaque, *Macaca fascularis*, and Pig tailed macaque, *Macaca nemenstrina*). The other vulnerable species were identified through interviews. There were also three species (3) categorised as near threatened. None of these species are likely to maintain resident populations exclusively in the direct impact zone or indirect impact zone but some of the species recorded using camera traps. A selection of photos of some of the species recorded are included in Figures 6-40 and 6-41 below.

In addition to the IUCN Red List, the Forest Department has published a list of nationally protected species (notification no. 583/94). Among the mammal species recorded or reported in the Project's impact zone, several appear on this list such as Chinese Pangolin (*Manis pentadactyla*), Banteng (*Bos javenensis*), Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Clouded Leopard (*Pardofelis nebulosa*), White handed gibbon (*Hylo bateslor*), and Gaur (*Bos gaurus*).

Table 7-22: Mammal species identified in the project area through direct observations or interviews categorised as threatened on the IUCN Red List (categories 'near threatened', 'vulnerable', 'endangered', and 'critically endangered').

Scientific name	Common and local names	Habitat	Data source	Conservation status
Manis pentadactyla	Chinese Pangolin	Forest	Interview	Critically endangered (CR)
Bos javenensis	Banteng, Saing	Forest	Interview	Endangered (EN)
Cuon alpinus	Dhole/Asiatic wild dog	River side	Visual obs.	Endangered (EN)
Hylo bateslor	White handed gibbon, Myauk hlwe kyaw	Trees	Interview	Endangered (EN)
Panthera tigris	Tiger, Kyar	Forest	Interview	Endangered (EN)
Trochypithecus phayrei	Pharyre's langur, Myauk myat kwin pyar	Trees	Interview	Endangered (EN)
Trochypithecus pileatus	Cappet langur, Myauk nyo	Trees	Interview	Endangered (EN)
Arctictis binturong	Binturong	Forest	Interview	Vulnerable (VU)
Bos gaurus	Gaur, Pyaung	Forest	Interview	Vulnerable (VU)
Cervus unicolon	Sambar, Sat	Forest	Interview	Vulnerable (VU)
Helarctos malayanus	Sun bear	Forest	Interview	Vulnerable (VU)
Macaca fascularis	Long-tailed macaque, Myauk tangar	Trees	Foot print	Vulnerable (VU)
Macaca nemenstrina	Pig tailed macaque, Myauk putee	Trees	Foot print	Vulnerable (VU)
Macaca arctoides	Stump-tailed macaque			Vulnerable (VU)
Naemorhedus baileyi	Red goral, Taung sateni	Forest	Interview	Vulnerable (VU)
Nycticebus bengalensis	Bengal Slow Loris			Vulnerable (VU)
Ursus thibetanus	Asian black bear, Wat won	Forest	Interview	Vulnerable (VU)
Panthera pardus	Leopard, Kyar thit	Forest	Camera trap	Vulnerable (VU)
Pardofelis nebulosa	Clouded leopard	Forest	Skin	Vulnerable (VU)
Capricornis midneedwards	Chinese serow	Forest	Camera trap	Near threatened (NT)
Macaca assamensis	Assamese macaque, Arsam myuk	Trees	Visual obs.	Near threatened (NT)
Presbytis femoralis	Banded langur, Myauk mhee shae	Trees	Interview	Near threatened (NT)

Leopard (*Panthera pardus*)

Leopard Cat (*Prionailurus bengalensis*)

Large Indian Civet (*Viverra zibetha*)

Small Indian Civet (*Viverricula indica*)

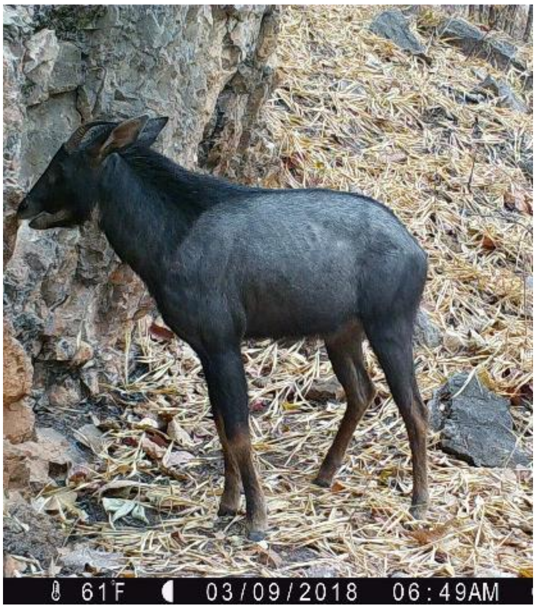
Rhesus Macaque (*Macaca mulatta*)

Northern Treeshrew (*Tupaia belangeri*)

Figure 7-55: Selection of mammal species recorded during surveys December 2017 – April 2018.

Red Muntjac (*Muntiacus muntjak*)

Yellow-throated Marten (*Martes flavigula*)



Chinese Serow (*Capricornis milneedwardsi*)

Eurasian Wild Pig (*Sus scrofa*)

Figure 7-56: Selection of mammal species recorded during surveys December 2017 – April 2018.

6.11.4 Amphibians and Reptiles

The surveys only identified nine (9) amphibian species. All identified species are categorised as of least concern on the IUCN Red List, but the status for some of the species needed updating. Abundance of amphibians was also reduced by human disturbance as well as climatic factors (seasonal dry periods with limited available wetlands).

The surveys identified 40 species of reptiles. Four (4) threatened species were identified, all in interview surveys. These were the endangered Elongated Tortoise (*Indotestudo elongate*), the vulnerable Burmese Python (*Python bivittatus*), the vulnerable King cobra (*Ophiophagus hannah*), and the near-threatened Indian Black Turtle (*Melanochelys trijuga*). All four species were reported on both river banks. Eight (8) of the species were categorised at of least concerns while the remaining 28 species had not been evaluated as part of the IUCN Red List. As for other species groups, abundance of reptiles was reduced by human disturbance. Some species were affected directly as they were killed by people or due to collection of eggs, others were indirectly affected through habitat loss. A selection of photos of some reptile species recorded are included in Figure 6-42 and some amphibian species in Figure 6-43 below. In addition to the IUCN Red List, the Forest Department has published a list of nationally protected species (notification no. 583/94). No reptile species on this list was recorded or reported in the Project's impact zone. The list has no amphibians.

Table 7-23: **Reptile species identified in the project area through direct observations or interviews categorised as threatened on the IUCN Red List (categories 'near threatened', 'vulnerable', 'endangered', and 'critically endangered').**

Scientific name	Common and local names	Habitat	Data source	Conservation status
Indotestudo elongate	Elongated Tortoise/Yellow-headed tortoise, Taung late	Near river	Interview	Endangered (EN)
Python bivittatus[6]	Burmese Python, Saba ohn	Forest	Interview	Vulnerable (VU)
Ophiophagus hannah	King cobra, Taw-gyi-mwe-hauk			Vulnerable (VU)
Melanochelys trijuga	Indian Black Turtle, Lake chaepan	Near river	Interview	Near threatened (NT)[7]

Green Vine Snake (*Ahaetulla nasuta*)

Copperhead Rat Snake (*Coelognathus radiatus*)

Forest Garden Lizard (*Calotes emma*)

Common Garden Lizard (*Calotes versicolor*)

Figure 7-57: Selection of reptile species recorded during surveys.

[6] Named *Python molurus* in expert reports (ref. http://www.iucnredlist.org/details/193451/0).
[7] According to the IUCN Red List, the conservation status for the species requires updating.

Asian Grass Frog (*Fejervarya limnocharis*)

Rana sp.

Figure 7-58: Selection of amphibian species recorded during surveys.

6.11.5 Birds

The surveys identified a total of 118 bird species across the two river banks. All species were identified through visual observation or bird calls. A striking characteristic was that very few water birds were observed across the various sampling sessions. One (1) endangered species was recorded, the Green Peafowl (*Pavo muticus*), while six (6) near-threatened species were observed. The near-threatened species were Olive-backed Woodpecker (*Dinopium rafflesii*), Red-breasted Parakeet (*Psittacula alexandri*), Alexandrine Parakeet (*Psittacula eupatria)*, Grey-headed Parakeet (*Psittacula finschii*), Long-tailed Parakeet (*Psittacula longicauda*), and River Lapwing (*Vanellus duvaucelii*). A selection of photos of some bird species recorded are included in Figures 6-44 and 6-45 below. In addition to the IUCN Red List, the Forest Department has published a list of nationally protected species (notification no. 583/94). Among the bird species recorded or reported in the Project's impact zone, the Green Peafowl (*Pavo muticus*) is a protected species.

***Table 7-24:* Bird species identified in the project area through direct observations as threatened on the IUCN Red List (categories 'near threatened', 'vulnerable', 'endangered', and 'critically endangered').**

Scientific name	Common and local names	Habitat	Data source	Conservation status
Pavo muticus	Green Peafowl			Endangered (EN)
Dinopium rafflesii	Olive-backed Woodpecker			Near threatened (NT)
Psittacula alexandri	Red-breasted Parakeet			Near threatened (NT)
Psittacula eupatria	Alexandrine Parakeet			Near threatened (NT)
Psittacula finschii	Grey-headed Parakeet			Near threatened (NT)
Psittacula longicauda	Long-tailed Parakeet			Near threatened (NT)
Vanellus duvaucelii	River Lapwing			Near threatened (NT)

Green Peafowl (*Pavo muticus*)

Red Jungle Fowl (*Gallus gallus*)

Puff-throated Babbler (*Pellorneum ruficeps*)

Large-billed Crow (*Corvus macrorhynchos*)

White-breasted Kingfisher (*Halcyon smyrnensis*)

Slender-billed Oriole (*Oriolus tenuirostris*)

Figure 7-59: Selection of bird species recorded during surveys.

Red-whiskered Bulbul (*Pycnonotus jocosus*)

Yellow-footed Green Pigeon (*Treron phoenicopterus)*

Spotted Dove (*Streptopelia chinensis*)

Collared Falconet (*Microhierax caerulescens*)

Figure 7-60: Selection of bird species recorded during surveys.

6.11.6 Insects

A range of insects and other invertebrate species were identified, including butterflies, beetles, dragonflies, grasshoppers, locusts, spiders, a species of scorpion and a species of praying mantis. A total of 138 species were recorded, of which 86 and 74 were identified on the left and right banks, respectively. These species are typically not yet considered as part of the IUCN Red List and therefore no clear overviews of conservation concern are available for these groups.

6.12 Aquatic Ecosystems

6.12.1 Materials and Methods

Aquatic surveys covered primarily fish and to a smaller extent other groups. The main sampling was undertaken:

- March-May 2015 (right bank, dry season)
- July-August 2016 (left bank, rainy season)
- December 2017 (right bank, dry season)[8]

A variety of methods were applied in collection data including:

[8] Different types of fish traps were tested in different locations during placement of wildlife camera traps and drone overflights, but systematic sampling of aquatic life was not planned during the December site visit.

- Voucher specimens were obtained from local fishermen along the river.
- Interviews with local people were undertaken.
- Local market surveys to identify species caught and sold.
- Limited sampling during testing of traps.

Species identified were checked for their conservation status according to the IUCN Red List and threatened species were flagged, that is, species in the categories 'near threatened' (NT), 'vulnerable' (VU), 'endangered' (EN), and 'critically endangered' (CR).

6.12.2 Main Habitats

The aquatic habitats in the direct impact zone that support fish, benthic macroinvertebrates and other aquatic life were categorised into six main habitats along the Myitnge River between the proposed dam site and the upper end of the reservoir:

A1. Falls and white-water rapids with very fast-flowing and turbulent waters. There was substantial mixing of air and water. This erosional habitat was characterised by boulders or bedrock as substrate except in some small sheltered areas with deposition of cobbles, pebbles, sand and some organic matter. River banks were generally steep and covered by primary forest, boulders and in some areas of the left bank near vertical cliffs. This habitat was only found 4-5 km upstream the dam site in a section about 800 m long, including two slower flowing pool areas, and therefore only covering approximately 1% of the affected river section. For most fish species, this section was likely to be a natural barrier to upstream fish migration.

A2. Fast-flowing and relatively shallow riffles. Rocks penetrated the water surface or rising close to the water surface resulting in turbulent water with mixing of air and water. This was also typically an erosional habitat with bedrock, boulders and cobbles as substrate. This habitat was usually found over rocky crests in the river bed and in very short sections. The river banks were typically covered by riverine forest. Overall, this habitat covered approximately 1-2% of the affected river section.

A3. Relatively fast-flowing deeper runs with water depth greater than rocks and consequently little or no turbulent water. The relatively fast flow erodes finer particles and the substrate was typically pebbles. The river banks were covered by riverine forest. This habitat was found in mosaic with slow-flowing deeper pools, and this mosaic was the overwhelmingly dominant types of habitat along the affected river section.

A4. Slow-flowing deeper pools often with deposition of sediments such as sand, silt and organic matter except in the outer edge of a bend in the river where there tends to be erosion. Some of the pools were deep (> 5 m). The river banks were covered with riverine forest. This habitat was found in mosaic with fast-flowing deeper runs, and this mosaic was the overwhelmingly dominant types of habitat along the affected river section.

A5. Stagnant or near-stagnant waters in seasonal small pools in a short area within the river section with falls and white-water rapids (A1). This habitat is available only in the low flow season along the sides of the river as water recedes.

A6. Tributaries to the Myitnge River. A limited number of tributaries, most of which are very steep and do not provide significant habitats for fish in the main river. An important exception is the Gotheik Stream on the right bank in the uppermost part of the reservoir that provide good quality aquatic habitats for fish and other aquatic organisms for a considerable distance away from the main river.

The distribution of the aquatic habitats is likely to be dynamic and change with varying river flow that also changes accompanying characteristics such as water speed, water depth, erosion, and deposition. This means that the habitat boundaries are not necessarily constant, they are to some extent dynamic.

None of these habitats were considered unique. It is worth mentioning that in the Strategic Environmental Assessment for Myanmar, the Project is located within an area with 'low' [9] geomorphology value and 'low'[10] aquatic ecology and fisheries value. In terms of river reach rarity, the affected river section was described as 'very common'.[11]

Figure 7-61: Part of the main falls and rapid section upstream of the proposed dam site. The largest fishing camp along the affected section is located near the first set of falls (red ellipse) where fish gathers and try to move upstream. Substrate dominated by large boulders.

[9] The value was assessed on a scale with the following five values: very low, low, medium, high, very high.
[10] The value was assessed on a scale with the following five values: very low, low, medium, good, very good.
[11] The rarity analysis applied the following four categories: very common, common, rare, very rare.

Figure 7-62: Part of the main falls and rapid section upstream of the proposed dam site (this section is visible as the uppermost rapids in Figure 6-46 above).

Figure 7-63: Looking downstream from the fishing camp towards the proposed dam site in the background (red arrow).

Figure 7-64: Slow-flowing deep pool area with fast-flowing and relatively shallow riffles in the background.

Figure 7-65: Typical river section that will be affected by the Middle Yeywa project – sections of pools (dominant aquatic habitat) interspersed by small riffle sections (red arrows) with bedrock or boulders penetrating the water surface.

Figure 7-66: Examples of riffle sections with boulders penetrating the water surface.

Figure 7-67: Example of long slow-flowing river section towards river bend where Gohteik Tributary joins Myitnge River (red arrow).

Figure 7-68: Gohteik Tributary just before joining the Myitnge River.

6.12.3 Fish Species

A total of 33 species of fish were identified, many through interviews with local respondents and approximately half of the species by voucher species caught by local fishermen. The fish fauna was dominated by cyprinids (family Cyprinidae) with 19 species. A total of eleven (11) families of fish were identified.

One fish species, which was identified by voucher specimen, was categorised as vulnerable (Gangetic loach, *Botia rostrata*). However, public records do not indicate that this species is found in Myanmar and hence this requires further clarifications. Five other fish species identified primarily through the interview survey were categorised as near-threatened (see ***Table 7-25***). The other fish species were largely categorised as of least concern except a limited number of species where data were either missing or the species were not evaluated in accordance with the IUCN Red List. A selection of photos of some fish species recorded are included in Figures 6-57 and 6-58 below.

Table 7-25: Fish species identified in the project area through direct observations as threatened on the IUCN Red List.

Scientific name	Common and local names	Habitat	Data source	Conservation status
Botia rostrata	Gangetic/Golden loach, Nga sin pyawt			Vulnerable (VU)
Anguilla bicolor	Shortfin eel, Nga myae			Near threatened (NT)
Osteobrama belangeri	Nga phal aung			Near threatened (NT)
Syncrossus berdmorei	Tiger botia, Nga sin pyawt kyar			Near threatened (NT)
Tor tor	Tor barb/Mahseer			Near threatened (NT)
Wallago attu	Butter fish/ Wallago, Nga but			Near threatened (NT)

Burmese Latia (*Crossocheilus burmanicus*)

Orange-fin Labeo (*Labeo kalbasu*)

Gangetic Loach (*Botia rostrata*)

Barbus Brevifilis (*Folifer brevifilis*)

Figure 7-69: Selection of fish species recorded during surveys.

Loach (*Botia* sp.)

Burmese Loach (*Lepidocephalichthys berdmorei*)

Loach (*Neonoemacheilus labeosus*)

Channa (*Channa aurantimaculata*)

Long-whiskers Catfish (*Mystus gulio*)

Mystus seengala

Spiny Eel (*Macrognathus* sp.)

Two different fish species climbing a vertical rock face in the main rapids area.

Figure 7-70: Selection of fish species recorded during surveys.

6.12.4 Other Species

Other species were also recorded during the surveys including freshwater crabs, freshwater shrimps and snails (see Figure 6-56 below). These were not identified to species level.

Freshwater snails

Freshwater Shrimp (*Cryphiops sp.*)

Figure 7-71: A species of freshwater snail and a species of freshwater shrimp caught in baited fish traps during trap testing in December 2017.

7 SOCIAL BASELINE CONDITIONS

7.1 Political and Administrative Context

The Republic of the Union of Myanmar is divided into seven states and seven regions as defined in the 2008 Constitution. In addition to the states and the regions, there are five self-administered zones, one self-administered division, and one union territory comprising the capital Nay Pyi Taw. The states/regions/zones represent the first administrative level in Myanmar. States and regions are constitutionally equivalent while the five self-administered zones/division have a constitutional status similar to that of a region or state.

The states /regions are sub-divided into districts as the second administrative level. Districts are further divided into townships (third level) which again is made up of village tracts and wards (fourth level). The village is the fifth and lowest administrative level in Myanmar.

The Middle Yeywa Project area is geographically fully located within the Shan State and the districts of Kyaukme (Northern Shan State) and Taunggyi (Southern Shan State). Within Kyaukme, the Project impinges on Nawnghkio and Kyaukme townships while in Taunggyi it touches the northern border area of Lawksawk Township.

Township administrations are headed by the senior official of the General Administration Department (GAD) of the Ministry of Home Affairs. The main tasks for the township government administration are birth registration, land registration, and most forms of tax collection. Districts are also headed by a senior official from the GAD.

7.2 The Shan State

7.2.1 History

The Shan State, within which the project area is located, forms the eastern portion of the present Union of Myanmar and consists of 52 townships. The state is bounded by the Kachin State on the north, the People’s Republic of China on the northeast, Lao PDR and the Mekong River on the east, Thailand on the southeast, Kayah State on the south, and the Mandalay Division to the west. The Salween River (Nam Khone in Shan), separates the Shan Plateau into two parts, flowing from north to south and emptying into the Gulf of Martaban, a part of the Indian Ocean.

The name “Shan states” (plural) referred to a group of some 46 states each with more-or-less autonomous status, though some were more powerful than others. The majority were ethnic Shan, with some notable exceptions such as Kokang (a small Chinese group), Pwo Karen (Pa-O), Nagas, Wa, Kachin, and Palaung (Ta-ang). The Danu speaking area surrounding the Middle Yeywa Project, and extending further south, was never considered one of the states, though in part it was more recently granted status as an SAZ (Self-Administered Zone) in 2010. Other ethnic groups found within the Shan states are Lahu, Akha, Lisu, Wa and many varieties of Ta-ang.

Following independence and the establishment of the Union of Burma, all of these areas were grouped together under the singular designation of “Shan State.”

7.2.2 Political Factions and Conflict

The Shan State has since independence seen armed conflict, mainly between the Union Government/national army and the ethnically based armed factions. The dominant armed faction that is now present and claims control over the part of the project area east of the Myitnge River (left bank) is the Restoration Council of Shan State (RCSS) with its armed wing, the Shan State Army - South (SSA-S). The SSA-S was formed in January 1996 while RCSS was formed in May 2000 as its political wing. RCSS is headquartered at 20 Loi Tai Leng in the Southern Shan State. The RCSS entered into an agreement with the Government in January 2012, which regulates the relationship between SSA-S and the Government when it comes to security issues and provides for cooperation between RCSS and the Government for regional development. The agreement also provided the basis for opening of liaison offices between the Government and the SSA-S in Taunggyi, Kholam, Kengtung, Mong Hsat and Tachileik and trading offices in Muse and Nanhkam[12].

Before the agreement with the Government, the SSA-S used to cross over to the right bank of the river but have since restricted their movements to the left bank. The project area has largely been peaceful since the agreement with the Government in 2012

7.2.3 Population

As noted above, the Shan State itself is quite diverse and comprises different ethnic groups such as the Shan, Pa-O, Palaung, Kachin, Intha, Danu, Kokang, Wa, Lahu, Taungyo, Myoungzee, Lishaw, and Yinnet. Of these, the Shan are the largest, numbering an estimated six million (although not all live in Shan State). Estimates of the total population of Pa-O and Danu vary (due to the lack of reliable censuses), but the Danu population is usually cited as 220,000 and the Pa-O population as 600,000. There are seven SAZs in Shan State, belonging to the Naga, Palaung, Kokang, Wa, Danu, and Pa-O. The Danu and Pa-O SAZs are located in southern Shan State. The Danu SAZ consists of two townships along the western edge of southern Shan State, with a total population of around 150,000, and the Pa-O SAZ consists of three non-contiguous townships with a total population of 400,000. Within both of these SAZs, the central government of Myanmar is present and performs all land management related functions.

7.2.4 Ethnic Groups of the Project Area

The Danu is by far the most numerous and dominant group in the Project area and in the socio-economic surveys that were conducted in 2015 and 2017 more than 90 of the sampled households were Danu (30% of all households sampled). The figure below shows the composition of the surveyed households in terms of ethnicity.

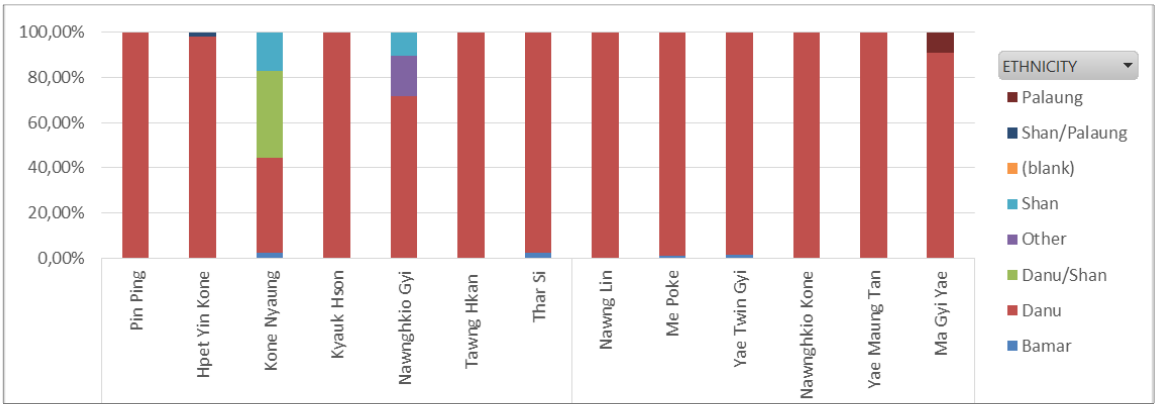


Figure 7-1: Ethnicity of the sampled households in the project area.

The second most numerous group in the project area, although far behind the Danu, are the Shan. They are present in some of the project area villages, most notably in the Kone Nyaung and Nawnghkio Gyi as indicated in the figure above. Intermarriage between the Danu and the Shan seems to be relatively common as indicated by the fact that 38% of the sampled households in Kone Nyaung were mixed Dany/Shan households.

Danu

Danu belongs to Burmish branch of Lolo-Burmese, part of the greater Tibeto-Burman stock. The Danu language is quite close to Burmese, and is one of numerous Burmese dialects than includes Intha, Taung'yo, Tavoy (Dawei), Beik and Rakhaing (Arakan). Most of these dialects can be understood by Myanmar speakers after a few weeks exposure indicating their separation from the mainstream is not

[12] https://en.wikipedia.org/wiki/Shan_State_Army_-_South

very old in linguistic terms. The Danu are said to have originated from a group of soldiers who were posted as a buffer between Pagan and the Shan States in the 18th century during the reign of King Alaungpaya, and whose territory stretches roughly from south to north between Taunggyi and Mandalay.

In the 1970s, the Japanese linguist Shiro Yabu travelled to the Danu speaking areas and made some observations on their geographical distribution and language. Yabu concluded that although northern and southern varieties of Danu differ slightly both are definitely Burmese and noted that the similarity of Danu, Taung'Yo and Intha dialects of Burmese. He estimated the total Danu population to be between 70,000 and 100,000.

The Danu often describe themselves as honest, hardworking and peaceful with great community spirit and solidarity within their villages, and this is evidenced by the fact that they construct their own roads collectively and help each member of the community with house building and other types of work

The Danu in the project area are keenly aware and proud of their ethnic identity and have their own flag that flies in all important locations in the village. They remain in touch with the Danu further south, the Pindaya Danu, and have adopted their dress and festivities, and have begun their own, Northern Danu, celebration, differing somewhat from the Pindaya.

The Danu are officially classed as an ethnic minority among the groups listed by the government, and they meet all of the criteria for qualifying as an indigenous group set forth in IFC's Performance Standard 7 on Indigenous Peoples:

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
- Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture;
- A distinct language or dialect, often different from the official language or languages of the country or region in which they reside.

However, with reference to the intent of the Performance Standard 7, the findings and evidence from socio-economic surveys, village meetings and consultations clearly indicates that the Danu are not marginalized or vulnerable:

- The Danu are the dominant ethnic group in the project area both numerically and, due to their close ethnic and linguistic affiliation with the Myanmar majority of the country, not a vulnerable minority;
- Their economic, social and legal status does not "limit their capacity to defend their rights to, and interest in, lands and natural and cultural resources";
- The Danu are well-off economically, have very large tracts of land averaging, by villager estimates, a minimum of 10 acres per household;
- Cultural pride is evident in a wide array of popular media, and annual ethnic festivals in which all villagers participate, and
- "Their ability to participate in and benefit from development," is not restricted in any form as far as can be concluded from the consultations and information collection conducted so far.

Based upon information gathering visits to a sample of seven widespread Danu villages in the project area, it is clear that the Danu have not had their lands and resources "transformed, encroached upon, or significantly degraded." Their languages, cultures, religions, spiritual beliefs and institutions are intact and not under threat, and in fact appear to be growing stronger. It is therefore highly unlikely that they will suffer "adverse impacts associated with project development" more than non-indigenous communities (there are in fact no non-indigenous communities in the project area regardless of how it may be ultimately defined). The Danu are not liable to lose their identity, culture, or natural resource-based livelihoods, nor are they likely to be exposed to impoverishment and disease at any time in the foreseeable future.

The Shan

Shan villages or villages with substantial Shan populations are found in Zone 4a (upper right bank) and also in Zone 4d (lower left bank) although they are few in relation to the Danu villages. The village of Nawnghkio Gyi in Zone 4 is for instance composed of roughly 50% Shan and 50% Danu households.

Linguistically the Shan belong to the Be-Tai sub-family of Kam-Tai family under the Kra-Dai ethnolinguistic stock. The Shan language spoken in the project area falls under the southwestern branch of Tai languages.

The Shan are an old and well-established ethnic group. Their current status as “minority” belies their historical position as a state nearly rivalling that of ancient Burma itself. What is now called the Shan State was formerly a group of principalities ruled by Saophas (or Sawbwas) since the 13th century. Today that includes a territory covering nearly one-third of Myanmar. Shan is a written language with an old literature both religious and secular.

With respect to IFC’s Performance Standard 7, the same reasoning applies to the Shan as to the Danu. They can be identified as an ethnic minority in the country as a whole as they see themselves as a distinct group, are attached to a geographically distinct area, have separate cultural and social institutions, and have a distinct language. However, they cannot be characterised as “marginalised or vulnerable” and their economic, social and legal status does not “limit their capacity to defend their rights to, and interest in, lands and natural and cultural resources”.

Palaung (Ta-ang)

The Palaung is the third notable ethnic group that is present in the wider project area. However, their villages are in general located further away from the reservoir and the dam site than the Danu villages or even the Shan villages. In the wider lower left bank area (below Zone 4d) there are six Palaung villages in Kyauk Ku village tract of Lawksawk township. There have been some involuntary relocations of this group from areas further north where armed resistance to the government has been taking place quite recently, but the villages in the project area do not appear to have been directly involved. The Palaung village that is located nearest to the dam site is Loi Hwang which lies around 10 km strait the south of the dam site.

Palaung, is an exonym applied to this group by the Burmese, and the general term preferred by the groups themselves is Ta’ang. This is a recently adopted political term, as there are said to be between 13 and 17 subgroups, whose languages are not all mutually intelligible. They prefer politically to be seen as speaking with a single common voice. In fact Ta-ang is also the name of a specific subgroup of Palaung. In the northern Shan State the Ta-ang (Palaung) have their own SAZ and an army. Internal Ta’ang diversity has also caused problems in the adoption a written language that can be understood by all dialects. The Palaung are thought to have predated the Shan in much of the area of the Shan State.

Ethnolinguistically, Palaung belongs to the Palaungic Branch of Austroasiatic, considered by some to be related to the Khasian Branch of Megdalaya in northeastern India. Palaungic includes several main groups, including Danau, Palaung, Riang, Angkuic, Lamet (Ramet, Xmet), and Waic (Plang, Lawa, Wa).

These groups are widely distributed around the Shan State, though their point of origin is thought to be in the north near the Chinese border. There are also Palaung languages spoken in Yuunan and Thailand. It is yet to be determined to which subgoup the Palaung in Lawksawk belong.

The Palaung are officially classified as an ethnic minority by the government, and although limited investigations have been undertaken in connection with the Middle Yeywa EIA studies, they are likely to meet all of the criteria for qualifying as an indigenous group set forth in IFC’s Performance Standard 7- Indigenous Peoples.

7.3 Socio-economic Conditions in the Project Area

7.3.1 Socio-economic Survey and Statistical Information

The socio-economic survey that forms the basis for the villages level information presented in the following sections has been carried out in two rounds. The first survey was carried out in May 2015 in six right bank villages (Zone 4a). The sample size was 33% of the households with the exception being the small village of My Gyi Yae which had a sample of 41% since there were only 27 households. The total sample size was 300 households of 902 in the six villages. The second round of the survey was carried out in June and October in 2017 and covered totally seven villages – six on the left bank (Zone 4c and 4d) and one the right bank (Zone 4b). In all 800 households were interviewed and the sample size was also here 33% of the total number of households in the village. The population in the survey villages along with number of households are listed in ***Table 7-1***. Village profiles and detailed information of each of the surveyed project area villages are found in Annex 4 along with the survey and interview forms that were used. The survey villages and their location in relation to the reservoir and dam site are shown on the map presented in ***Figure 7-2***.

All statistical information for the districts and townships in the project area has been extracted from the 2014 Census Report for the Shan State (Department of Population, 2015)[13].

Table 7-1: Population in project area villages covered by socio-economic survey.

Villages		Zone	Population	No of Households	Household size
Surveyed May 2015	Ma Gyi Yae	4a	173	37	4.7
	Me Poke	4a	1213	293	4.1
	Nawng Lin	4a	1387	300	4.6
	Nawnghkio Kone	4a	287	60	4.8
	Yae Maung Tan	4a	363	87	4.2
	Yae Twin Gyi	4d	1163	220	5.3
Surveyed in June and October 2017	Nawnghkio Gyi	4a	1344	290	4.6
	Kone Nyaung	4c	1360	273	5.0
	Pin Ping	4c	1754	367	4.8
	Thar Si	4c	1327	277	4.8
	Hpet Yin Kone	4d	870	180	4.8
	Kyauk Hson	4d	867	183	4.7
	Tawng Hkan	4d	387	97	4.0
Total Survey Village Population			**12 497**		

[13] *Department of Population, Ministry of Immigration and Population. 2015. The 2014 Myanmar Population and Housing Census, Shan State Report, Census Report Volume 3 – M, Nay Pyi Taw, Myanmar*

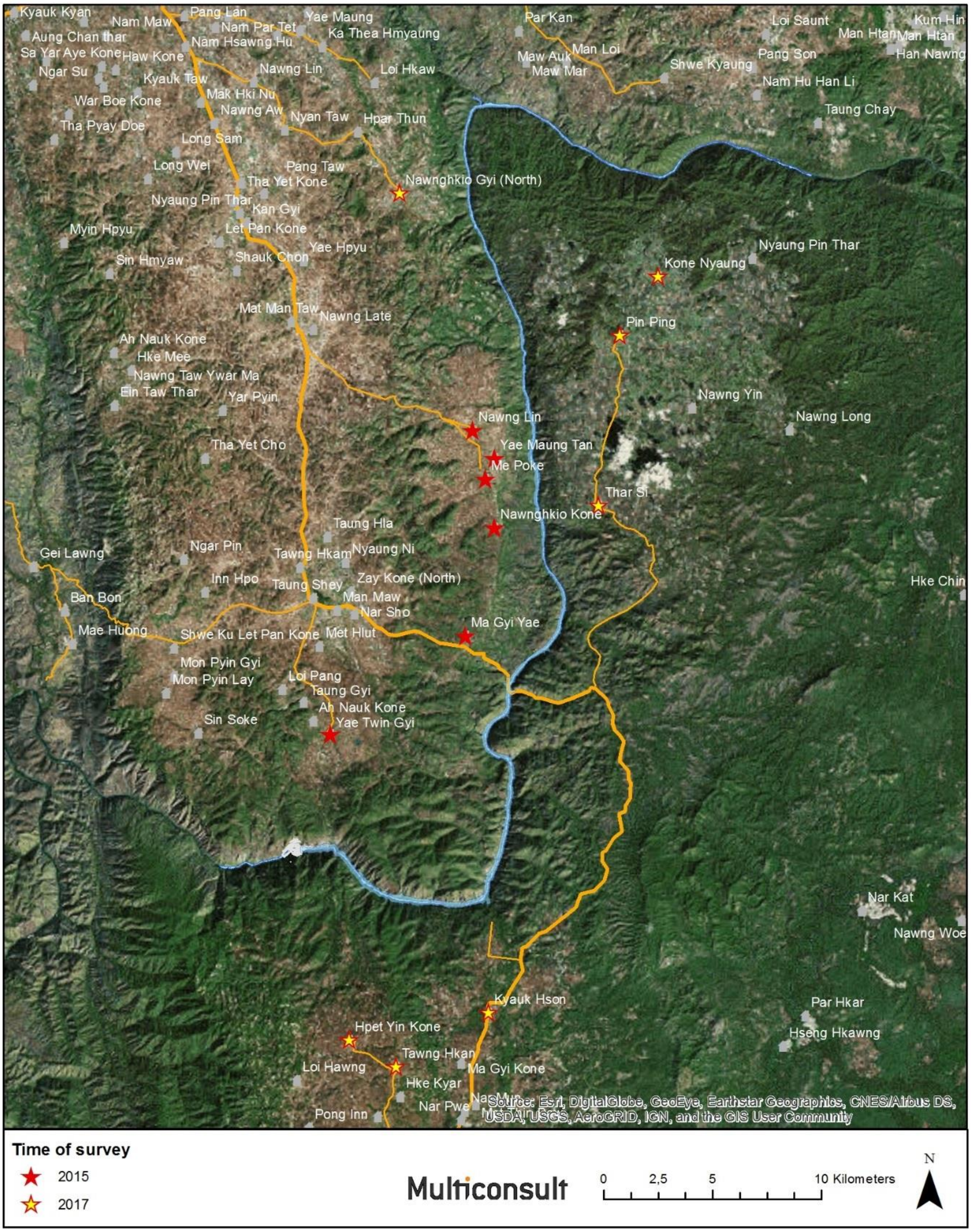


Figure 7-2: Location of socio-economic survey villages in the in the indirect impact zone.

7.3.2 Demographic Characteristics

According to the 2014 Census the population of Shan State has increased by 56 % since the last census in 1983. With its 5.8 million people the Stan State has the 4th largest population compared with the other states and regions in Myanmar. The population density of the Shan State in 2014 was 37 persons per square kilometre compared to the average for the whole country with 76 persons per square kilometre. This makes the Shan State one of the least densely populated states in Myanmar. Since the last census in 1983 the population density of Shan State has increased from 24 to 37 persons per square kilometre. The population in the districts and townships within which the project is located had according to the Census the following population numbers in 2014.

Table 7-2: Population and household characteristics in the wider Middle Yeywa project area

Administrative Unit/Level	Female	Male	Total	Number of HHs	HH Size	% Female Headed HHs	% Urban Population
Kyaukme District	393 962	376 103	770 065	163 679	4.4	24.5	15.5
Nawnghkio Township	74 081	75 761	149 842	32 224	4.3	18.8	12.6
Kyaukme Township	65 916	61 644	127 560	28 371	4.2	28.6	31.3
Taunggyi District	858 744	842 594	1 701 338	368 509	4.4	21.4	27.3
Lawksawk Township*	61 606	64 961	126 567	25 957	4.6	17.3	23.3

*In the 2014 Census Report spelled as Yatsauk

The population distribution across age classes for the Shan State is similar to that of the Union as a whole. The population data from the 2014 Census gives an "onion-shaped" age class pyramid with the age group of 10 - 14 as the largest. This indicates that the birth rate is declining. The figure below shows the age distribution pyramid for the Shan State.

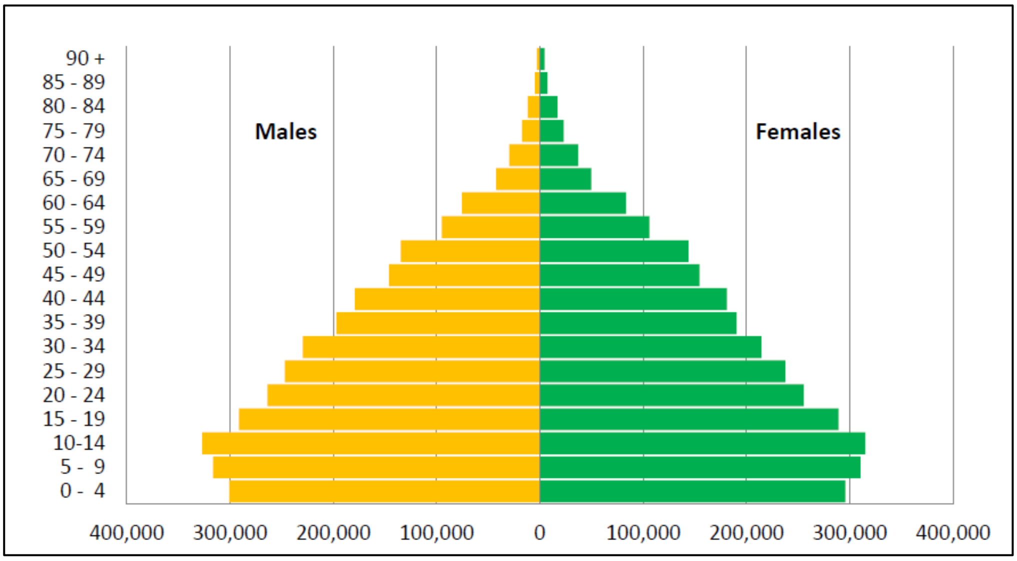


Figure 7-3: Population pyramid Shan State, 2014.
Source: Shan State Census Report (2014)

The dependency ratio measures the percentage of dependent people (not of working age) in a society against number of people of working age (economically active). It indicates the pressure on a productive population. The dependency ratios in the Shan State (56.9%) and in the project area are high because of the large segment of children below 14 years compared to the working age segment (15 – 64 years). In Europe, dependency ratios are typically 20 – 30% but are on the increase due to an ageing population. However, neighbouring Bangladesh and Thailand has similar dependency ratios with 51 and 40, respectively, for the year 2016 (https://data.worldbank.org/).

Table 7-3: Dependency ratios

Administrative Unit/Level	Dependency Ratio		
	Children	Elderly	Total
Shan State	50.2	6.7	56.9

Kyaukme District	47.2	7	54.2
Nawnghkio Township	43.0	6.3	49.3
Kyaukme Township	45.4	8.1	53.5
Taunggyi District	47.3	6.3	53.6
Lawksawk*	48.2	5.2	53.4

*In the 2014 Census Report spelled as Yawksawk

7.3.3 Road Access

Villages in the indirect impact zone primarily rely on unpaved roads of varying quality. Most villages on the right bank (Zone 4a) and several on the lower left bank (Zone 4d) have easy access to Road 41 via unpaved village roads. Two of the surveyed indirect impact zone villages are located on Road 41 itself, and both have notable higher income and education levels than the surrounding communities, most likely as a result of the good road and market access.

The villages located on the upper left bank (Zone 4c) have by far the most difficult access to Road 41 including the market centres and government services that are located along the route. Access from the main road to Thar Si village takes more than 1.5 hours on a very rough and steep road that crosses several large hills. In the dry season, it is accessible by four wheel drive cars, but for six to nine months a year it is only accessible by motorbike or local *trologyi* (large truck). Pin Ping and Kone Nyaung village lie beyond Thar Si, taking approximately an additional 30 minutes and one hour, respectively, to travel to by motorbike over relatively flat terrain but on unimproved and unpaved roads.

7.3.4 Literacy and School Attendance

Literacy in Myanmar is high relative to income levels and poverty incidence, with a rate of 89.5%. As shown in ***Table 7-4***, the Shan State is well below the national average, but the figures for two townships, Nawnghkio and Lawksawk, where the project is located, are both closer to the national numbers. These literacy numbers reflect the extensive primary school system across the country where almost all villages have at least a primary school with a small number of primary teachers. This ensures that most children are literate, but the rapid drop in education achievement after primary school shows the limitations of this system, where middle and high schools are much harder for rural communities to access.

Table 7-4: Literacy rates and school attendance in the Shan State and the wider project area.

Administrative Unit/Level	Literacy Rate of Population over 15 Years (%)			School Attendance (%) of Total Population between 5 and 29 Years		
	Female	Male	Total	Currently Attending	Previously Attending	Never Attended
Shan State	59.4	70.3	64.6	32	39	29
Kyaukme District	73.2	83.0	77.8	35	48	16
Nawnghkio Township	88.6	94.3	91.4	33	59	8
Kyaukme Township	74.3	84.3	78.9	38	50	12
Taunggyi District	79.3	91.7	85.2	38	54	8
Lawksawk*	81.4	91.2	86.2	40	52	8

*In the 2014 Census Report spelled as Yawksawk

The socio-economic survey results for the right and left bank villages (see ***Figure 7-4***) in the indirect impact zone show clear distinctions by area and gender for literacy. Male respondents' literacy is similar to the district and township levels across most areas, with slightly lower rates in the upper left bank (Zone 4C) reflecting access challenges. The high male literacy rates in the lower left and upper right bank area (Zones 4a and 4d) similarly reflect the better access these communities have to schools.

Female respondent's literacy rates, however, are well below their township averages: Yae Twin Gyi (YTG) in Zone 4b have literacy rates of 76% and 72% compared to 88.6% across Nawnghkio Township. On the lower left bank, the well-connected villages in indirect impact zone 4d actually beat Lawksaw's average of 81.4% with 91% of women being able to read and write but in the remote upper left just 47% of women are literate.

These numbers reflect that in particularly remote areas, where there is limited education infrastructure, women are likely to be left behind. It should be noted, though, that these numbers reflect respondents' literacy and so are reflective of an adult female population rather than the young women attending school at present. Indeed, a number of villages reported that active government schools had only appeared in their villages within the last 10 years. Prior to that, these communities relied on monastic education, an option frequently open only to young men and boys.

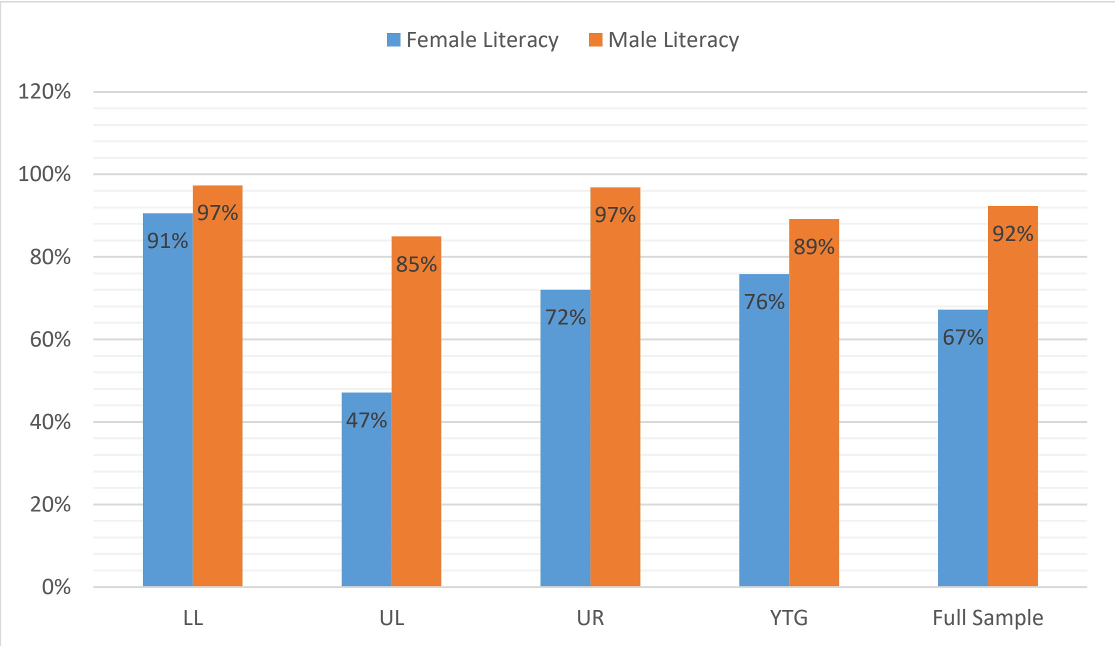


Figure 7-4: Literacy in right and left bank villages in the Middle Yeywa indirect impact zone.
(LL = lower left bank – Zone 4d; UL = upper left bank – Zone 4c; UR = upper right bank – Zone 4a; YTG = Yae Twin Gyi village – Zone 4b)

Figure 7-5 below shows the highest level of education attended by survey respondents. Educational outcomes show that for most residents in the project's impact zones, primary school is the highest level of education available. The high levels of monastic education in the three upper left villages of Thar Si, Pin Ping, and Kone Nyaung highlight the gender gap in literacy mentioned above.

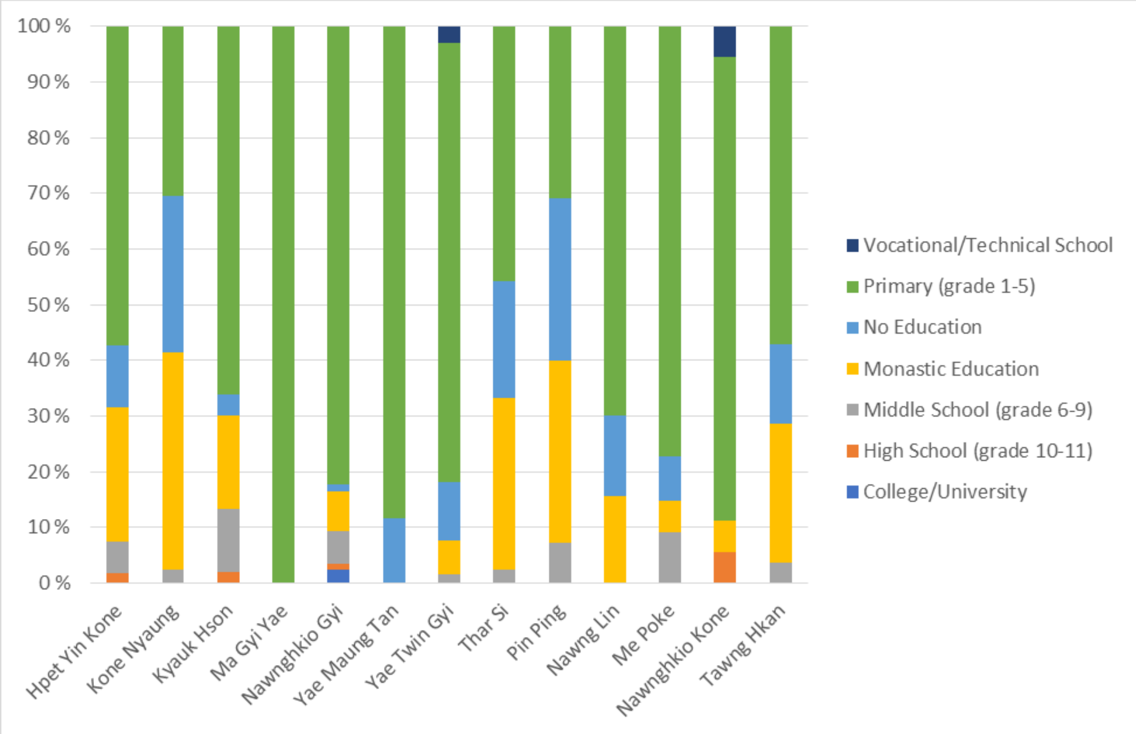


Figure 7-5: Education level in indirect impact zone villages.

7.3.5 Access to Education Services

Overview

Nationally, education services in Myanmar vary. There are a high number of primary schools across the country and access to basic education services is relatively good which in turn results in high literacy rates, as shown in Section 7.3.4. However, for rural communities, access to education beyond the primary level remains poor. As ***Table 7-5*** below shows, from almost universal access to village level primary schools, there is a rapid decline within impact zone villages of education access. None of the impact zone communities have their own high school and the survey found very few students in the villages that had completed their high school studies.

Table 7-5: Presence of educational institutions in indirect impact zone villages.

Village Name	Kindergarten	Monastic School	Primary School	Middle School*	High School
Hpet Yin Kone	Yes	No	Yes	No	No
Kone Nyaung	No	No	Yes	No	No
Kyauk Hson	No	No	Yes	Yes	No
Ma Gyi Yae	Yes	No	Yes	No	No
Nawnghkio Gyi	Yes	No	Yes	Yes	No
Yae Maung Tan	No	No	No	No	No
Yae Twin Gyi	No	No	Yes	Yes	No
Tawng Hkam	Yes	No	Yes	No	No
Thar Si	No	No	Yes	Yes	No
Pin Ping	Yes	No	Yes	Yes	No
Nawng Lin	No	No	Yes	Yes	No
Me Poke	No	No	Yes	Yes	No
Nawnghkio Kone	No	No	Yes	No	No

* There were more split responses within villages for this question, reflecting different villager perceptions of whether village schools that teach some, but not all, middle school grades are middle schools or not. For the analysis, we count all schools that teach middle school grades as middle schools.

Monastic Schools

Despite a significant number of adult respondents reporting they had received their education from Buddhist monastery schools, no villages reported having active monastic education systems at the time of the survey. This is likely due to two factors: firstly, as government schools have expanded their presence in ethnic minority areas over the past two decades (including in the project area), rural communities' reliance on monasteries for primary education has been reduced; and secondly, village monastic schools have over time become increasingly centralized at large monastery locations which have purpose-built education facilities. Village monasteries, particularly in ethnic areas, do continue to play an important role providing classes on Buddhism and ethnic minority languages and in some cases summer classes on other subjects. However, village monasteries rarely play the role of primary education provider at present.

Primary Schools

Outside of non-government controlled areas, village level primary schools have become almost ubiquitous across Myanmar in recent years. The villages within the impact zones are no different, and all but one village reported they had a primary school within the village limits. Most respondents in the one village without a primary school, Yae Maung Tan, reported that they had access to the school in nearby Me Poke, a 20-25-minute walk or 10-minute motorbike ride away. One village, Kone Nyaung, had previously built its own school and hired its own teachers independent of government systems, but last year it was formally amalgamated into the Ministry of Education system and has had its first government teachers assigned to it.

While access to primary schools is high, there are other limitations experienced by villages within the impact zone. As is the case across much of Myanmar, the teacher-student ratio is high and in almost all focus group discussions the need for more teachers was a key point that was raised by villagers. Many communities take it upon themselves to find and hire additional teachers through community initiative funds though the training and capacity of these auxiliary teachers can vary significantly. Such initiatives are particularly common in ethnic minority areas that have trouble retaining teachers, many of whom are of a different ethnicity and often leave after 2-3 years in these relatively remote areas of the country.

Middle School

Middle schools are much less common than primary schools across Myanmar and there is an additional definitional complexity. Instead of a strict classification of schools as primary or middle, as more teachers become available, primary schools in villages 'add' grades. These schools are often known as 'post-primary' schools, able to provide at least partial middle school education for local students. Of the thirteen surveyed villages, the majorities of respondents in seven villages reported that they had access to middle school, i.e. that their village schools were teaching at least some middle school grades.

High School and Beyond

None of the surveyed villages in the indirect impact zone have access to a high school within the village; all reported having to travel at least to the main village in the village tract in order to attend high school. For villages on the left bank (Zone 4d), a clear majority of respondents reported Kyauk Ku as the most accessible high school, with Nawnghkio and Lawksawk also mentioned. Responses from people on the right bank (Zone 4a) were more varied, with Taun Shae and Kan Gyi villages on the main road to Nawnghkio and 'no answer' being the most common responses. Individual households reported sending their children to Pyin Oo Lwin and Mandalay for high school.

For those students who complete high school, further education options are either distance university courses or travel to Mandalay, Pyin Oo Lwin, or even Yangon. There are no reported vocational or technical schools in the villages, and most respondents (55%) were not able to identify one they could access. For those who did identify the location of a vocational school, Mandalay (22%) was the most common response, followed by Taunggyi (12%).

7.3.6 Common Illnesses

Respondents were asked to list all incidents of illnesses that had occurred within the household by population group (men, women, children under 15 years, children over 15 years) over the year prior to the survey. The results, as shown in ***Figure 7-6***, illustrate that the major health challenges are fever and cold/flu. Malaria and tuberculosis are present, but with a low incidence in the impact zones communities, with 28 cases of the former and 19 of the latter reported across the thirteen villages.

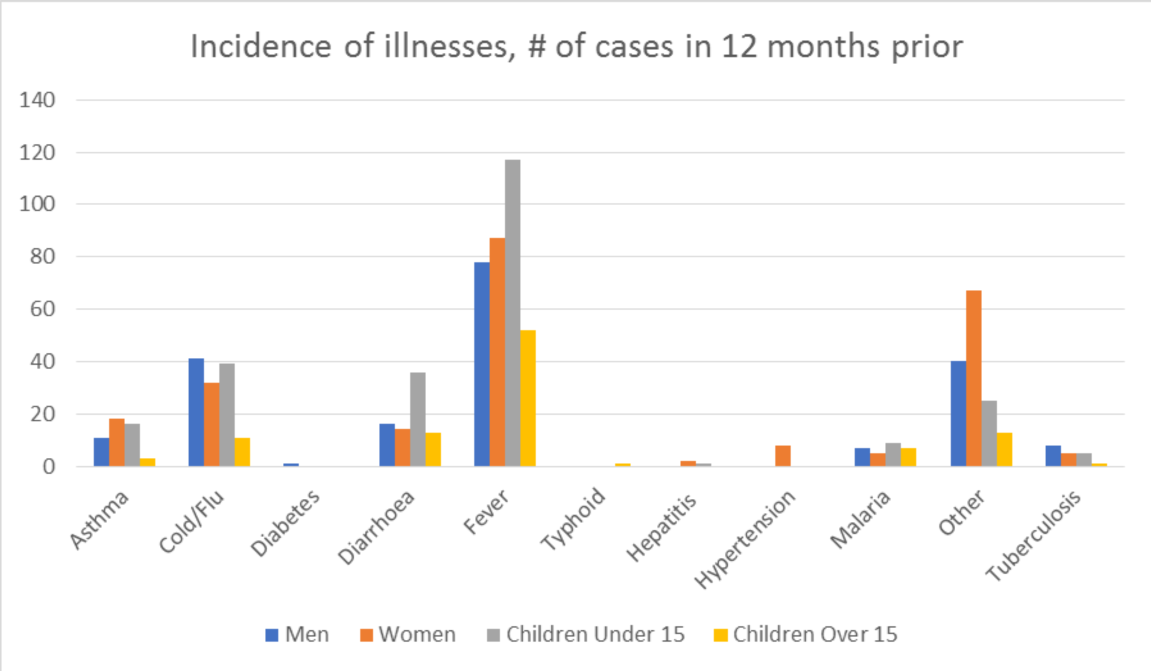


Figure 7-6: Incidence of illnesses in indirect impact zone villages.

7.3.7 Access to Health Services

The core component of Myanmar's healthcare provision in rural areas are the Rural Healthcare Centres (RHC), generally staffed with one to three midwives who are trained by the government and who receive a salary from the Department of Health (DOH). Their primary responsibilities are maternal and post-natal care for women in the villages, and they also provide both initial diagnostician and referral services and collect health data on behalf of the DOH. Their ability to treat is extremely limited and for any serious illness, patients are referred to the township hospitals or beyond.

RHCs are generally located in the largest village in a village tract, but there are also 'sub-centres' (RHSCs) which may exist in smaller villages around the tract and are generally staffed by one midwife and represent the most grassroots level of healthcare provided by government. Larger village tracts, and, occasionally, large villages within tracts may have a full 'station hospital' with assigned doctors (at least one, sometimes up to three), additional nursing staff, and a public health official. This latter individual is responsible for health education and for public health testing including for tuberculosis.

Table 7-6 shows the presence of RHCs and RHSCs across the impact zones. Less than half of the villages have a health centre within their community. As the table also shows, for many of those communities without a health centre, accessing health care requires a 30-minute motorbike drive.

Table 7-6: Location of nearest healthcare centre.

Village Name	Rural Health Care (Sub) Centre in Village?	If No, Location of Nearest RHC?
Hpet Yin Kone	No	Kyauk Ku Village, 30 min by motorbike
Kone Nyaung	No	Pin Ping Village, 30 min by motorbike
Kyauk Hson	Yes	
Ma Gyi Yae	No	Tae Shae Village, 15 min by motorbike
Nawnghkio Gyi	Yes	
Yae Maung Tan	No	Me Poke Village, 5 min by motorbike
Yae Twin Gyi	Yes	
Tawng Hkam	No	Kyauk Ku Village, 30 min by motorbike
Thar Si	No	Pin Ping Village, 45 min by motorbike
Pin Ping	Yes	
Nawng Lin	No	Me Poke, 30 min by motorbike
Me Poke	Yes	
Nawnghkio Kone	No	Me Poke, 15 min by motorbike

Despite RHCs and sub-centre midwives being primarily responsible for maternal and child health, they do act as the primary care provider for almost half of the survey respondents. ***Figure 7-7*** below shows the breakdown of responses for the question of what healthcare option a household will seek out first when someone falls ill. For 47%, the village health centre, i.e. a RHC or RHSC, will be the first choice while 24% reported other—an option that includes another village's RHC/RHSC. Notably, 15% reported they would first seek out a traditional healer, with a higher proportion of men selecting this option. This may be because the traditional healer is more accessible and cheaper but also because some people are more familiar with traditional healers and trust them more than the public health services.

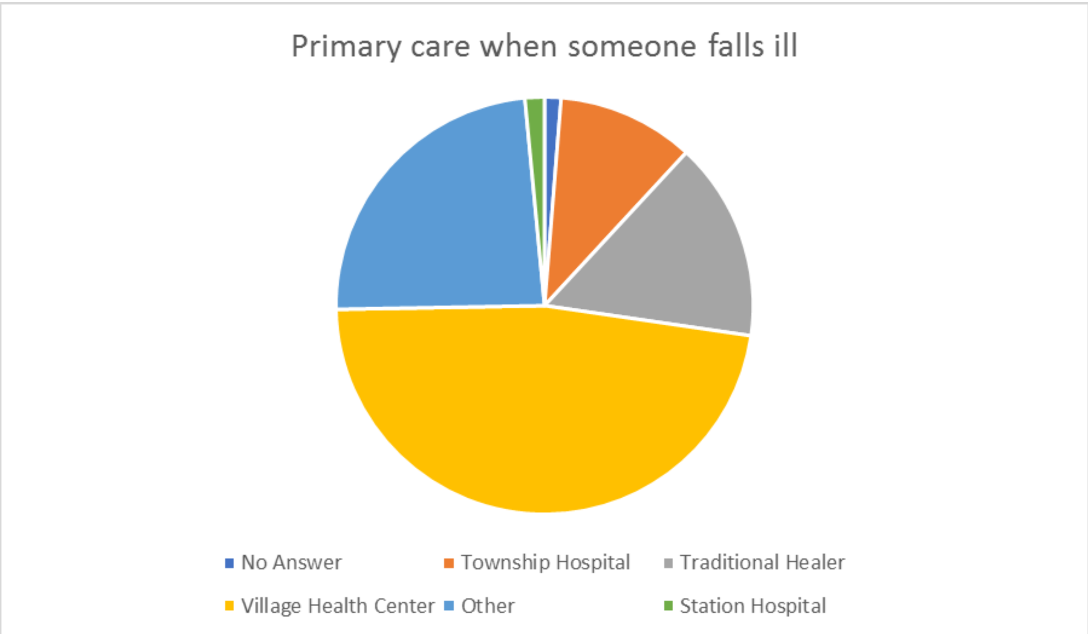


Figure 7-7: Preferred health care option in indirect impact zone villages.

7.3.8 Economy and Livelihoods

Regional Economy

The largest economic sector in Myanmar is agriculture contributing 38% of GDP and accounting for some 70% of labour employment.[14] The regional economy of northern Shan State is no different, and the majority of inhabitants across Nawnghkio and Lawksawk townships are farmers. Local towns provide services (especially agricultural inputs) and markets for farmers to sell their harvests. Shan State generally is known across Myanmar for its high quality produce thanks to its temperate climate and fertile soil. Markets in the region tend to rotate on a five-day basis, with villagers from surrounding communities traveling to the market.

Figure 7-8: Photo from market at Lawksawk, selling NTFPs and tea (Palaung ethnic group)

There is some natural resources extraction on a commercial scale in the northern Shan State, notably the Bawdwin mine which is one of the world's longest running silver, zinc and lead mine. There are smelters located near Namtu town.

The road from Mandalay to Nawnghkio is one of the important trading corridors to China, and there is considerable heavy traffic of a variety of goods to border towns. . The town of Muse is the largest of these towns, located some five hours drive north of Nawnghkio.

7.3.9 Local Project Area Economy

Analytic Approach

Communities in the wider project area and in the indirect impact zone depend predominantly on agriculture for their primary and secondary incomes. Livestock raising is common, but almost entirely for household consumption or sale within the village. Very few households sell livestock at markets or have significant cash income from livestock raising. Instead, as in much of the rest of Myanmar's more hilly and mountainous areas, upland farming and crop cultivation is the dominant livelihood.

This livelihood analysis focuses on the two geographically different areas in the indirect impact zone, the right bank and the left bank. The socio-economic survey for the right bank was carried out in 2015 with the exception of one village (Nawng Cho Kone) while the left bank survey was carried out in 2017.

[14] *http://www.fao.org/myanmar/fao-in-myanmar/myanmar/en/*

The difference in geographic features has been taken into account by dividing the villages into four indirect impact zones (see Figure 3-1). The upper right bank villages (Zone 4a), the upper left bank villages (Zone 4c), the lower right bank village of Yae Twin Gyi (Zone 4b), and the lower left bank villages (Zone 4d). Zone 4a only includes one village, Yae Twin Gyi, which is the village likely to experience the greatest impacts of the Middle Yeywa HPP due to its proximity to the dam site and the access road. The lower left villages are those located in Kyauk Ku village tract, on the left side of the lower section of the reservoir.

Land Use

On both sides of the Myitnge River, farmland consists of non-irrigated uplands fields. Many households rely on slash and burn techniques and have traditionally left the land fallow for 1-3 years between plantings. However, as population has grown in the villages and average plot sizes have decreased, the ability to leave the land fallow is decreasing. As a result, fertilizer use is increasing significantly and to date appears to have forestalled any drop in average yields caused by planting the same acres every year though farmers interviewed expressed concern that maintaining yield is requiring more and more fertilizer.

Land Access

Most households across the impact zones have access to their own land. This stands in contrast to the central regions of Myanmar where the land ownership is comparatively concentrated. In large part, this is a reflection of the low population density and the ability of households to clear forest land and create new upland agriculture plots, or *Taunggya* (specifically meaning shifting cultivation, but often used as a generic term for upland land).

Some villages have already expanded their fields to the edges of the traditional borders of the village. In these communities there is no possibility for expansion and plot sizes are being reduced in size as village population increases and land is passed down through inheritance.

Very few farmers reported having any formal rights to their farmland. The land registration process, which was initiated in 2015, has not yet reached many communities across Myanmar. In only two villages visited in 2017 did research respondents say their land had been surveyed by government representatives. Most farmers rely on historical or customary usage rights that are well understood within the village but have no formal protection under Myanmar law. There is no private ownership of agricultural land in Myanmar, as all land is in theory owned by the state.

Crop Selection

The most common crop grown by farmers is maize; 728 of 771 farmers who responded to the survey had grown maize in the previous agricultural season. However, the most profitable crop varies from one side of the river to the other, primarily a reflection of the presence of a large sugar mill located in Nawnghkio Township not far from Nawnghkio town. This sugar mill, which has been in operation for more than ten years, has had a large influence on agriculture in all right bank villages.

When the first phase of the baseline was undertaken in 2015, only a small number of the interviewed farmers were growing sugar cane and were able to take advantage of its profitability. Two years later, in the one right bank village included in the baseline's second phase, 82 out of 87 farmers reported to grow sugar cane, maize and upland paddy were supplementary, while sugar cane was cited by these villagers as easy to grow and a crop for which there was a reliable market. This one right bank village included in the 2017 survey indicates how villages on that side of the river have benefited from the attractive and reliable market for sugar cane; its households' average income was 20% higher than any other village, and nearly 60% higher when villages not located on the main road were excluded.

Notably, the factory does not buy sugar cane from the other side of the river (left bank) and so the agricultural context is quite different there. Communities reported that the reason for this was the poor road conditions leading across the river. As a result, the cash crops grown by left bank communities are different, primarily maize (which is shipped to China) as well as soybean (in a small number of villages).

In addition to these cash crops, communities grow a range of crops for home consumption, with any surplus being sold within the village rather than at a market. In most villages, upland rice is a staple, though a few villages with irrigated farmland grow paddy (wet rice). Peanuts, garlic and sesame were also mentioned by some respondents. Peanuts are notable as they are often processed into oil at the village level and used as the households' main cooking oil.

Livestock

Most households have a small number of livestock, almost exclusively poultry and pigs, for their own consumption. No households reported relying on livestock for primary or significant secondary income sources in any of the villages.

Market Access

Most farmers in the impact zones sell their harvests in the main town of Nawnghkio and the large village of Kyauk Ku (below Zone 4d). There is a rotating five-day market in Kyauk Ku village tract and a number of medium and large scale traders are based in Nawnghkio. Farmers finance transportation of the harvest to these markets, often joining to share the cost of hiring a large truck or *trologyi*. These costs can constitute a significant amount that reduce the profitability of maize cultivation in villages with poor road access.

Figure 7-9: Cultivated areas on the plateau above the Myitnge River Valley at Nawnghkio Gyi Village

7.3.10 Income Levels and Poverty

National Context

Despite five years of 6% or more annual economic growth, Myanmar remains one of the poorest countries in Southeast Asia. The World Bank calculates the country's GNI per capita as US$ 1,190, comparable to Cambodia (US$ 1,140) and well below Vietnam (US$ 2,060) or neighbouring Thailand (US$5,640).[15]

Poverty in Myanmar is relatively high. A recently released World Bank study that used household data from 2015 and set the poverty rate at 1,303 MMK (US$ 1.1)[16] per adult per day, found that in 2015, 32% of Myanmar's population lived in poverty. It also found that rural poverty was notably higher than

[15] *World Bank, GNI per capital 2016 in 2016 dollars, Atlas Method*
[16] *Using 2015 average exchange rate of MMK 1,182 to US$*

urban poverty (39% vs. 14.5%) and that the country's hilly and mountainous areas (which include the project site) had the second highest incidence of poverty (40%).

However, while poverty levels are high they have been declining: the same World Bank study estimated that poverty has declined from almost 55% in 2004/5 to 48% in 2009/10, to 39% in 2015.

Income Levels in the Project Area

Declared income levels within the project's impact zones are substantially above the World Bank's poverty assessment described above as well as above the global poverty line of US$2/day. Average income across the 13 villages was MMK 4,105,567 per year, or US$ 3,059, which corresponds to US$ 8.3 per day.[17] It is also important to note that declared income is likely to be an underestimate of the total household income[18]. Measurement of consumption and expenditure is often the preferred monitoring tool. However, the results for the project area indicator high rural income levels on average.

Breaking down the data between those villages surveyed in 2015 and those that were surveyed in 2017, there are clear indications that income levels have increased since 2015; average income was $8/day in 2015 versus $9.1/day in 2017, an increase of 12% over two years. This does not take into account that communities surveyed in 2017 were predominantly on the left bank which has reduced market access and less ability to grow the most profitable cash crop (sugar cane). The one right bank village surveyed in 2017 where sugar cane is grown extensively had average income of over US$16/day.

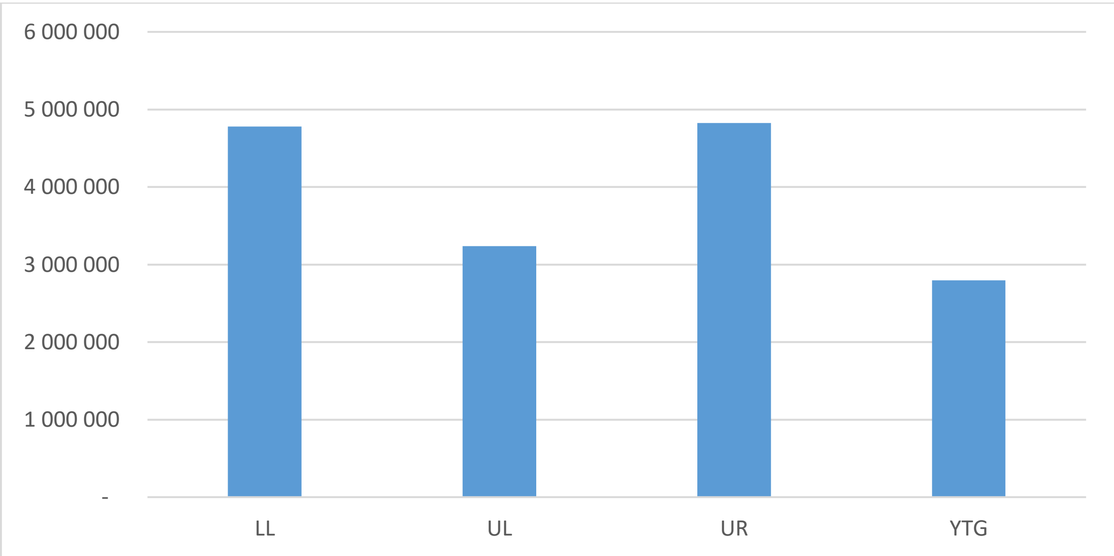


Figure 7-10: Income in right and left bank villages in the Middle Yeywa indirect impact zone.
(LL = lower left bank – Zone 4d; UL = upper left bank – Zone 4c; UR = upper right bank – Zone 4a; YTG = Yae Twin Gyi village – Zone 4b)

Non-farm Income

The figure below shows the average on-farm income compared to the average off-farm income which includes all other income sources such as income from forest products, casual labour and salaries. As can be read from the figure, the on-farm income share is the dominant source of income in all the surveyed villages. On the average across all surveyed villages, the on-farm income share represents around 80%.

[17] *Using 2017 average exchange rate of MMK 1,342 to US$*
[18] *Measure for Measure: Systematic Patterns of Deviation between Measures of Income and Consumption in Developing Countries. Evidence from a New Dataset. WYE City Group on Statistics on Rural Development and Agricultural Household Income. Economic Research Service, US Department of Agriculture, Washington DC*

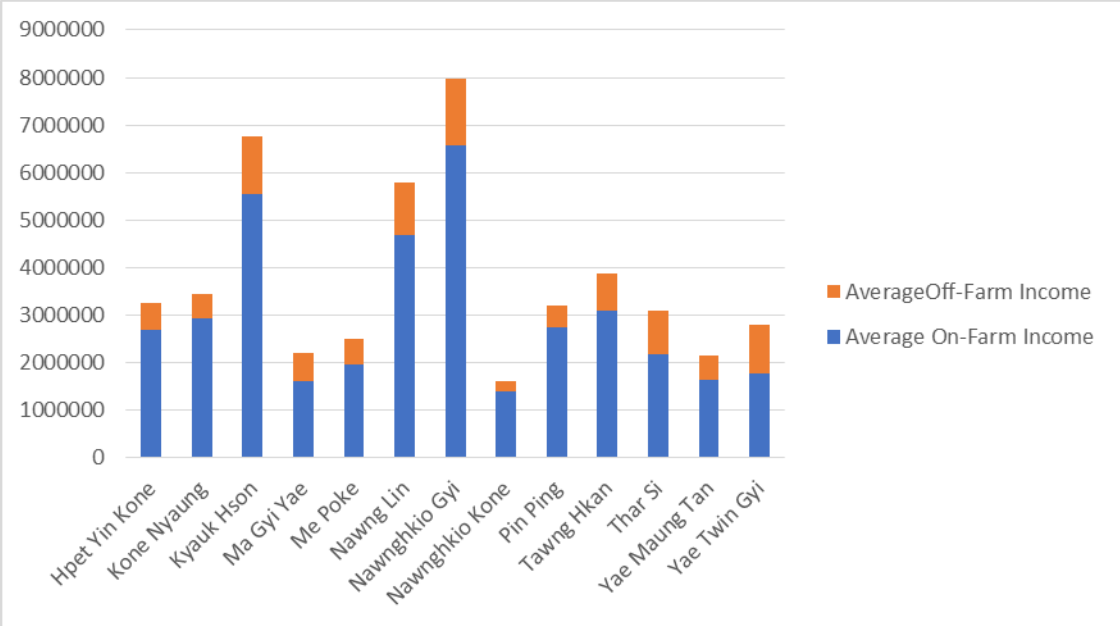


Figure 7-11: On-farm income in compared to off-farm in the Middle Yeywa indirect impact zone.

Income Levels of Vulnerable Groups

Within the context of the project site villages and Myanmar more generally, vulnerable groups are defined as women-headed households, landless households and households with disabled people. Some vulnerable groups within the villages were comparatively poorer than other households, but none of these groups, on average, fell below the US$2/day line. For example, of the 52 surveyed women who were identified as head of households, average income (at the 2017 exchange rate) was $7.58/day compared to US$9.1/day for male respondents identifying as head of households. Further income data on vulnerable groups is presented in the table below.

Table 7-7: Income levels among vulnerable groups.

Vulnerable Group	Average annual income (MMK)	Average annual income (US$)	Average daily income (US$)
All Households	4,105,567	3,059.29	8.38
Women-headed households	3,716,009	2,769.01	7.59
Landless Households	1,653,621	1,232.21	3.38
Households w/ Disabled Persons	4,166,816	3,104.93	8.51

These results suggest that in the project area landlessness is one of the most important factors with regard to the actual vulnerability of a household as it as it appears to have a stronger impact on the income level that the other vulnerability factors.

7.4 Natural Resource Use in the Impact Zones

Natural resources in and around the impact zones can be divided into two categories: forest resources and river resources. Communities within the impact zones are made up primarily of small farmers who plant a variety of upland crops on unirrigated farmland. As a result, few if any households within the 13 surveyed communities rely on either category of local natural resources for their primary income and only a handful derive any significant contribution from them.

7.4.1 Forest Resources

Forest resources include timber (for construction as well as firewood), foraged plants (for consumption and sale), and hunting (consumption and sale). Discussions with community leaders indicated that while many villagers participate in 'recreational' use of the forests, very few rely on them for any portion of their income. For example, many villagers reportedly hunting for recreation and to provide dietary diversity while others collected herbs and other plants from the forest, but very few reported selling any forest resources/products at the market.

Figure 7-12 shows the proportion of income derived from forest resources / products[19] across the thirteen villages.

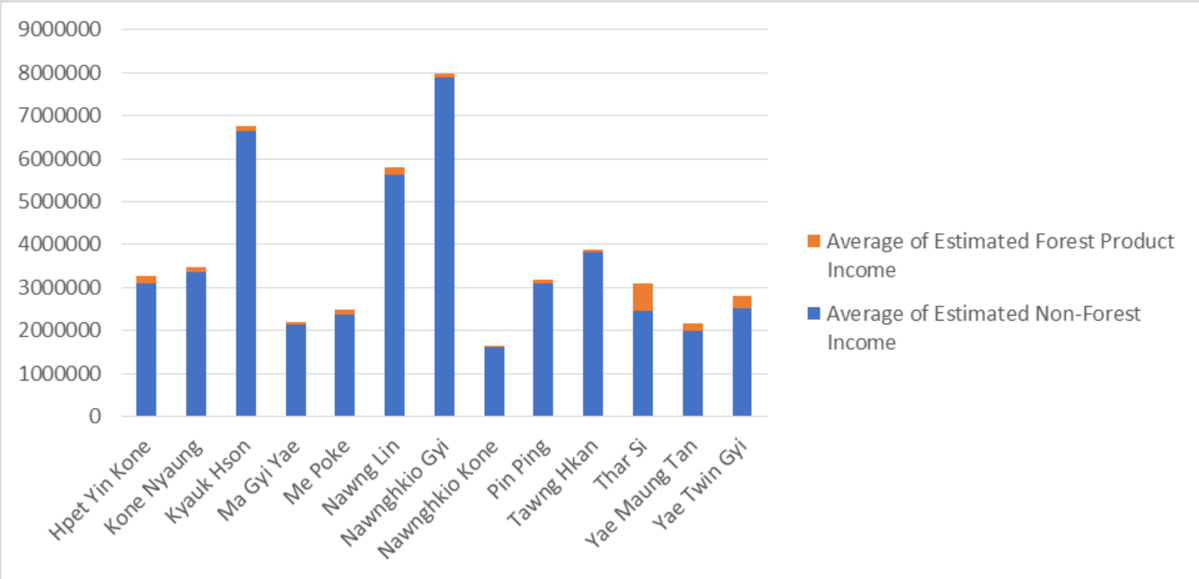


Figure 7-12: Average estimated non-forest income against estimated forest product income.

Thar Si village has a notably higher contribution to income from forest products, reflecting the large forests that surround the village that has not yet been converted into farmland due to the steep hills and rocky terrain in that area.

7.4.2 River Resources

River resources primarily involve fish and other food sources though in certain cases sand/gravel and water itself may be important natural resources used by nearby communities. In this case, none of the 13 villages within the indirect impact zones rely on the river as a primary or even secondary water source and the distances from the river to villages are too far for sand, gravel or stones to be useful. Some households reported recreational fishing, but this did not contribute in any significant way to household incomes.

[19] Forest products income defined as income from the following sources: cutting firewood, other hardwoods cut, bamboo, wild animals, foraged fruit and vegetables, honey, foraged herbs, and flowers.

Table 7-8 shows the average income from fishing per household. In no village did fishing account for more than 1% of average income.

Table 7-8: Income from fishing.

Village	Average HH Income from Fishing	Average Estimated Total Income	% of Income from Fishing
Pin Ping		3,191,605.45	0.00%
Hpet Yin Kone	3,148.15	3,258,760.93	0.10%
Kone Nyaung	1,463.41	3,458,945.24	0.00%
Kyauk Hson	927.27	6,770,728.91	0.00%
Nawnghkio Gyi	-	7,979,756.32	0.00%
Tawng Hkan	-	3,871,726.00	0.00%
Thar Si	1,903.61	3,078,926.51	0.06%
Ma Gyi Yae	5,454.55	2,207,136.36	0.25%
Me Poke	2,045.45	2,494,111.36	0.08%
Nawnghkio Kone	5,555.56	1,625,555.56	0.34%
Nawng Lin	1,240.56	5,792,230.87	0.02%
Yae Maung Tan	384.62	2,157,526.92	0.02%
Yae Twin Gyi	21,318.18	2,797,912.12	0.76%

Of the 800 households sampled, only 30 reported any fishing income, corresponding to 0.04% of the total number of sampled households. The average income from fishing for these households amounted to averaged MMK 78,922, corresponding to 2% of their reported income.

7.5 Archaeological Sites and Cultural Heritage

No archaeological or cultural heritage sites have been identified or reported in the direct impact zone of the Middle Yeywa HPP. However, villages in the indirect impact zone have temples and sometimes more local Buddhist shrines that are visited and maintained by the local population.

Figure 7-13: Example of large monastery on the right bank – Yae Twin Gyi

Figure 7-14: Local village guardian spirits (Nats) in Pin Ping

8 PROJECT IMPACTS

8.1 Introduction

This chapter presents the potential environmental and social impacts of the proposed Middle Yeywa HPP. The impact assessment has been based on the following information:

- Scoping of the social and environmental impacts carried out in 2015 with the preparation of the Pre-Feasibility Environmental and Social Impact Assessment Report;
- Consideration of present project layout and engineering plans in terms of geographical location and scale (presented in Chapter 2);
- Consideration and assessment of the Area of Influence of the Project;
- Stakeholder consultations related to the potential environmental impacts arising from the hydropower development plans (presented in Chapter 5);
- Baseline studies carried out in the Scoping and EIA phases (presented in Chapters 6 and 7);
- Consideration of the conservation, human and biodiversity value of the affected aquatic and terrestrial resources affected by the hydropower development.

8.2 Environmental Impacts

8.2.1 Topography and Landscape

Construction Phase

Visual impact: During construction, there will be substantial vegetation clearance, earthworks and movement of machinery in the direct impact zone. The Middle Yeywa HPP is a major construction project that will last for several years, and hence affect the appearance of the landscape to a large degree. However, the visual impacts will be concentrated mainly at the dam site, along the access road down the river valley and any other areas with construction activities including reservoir clearance. Towards the end of the construction phase, the reservoir will be filled and this will change the landscape significantly (see 'Operation Phase' below).

Mitigation measures:

- During earthworks, the good topsoil, where available, shall be removed first and be stockpiled separately for use in replanting and restoration;
- All disturbed surfaces shall be subject to landscaping, including revegetation using local topsoil and native plant species;
- Temporary construction facilities shall be decommissioned and the sites be restored to pre-construction state;
- Excess material (that cannot be incorporated into permanent works) shall either be disposed of in the Middle Yeywa reservoir area, or in spoil dump yards taking into consideration the natural terrain and be subject to revegetation, drainage and landscaping.

Operation Phase

Visual impact: In general, the aesthetic impact of infrastructure developments, including hydropower plants, is largely a subjective matter determined by individual preferences. The physical structures might be considered as architectural monuments and symbols of development, or as an intrusion in the natural landscape. The attitudes and perceptions will change with cultural background and over time.

The Middle Yeywa HPP will change the landscape from a natural and largely uninterrupted landscape with a dynamic river environment including rapids to a man-made landscape dominated by an artificial and more uniform lake. The dam and reservoir will become a significant landscape feature, which can be seen from far away, especially from the hills on both sides of the river valley. However, in contrast to seasonal storage reservoirs where the drawdown zone typically leaves a large eroded scar in the landscape during the dry season, the narrow zone (1.5 m) required for hydro-peaking in the Middle Yeywa power plant will hardly be noticeable on the steep slopes of the Myitnge valley.

Arguably, the new lake environment may also be considered to enhance the aesthetic qualities of the area and possibly attract visitors for recreation purposes. ***Figure 8-1*** and ***Figure 8-2*** show 3D-views of the Middle Yeywa reservoir.

Mitigation measures:

- Conduct pre-impoundment clearing of trees in the reservoir area in order to avoid dead trees standing in the water where feasible and accessible

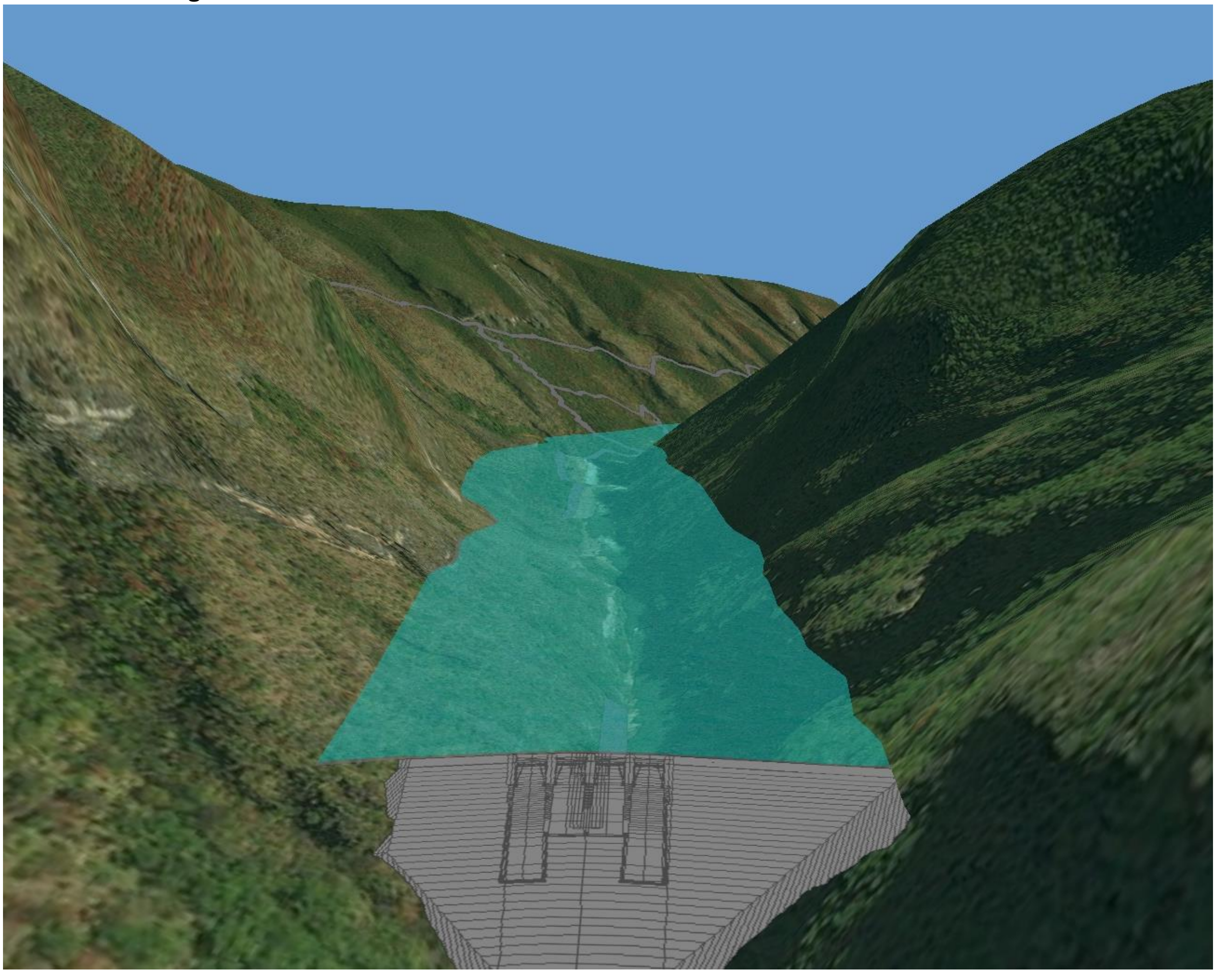


Figure 8-1: Illustration of the Middle Yeywa reservoir area after impoundment.

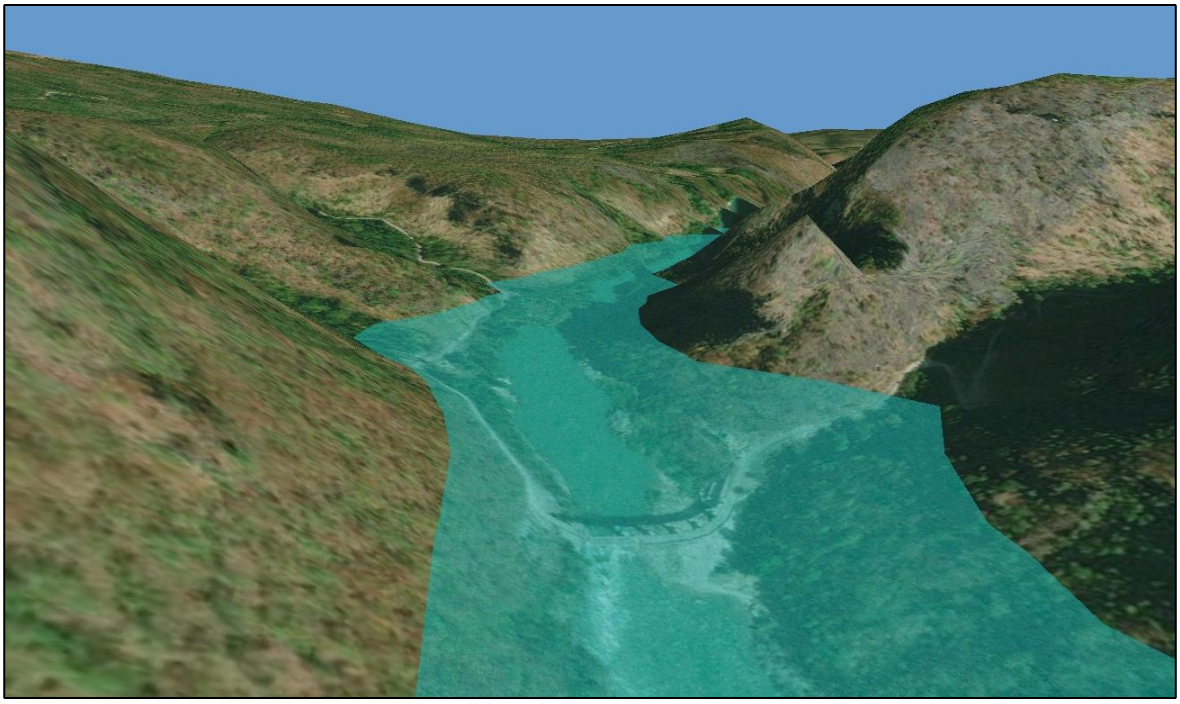


Figure 8-2: Illustration of the Middle Yeywa reservoir at the Myitnge bridge.

<u>Conclusion</u>

Phase	Magnitude – Topography and Landscape				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation		▲			

8.2.2 Geology and Soils

<u>Construction Phase</u>

Soil erosion: During construction, surface soil conditions will be impacted by activities, such as vegetation stripping, grading, soil removal, backfilling, compacting, excavation and disposal of surplus soil, etc. This applies especially to the road upgrade/construction works on the steep slopes of the Myitnge valley. Exposure of the ground and removal of vegetation cover will make the soil liable to erosion by wind and water runoff in particular.

Mitigation measures:

- Except where vegetation clearing is required for permanent works or excavation operations, all trees and vegetation shall be preserved;
- Erosion control practices including timely installation of drainage shall be implemented prior to any major soil disturbance and be maintained until permanent protection is established;
- All exposed surfaces (including roadsides) and spoil areas shall be covered with topsoil and replanted or re-seeded with native species;

Land contamination: Construction activities may result in the accidental pollution through the release of petroleum-based products, such as lubricants, hydraulic fluids and fuels during their storage, transfer or use in equipment. Other hazardous components include paint and other chemicals used in the building process. If such hazardous materials are not contained and handled properly, there is a risk that they can cause soil contamination as well as water pollution (see below).

Mitigation measures:

- Storage areas for fuel and hazardous materials shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills;
- Diesel shall be stored in a standard skid tank with secondary containment proving 110% volume of the total capacity of the tank;
- Maintenance of machinery and trucks shall be done in workshop servicing and repair areas with impervious concrete platforms and oil traps;
- All storage areas and major construction sites shall have spill kits, sand, dust, and other appropriate absorbent materials;
- A proper waste management system including approved waste disposal procedures should be established.

Operational Phase

Soil erosion: After commissioning of the power plant, the proposed peaking operations will create a narrow drawdown zone in the reservoir (from 316.5 to 317.0 masl). Such daily or regular fluctuations in water levels are typically associated with a risk of shoreline erosion. When the reservoir is drawn down, local slips and failure of soils and material will occur with subsequent movement of soils/sediments into the reservoir due to a combination of groundwater in the soils, rain and wave action. However, the risk of large landslides during normal operation is considered relatively low due to the narrow drawdown zone (1.5 m) and limited depth of soils and loose material.

Major soil erosion and landslide risks will be significantly greater if/when the reservoir is drawn down to MOL or a lower level. This is expected to happen during sediment flushing operations, which will commence after tentatively 15 years of operation and will occur at least every 4 years thereafter (see Section 8.2.7). Even if such events may cause much erosion on the “riverbanks” below the reservoir FSL, the overall effect of sediment flushing is indeed to erode and remove the sediments from the reservoir in order to maintain the storage capacity and increase the lifetime of the hydropower plant.

In the downstream reaches (i.e. below the Middle Yeywa dam and upstream of the existing Yeywa reservoir), daily peaking operations and sediment trapping (creating water with little sediment and consequently a capacity to mobilise and transport more sediment) is likely to cause riverbank erosion. However, as explained in Section 8.2.7, the fact that the tailrace outlet is located a very short distance upstream of the existing Yeywa reservoir, combined with the predominantly bedrock and boulder characteristics of the riverbanks, suggests that the scale of downstream erosion will be relatively limited.

Outside the reservoir and the downstream reaches, soil erosion is expected to be temporary and short-term because exposed soils will be re-vegetated when the earthwork and construction activities have been completed. Limited erosion may nevertheless occur during heavy rains, especially along the access road.

Mitigation measures:

- Consider the need for adjusting the ramping rates and/or physical interventions along the reservoir perimeter and in the downstream (e.g. targeted tree planting, bank protection works) in order to prevent riverbank erosion and landslides/slips during peaking operations;
- Install drainage structures along access roads and areas disturbed by project activities including sufficient cross-drains and protection of drainage outlets and downstream areas until a natural drainage with sufficient capacity to handle water has been created; and ensure regular maintenance and cleaning of drainage structures.

Land contamination: During operation, soils can be impacted due to spillage of hazardous wastes and materials, including hydrocarbons. Failure or lack of spill prevention systems and inadequate handling of hazardous waste may cause soil contamination.

Mitigation measures:

- All permanent facilities where fuel and hazardous materials are used or stored shall be equipped with secondary containment, oil traps, spill kits and absorbent materials;
- A proper waste management system including approved waste disposal procedures should be established.

<u>Conclusion</u>

Phase	Magnitude – Geology and Soils				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation		▲			

8.2.3 Climate

<u>Construction Phase</u>

GHG emissions: During the construction phase, greenhouse gas (GHG) emissions will be generated from increased traffic, a range of motorised construction machinery and from diesel generators used to supply power for construction-related activities. In addition, pre-impoundment clearing of trees in the reservoir will cause emissions from deforestation. Assuming that the average CO_2 emissions from deforestation in Indaing forests are 581 tonnes per hectare (FAO data), the total emissions can be roughly estimated to 475,000 tonnes CO_2 from clearing all the forest in the reservoir (approx. 816 ha). This land use conversion represents a significant source of GHG emissions although the overall impact in terms of climate change is low.

Mitigation measures:

- Compensate the emissions from deforestation in the reservoir area by restoration of an equivalent area (816 ha) of comparable quality outside the reservoir area.

<u>Operational Phase</u>

Micro-climate changes: Large bodies of water influence the climate of their surroundings, especially the temperature and the humidity. The most notable effects are cooling in warm periods, warming in colder periods, and reduction of the daily temperature variations near the water body. In the case of Middle Yeywa reservoir, some minimal effects on temperature and humidity can be expected at local level.

Evaporation from the surface of the reservoir will replace the present evapotranspiration from the soil of the area to be covered by the reservoir. In certain months, evapotranspiration from the soil would exceed the evaporation from the reservoir as a result of heavy rainfall periods when the soil becomes saturated (see Section 8.2.6).

Mitigation measures:

- N/A

GHG emissions: The operation of the Middle Yeywa power plant is intended to supply renewable energy using a technology which is not generally considered to cause GHG emissions. Assuming that the power generation will replace fossil fuel based electricity generation, it will instead contribute to avoidance of GHG emissions from those other sources.

However, under certain conditions, hydroelectric projects can turn into a significant source of GHG emissions. This mostly applies to relatively shallow hydroelectric reservoirs in tropical areas with low energy production / flooded area ratio (i.e. power density).

According to the Intergovernmental Panel on Climate Change (IPCC 2006), there is usually a rapid surge of reservoir emissions immediately after flooding, after which emissions return to a relative stable level. Evidence suggests that CO_2 emissions for approximately the first ten years after flooding are the results of decay of some of the organic matter on the land prior to flooding.

Subsequent to flooding (and land clearing), CO_2 emissions, and CH_4 (methane) emissions if applicable, can occur via the following pathways:

- Diffusive emissions, due to molecular diffusion across the air-water interface;
- Bubble emissions, or gas emissions from the sediment through the water column via bubbles;
- Degassing emissions, or emissions resulting from a sudden change in hydrostatic pressure, as well as the increased air/water exchange surface after reservoir waters flow through a turbine and/or a spillway

The power density of the Middle Yeywa project is 64 (i.e. 700 MW / 11 km^2), which is significantly higher than the threshold of 10 W/m^2 above which the overall GHG emissions can be assumed to be zero (IPCC 2006). More recently, an even lower threshold (5 W/m^2) has been recommended based on more up-to-date evidence and research (including observations from the G-RES data set). Hence, even if there would be GHG emissions from the reservoir beyond the initial few years, they are considered to be negligible in comparison to the high power production that will replace emissions from fossil fuel based electricity generation (***Table 8-1***). The inundation areas do not contain wetland areas or other areas with substantial volumes of organic material that could be converted to greenhouse gases like the highly potent GHS methane following inundation.

For this reason (and because of insufficient data), detailed modelling of reservoir emissions has not been undertaken at this stage. There are also few mitigation measures available other than the planned removal of biomass from the inundation zone prior to filling of the reservoir.

Mitigation measures:

- Conduct pre-impoundment vegetation clearing in order to reduce emissions from decay of organic matter in the reservoir.

Table 8-1: Estimated CO_2 emissions produced by a steam-electric generator for different fuels.

Fuel	kg CO_2 / kWh*	tonnes CO_2 / 3,253 GWh
Coal (Bituminous)	0.94	3,057,820
Coal (Sub-bituminous)	0.98	3,187,940
Coal (Lignite)	0.99	3,220,470
Natural gas	0.55	1,789,150
Distillate oil (No. 2)	0.76	2,472,280
Residual oil (No. 6)	0.82	2,667,460

* Source: EIA (US Energy Information Administration), March 30, 2015.

Conclusion

Phase	Magnitude – Climate				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction					
Operation					

8.2.4 Air Quality

Construction Phase

Air pollution: The main impact to air quality during construction will be from increased dust levels arising from construction machinery, blasting, quarrying, excavations, earthworks, cement mixing and road construction. Emissions of small particles from diesel trucks as well as dust pollution have not been estimated, but the impacts from these emissions will be intermittent and short term. In addition to emissions of particles, there will be minor emissions of NOx and SO_2 from construction machinery, vehicles and from diesel power generators.

Mitigation measures:

- Water shall be sprayed on dirt roads to minimise dust dispersion when necessary, in particular in the vicinity of inhabited areas along transport corridors;
- Trucks transporting loose/friable materials shall be covered by tarpaulins to reduce wind entrainment of dust;
- Stockpiles of excavated soils located near residential areas shall be subject to water spraying.

Operation Phase

Air pollution: Air pollution during the operation phase is expected to be very limited. The main source of air pollution will be from vehicle emissions and dust from traffic on unpaved roads. In addition, there might be some dust caused by wind erosion from construction sites before they are properly re-vegetated.

Mitigation measures:

- N/A

Conclusion

Phase	Magnitude – Air Quality				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.2.5 Noise and Vibration

Construction Phase

Construction noise: During construction, noise will be generated from vehicular movements, quarrying, sand and aggregate processing, concrete mixing, excavation machinery, blasting operations, etc. Noise levels in the construction area from machinery and vehicles will be quite high (typically from 80 to 95 dBA at a distance of 15 m). However, due to very few people living near the construction sites, the noise impacts will mainly be experienced by construction workers while community exposure will occur along the main access road due to increased traffic into the project area. Ground vibration caused by blasting will only occur at the main construction site (dam and powerhouse), a long distance from the nearest receptor.

Mitigation measures:

- Noisy installations shall be located in adequate distance to residential areas to meet noise limit values;
- Noisy activities shall be scheduled to daytime hours if possible;
- Noise control devices shall be installed in construction equipment if noise levels exceed the applicable guidelines.

Operational Phase

Operation noise: The only source of noise during the operation phase is the traffic to and from the power station and offices. The impact will be intermittent and short-term. The noise level from the operation of turbines and generators is expected to be insignificant (except occupation noise).

Mitigation measures:

- N/A

Conclusion

Phase	Magnitude – Noise and Vibration				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.2.6 Hydrology

Construction Phase

River diversion: To allow for the construction of the Middle Yeywa dam, the Myitnge River will be temporarily diverted by means of upstream and downstream cofferdams and a diversion tunnel. However, this bypass arrangement will not affect the "natural" flow regime in the river (in terms of water volume) during the construction phase (until initial filling of the reservoir, see below). It should be noted that the river discharge, at the time of construction, is likely to be controlled or modified by the Upper Yeywa power plant which is currently under construction.

Mitigation measures:

- N/A

Reservoir filling: The filling of the Middle Yeywa reservoir will be done at the very end of the construction phase before commissioning. The filling schedule has not yet been defined, but it will allow for release of a continuous minimum flow during filling. This water can for instance be released through the lower level outlets during initial filling. The amount of water being released will depend on, inter alia, dam safety requirements (filling should be slow to ensure the integrity of the dam), the timing/season and duration of filling, and the downstream water demand (i.e. power generation at Yeywa HPP).

Given the short distance between the dam and the tail of the Yeywa reservoir, combined with the fact that this river reach will be severely affected once the power plant has been commissioned, the downstream water demand may be defined both by ecological requirements and by power generation needs in the downstream Yeywa power station.

The minimum flow to be adopted for the reservoir filling period will be negotiated and agreed once the project design has reached feasibility stage and further details are known about the joint operation of the power plants in the cascade.

Mitigation measures:

- Ensure continuous release of minimum flow during the initial filling of the Middle Yeywa reservoir not less than the minimum flow for the operation phase (to be defined).

Operational Phase

Reduced flow in the diversion reach: Since the powerhouse will essentially be located at the foot of the dam within a distance of less than 200 m from the dam axis to the turbine outlets, the project is proposed to be operated without release of environmental flow into the short diversion reach. This may cause a complete dewatering of the river below the dam (depending on local topography of the river bed and the backwater effect from the tailrace), except when there is spilling of water over the dam or the gates are open. The volume and frequency of spilling have not yet been modelled, but the limited storage capacity of the reservoir suggests that spilling will occur during much of the rainy season (when inflows are significantly higher than the maximum turbine flow) and in periods where the power station is not operating (e.g. due to power grid failures or faults in the power station). When the downstream Yeywa reservoir is full, the reservoir may reach the foot of the Middle Yeywa dam effectively creating a lake-like environment between the Middle Yeywa and Yeywa dams. The duration of such situation in an average year is not known at present.

Mitigation measures:

- N/A

Hydro-peaking effects: The Middle Yeywa power station will be operated as a peaking scheme. However, given the very limited live storage of Middle Yeywa, hydro-peaking will only be undertaken in parts of the year. The detailed operation regime of Middle Yeywa will be defined following the Power Purchase Agreement (PPA) negotiations between the Developer and the Government of Myanmar.

The operation of the plant will most likely vary from running continuously at full capacity (580 m^3/s) to running at full capacity only for a few hours. The power station will probably run at full or near full capacity in the rainy season/periods of high inflow to the reservoir, which is likely to be kept at FSL to avoid head loss. When the inflow to the reservoir is less than the turbine capacity, the power plant is likely to be operated in peaking mode. This means that water will be stored in the reservoir daily, and then the reservoir's live storage can be used to run the power plant at full or near full capacity for a shorter or longer period of the day depending on the water availability and power demand.

For periods of the year, hydro-peaking is likely to involve 7 to 10 hours of operation at full design discharge (580 m^3/s) combined with 14 to 17 hours of operation only to release a minimum flow or no operation (to refill the reservoir up to FSL). The maximum drawdown will be 0.5 m from FSL at 317 masl. to a minimum of 316.5 masl. (subject to verification during feasibility study and detailed design). This implies that the river downstream of the turbine outlets will be subject to only the minimum flow or zero flow in hours of refilling the reservoir (i.e. 14 to 17 hours per day in the example above). The distance of the downstream dewatered river section will depend on how far the Yeywa reservoir at any given time backs up in relation to the tailrace of Middle Yeywa.

Such extreme hydro-peaking involves very high ramping rates, i.e. rapid fluctuations in downstream river flows and water levels. However, in the case of Middle Yeywa, the turbine outlets empty the water into the river a short distance upstream of the existing Yeywa reservoir, in periods of the year probably directly into the Yeywa reservoir. The water level in these downstream reaches is largely controlled by the backwater effects of the Yeywa reservoir, at least during the rainy season and when the downstream reservoir is operated at FSL (185 masl.). This means that the length of the river section between the Middle Yeywa tailrace and the Yeywa reservoir will vary through the year, possibly from no river section at all (lake-like environment between the Middle Yeywa and Yeywa dams) to a river section of at least 1 km.

A likely important consideration for the Government of Myanmar is the joint operation of the cascade consisting of the Upper and Middle Yeywa HPPs that have relatively small live storage capacity and the downstream Yeywa HPP with a substantial live storage capacity. For instance, the Upper Yeywa and Middle Yeywa HPPs may either be running in the same daily mode or be allocated one of the two daily peaking periods (morning or evening) to each of the schemes. An example of daily fluctuations in reservoir level and turbine flow (equal to downstream river flow immediately below the turbine outlets in periods without spilling) is shown in ***Figure 8-3***.

Despite the short but varying distance between the tailrace of Middle Yeywa and the backwaters of the Yeywa reservoir, the extreme fluctuations in downstream flow (including several hours with very small or no flow) will have a significant local impact on riverbank and riverbed stability, aquatic life and potentially on the movement of terrestrial wildlife across the river (loss of existing barrier effect). This applies especially to the dry season when the Yeywa reservoir is drawn down to its lowest level, thus exposing the upstream river reach. For this reason, a less extreme peaking operation should be considered in order to maintain a continuous flow downstream of the turbine outlets. This can be achieved for instance by always running one turbine even in non-peak hours.

Mitigation measures:

- Always running at least one of the turbines in non-peak hours in order to maintain a continuous minimum flow between the tailrace and the downstream Yeywa reservoir.

- Carefully consider the ramping rates to reduce downstream safety risks and environmental impacts.

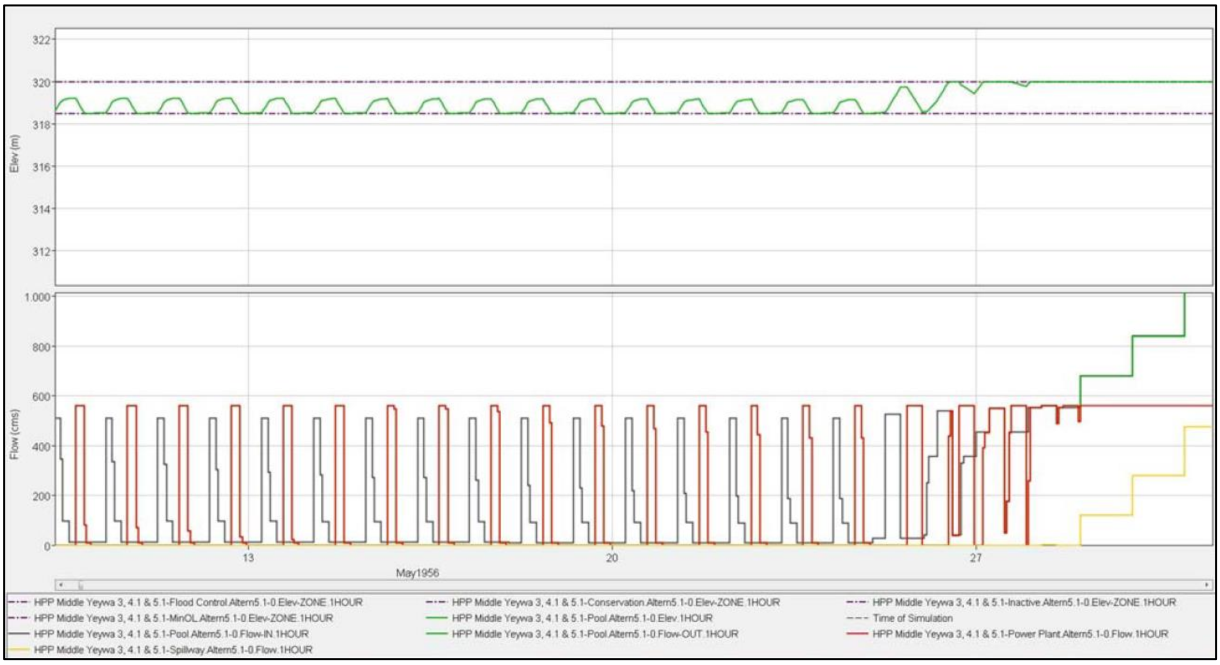


Figure 8-3: Example of daily fluctuations in reservoir level and turbine flow for peaking operations.
Source: Pöyry (2015)

Downstream flows during power station outages and after sediment flushing: The hydrological effects of planned or unplanned outages of the power station (including maintenance works) will resemble those of the no operation hours during unmitigated peaking operation, i.e. no turbine flow and no downstream flow. Such power generation stops may last for minutes, hours, days or even weeks, potentially having adverse impacts on the downstream environment (depending on the water levels in the downstream Yeywa reservoir and the time it takes for spilling to start at Middle Yeywa). However, instead of installing a bypass valve in the power station, water can be released from the reservoir by opening the spillway gates in order to compensate for the lack of turbine flow, assuming the gates are at a level that ensures flow. This will ensure that the no flow period during outages of the power station is minimised. Timely opening of the gates can ensure continuous water in the downstream section. The exception would be (i) if the outage occurs in an extreme low flow period and the reservoir level is below the Ogee crest, in which case it may take a longer period to fill the reservoir up to the level of the spillway gates, and (ii) during refilling of the reservoir after sediment flushing operations when the reservoir is drawn down to approx. 245 masl. (see Section 8.2.7). Alternatively, the use of the sediment flushing gates or alternative water release mechanisms can be considered.

Mitigation measures:

- Make provisions for immediate opening of the spillway gates or alternative mechanisms to release a minimum flow in case of power station outages;
- Make provisions for release of a minimum flow through the mid-level outlets or alternative mechanisms during the reservoir refilling period associated with sediment flushing operations until water is released through the turbines.

Evaporation from reservoir: Dam reservoirs transform the river and its riparian/terrestrial zone into a permanent water body. The moderate increase in water surface will cause higher evaporation, but the loss of water will be insignificant compared to the total river flow. According to Tractebel (2017), the net evaporation losses over the year will amount to approx. 250 mm per year (***Table 8-2***).

Mitigation measures:

- N/A

Table 8-2: Net evaporation losses for the Middle Yeywa reservoir in mm per year.

Period	Pan Evaporation (mm)	Reduction coefficient (-)	Lake Evaporation $E_{reservoir}$ (mm)	Precipitation (mm)	Actual Losses (mm)	Net Losses due to reservoir creation (mm)
Jan	78	0.8	62	8	5	57
Feb	97	0.8	78	2	1	76
Mar	138	0.8	110	14	9	102
Apr	174	0.8	139	33	20	119
May	152	0.8	122	135	84	38
June	115	0.8	92	191	118	-26
July	100	0.8	80	261	162	-82
Aug	98	0.8	78	360	223	-145
Sep	105	0.8	84	164	102	-18
Oct	107	0.8	86	121	75	11
Nov	97	0.8	78	27	17	61
Dec	81	0.8	65	10	6	59
Year	**1 342**		**1 074**	**1 326**	**822**	**251**

Source: Tractebel (2017)

Changes in groundwater tables: River impoundment and the altered flow regime will to some extent affect the groundwater tables along the riverbanks, including the shores of the Middle Yeywa reservoir. However, the Myitnge River has little influence on the overall hydrogeology on the Shan Plateau and no influence on water availability in the groundwater wells used by people. This is due to the fact that the reservoir shores will be located relatively deep down in the river valley quite far away from the settlements in terms of both vertical and horizontal distance from the plateau. Localised impacts on alluvial water tables will occur in the downstream reaches (due to hydro-peaking) and, for example, on the riverbanks along the Gotheik tributary in the upper end of the reservoir.

Mitigation measures:

- N/A

<u>Conclusion</u>

Phase	Magnitude – Hydrology				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation		▲			

8.2.7 Sediment Transport

<u>Construction Phase</u>

Sediment releases from construction works: During the construction phase, soil erosion from earthworks, including construction and removal of cofferdams, and runoff of crushed and ground rock material from drilling, blasting, stone crushing, etc. are expected to cause increased sediment load, and hence increased turbidity and other water quality impacts in the downstream reaches of the river and in the upper end of the existing Yeywa reservoir. A proportion of the particles mobilised will not be naturally eroded and rounded particles but rather sharp-edged or needle shaped particles that can have damaging effects on aquatic life (see Section 8.2.12). Sediment releases will also occur as a result of in-stream construction works at the new Myitnge Bridge (and demolition of the old bridge).

Mitigation measures:

- Erosion control practices including timely installation of drainage shall be implemented prior to any major soil disturbance on the riverbanks;
- Sedimentation controls shall be implemented in the form of silt trap fences, sedimentation ponds and drainage channels where appropriate;
- Coffer dams shall be constructed such as to minimise releases of sediments and pollutants to the downstream environment (e.g. avoiding rock material with high content of fine particles);
- All the water draining down from tunnelling operations, batching plants, crusher plants, etc. shall be led to sedimentation and neutralisation ponds and has to be treated until acceptable water quality is achieved before releasing it to the recipient water body;
- Close monitoring of water quality should be undertaken to track changes in water quality and inform decision-making on required changes to mitigation strategies.

Operational Phase

Sediment trapping and flushing: The Middle Yeywa dam will obstruct the flow of sediments from the upstream to the downstream. Coarse sediments (sand, gravel) and bedload will be deposited in the upstream reach of the reservoir before progressively filling up the lake towards the dam, while a fraction of the fine sediments (clay and silt) will remain suspended and enter the waterways/turbines or pass over the dam during spilling.

The sediment management plan for the Middle Yeywa reservoir has not yet been defined. This is mainly due to the lack of detailed data on sediment transport in the Myitnge River and especially the lack of a sediment management plan for the Upper Yeywa reservoir. It should also be noted that the extent of sedimentation in the existing Yeywa reservoir, commissioned in 2010, has not been documented.

However, Tractebel (2017) has conducted modelling of sediment transport and sediment deposition patterns in the Middle Yeywa reservoir based on available data. The results show that the reservoir will greatly profit from the sediment trap created by the Upper Yeywa reservoir where an estimated 51% of the sediments will be captured.

Figure 7-29 shows the bed level developments (longitudinal profiles) in the Middle Yeywa reservoir after 0, 5, 10, 15, 20, 25 and 30 years (without sediment flushing). It appears that the progress of the sediment delta within the first 30 years of operation is in acceptable limits and does not reach the Middle Yeywa dam (i.e. does not affect the power intakes). However, sediment deposition in the upper end of the reservoir will gradually affect the tailwater level at Upper Yeywa HPP (323 masl. at rated flow), causing a reduction in the available head by as much as 2.0 m after 15 years of operation (when the tailwater elevation is at 325 masl.).

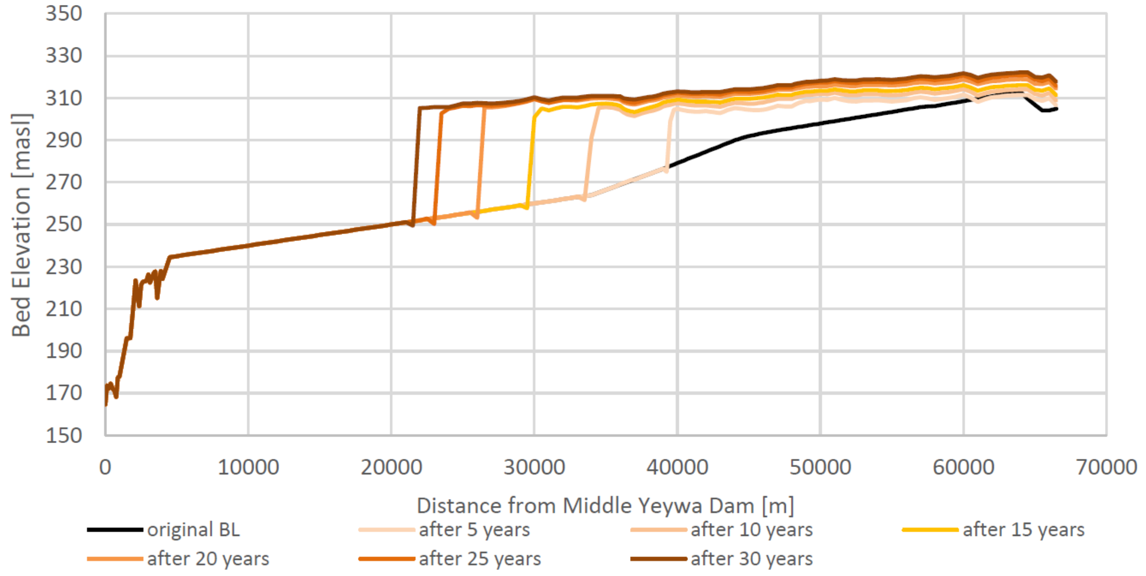


Figure 8-4: Bed level development in the Middle Yeywa reservoir over 30 years without flushing.
Source: Tractebel (2017)

As explained above, the Upper Yeywa will serve as a sediment trap for Middle Yeywa, meaning that the sediment inflow into Middle Yeywa is significantly reduced. However, as soon as the sediments, which accumulated over the years in Upper Yeywa, will be flushed, the sediment will flow in a very high concentration into the Middle Yeywa reservoir and settle there. According to Tractebel (2017), the total sediment inflow into the Middle Yeywa reservoir during normal operation of Upper Yeywa HPP will be approx. 9.1 Mm^3 per year, while sediment flushing will add another 10 Mm^3 per year (on average) from the year that flushing begins. This calls for a joint operation regime whereby sediment flushing is performed simultaneously at Upper Yeywa and Middle Yeywa.

Tractebel (2017) estimated that the first flushing at Upper Yeywa will occur in the 19th year of operation, when the dead storage of its reservoir (and 20% of its active storage) has been filled. Assuming that the Middle Yeywa HPP will be commissioned 4 years after Upper Yeywa HPP, the first flushing at Middle Yeywa will then occur in the 15th year of operation.

Without having access to the sediment management strategy for Upper Yeywa HPP, Tractebel (2017) assessed two different flushing scenarios; an annual flushing cycle and a 4 years flushing cycle. These two scenarios involve an 8 days and a 33 days flushing duration, respectively, while the flushing period would be in mid/late-August for the annual flushing alternative and the whole of August (until 3rd September) for the 4 year flushing alternative. This will allow the flushing to occur when the river has high sediment concentrations while also ensuring that sufficiently high flows will be available to refill the reservoir before the end of the rainy season.

The flushing operation for the two alternatives described above will be accomplished as follows:

Annual flushing cycle:

- Objective: flushing 10 Mm^3 of sediments out of the Middle Yeywa reservoir.
- The water level will be drawn down to approx. 245 masl. (i.e. 75 m below FSL) at a rate of 2.0 m per day by opening the mid-level outlets.
- With this operation, power production is interrupted for 64 days per year.

4 years flushing cycle:

- Objective: flushing 40 Mm^3 of sediments out of the Middle Yeywa reservoir.
- The water level will be drawn down to approx. 245 masl. (i.e. 75 m below FSL) at a rate of 2.0 m per day by opening the mid-level outlets.

- With this operation, power production is interrupted for 87 days every 4 years.

Figure 8-5 illustrates the water level development in Middle Yeywa as well as Upper Yeywa for the two flushing scenarios (but note that the water level will depend on the prevailing discharge).

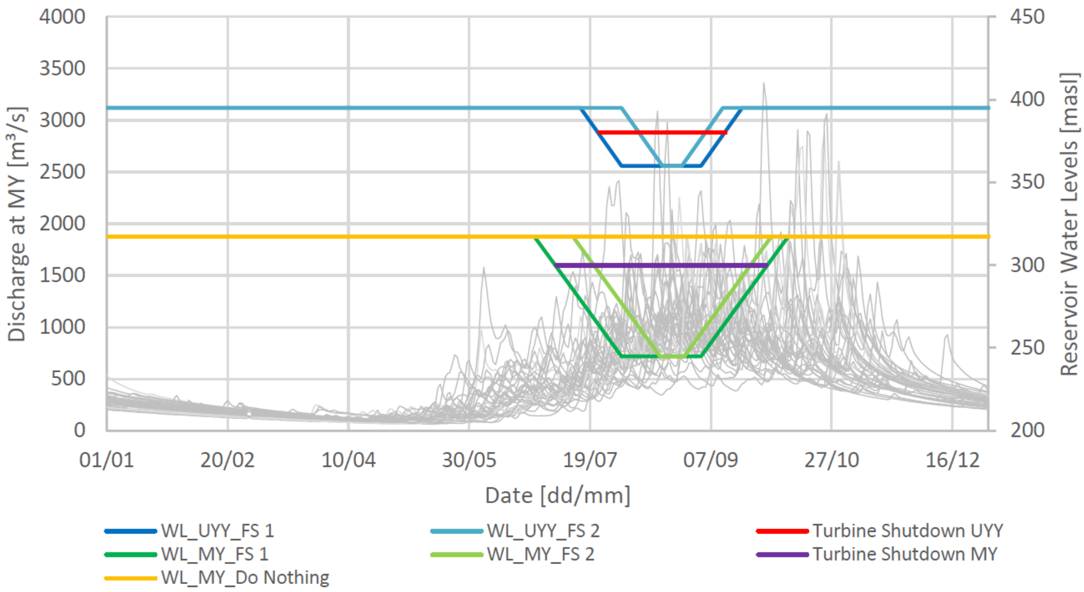


Figure 8-5: Water level at Middle Yeywa and Upper Yeywa for the two flushing scenarios.
Source: Tractebel (2017)
Note: UYY = Upper Yeywa; MY = Middle Yeywa; FS 1 = 4 years flushing cycle; FS 2 = annual flushing cycle

Figure 8-6 and ***Figure 8-7*** show the bed level developments (longitudinal profiles) in the Middle Yeywa reservoir after 0, 5, 10, 15, 20, 25 and 30 years for the two flushing scenarios (i.e. annual flushing and a 4 years flushing cycle). Both alternatives seem to perform satisfactory in remobilising sediments in the upper reach of the reservoir and keeping the lamella of active storage for the peaking operation free of sediments. However, whereas the annual flushing cycle achieves balanced and stable bed level elevations over the years, the 4 years flushing cycle results in prolonged sediment accumulation in the periods between the flushing events.

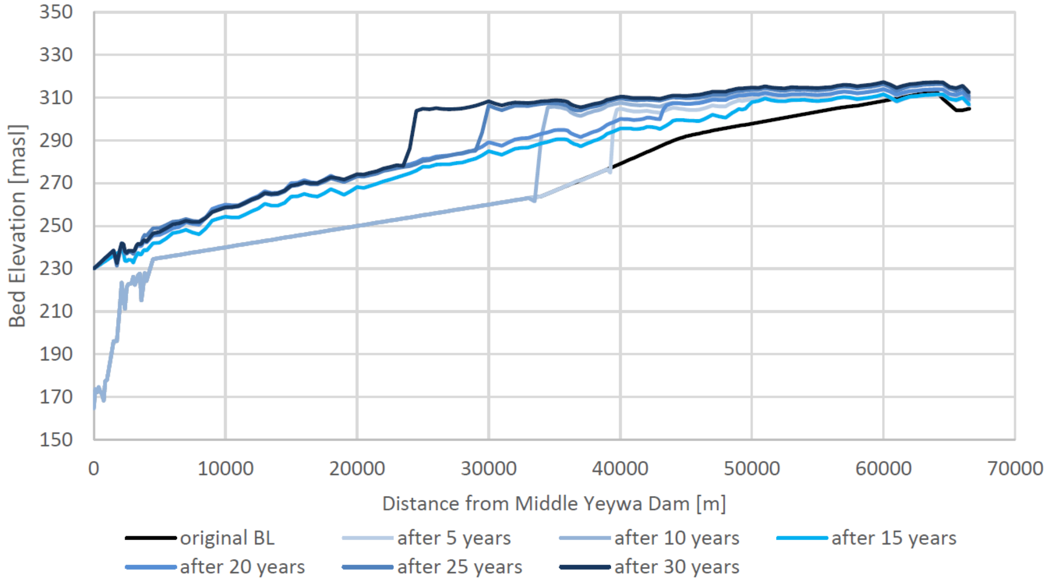


Figure 8-6: Bed level development in the Middle Yeywa reservoir over 30 years with a 4 years flushing cycle.
Source: Tractebel (2017)

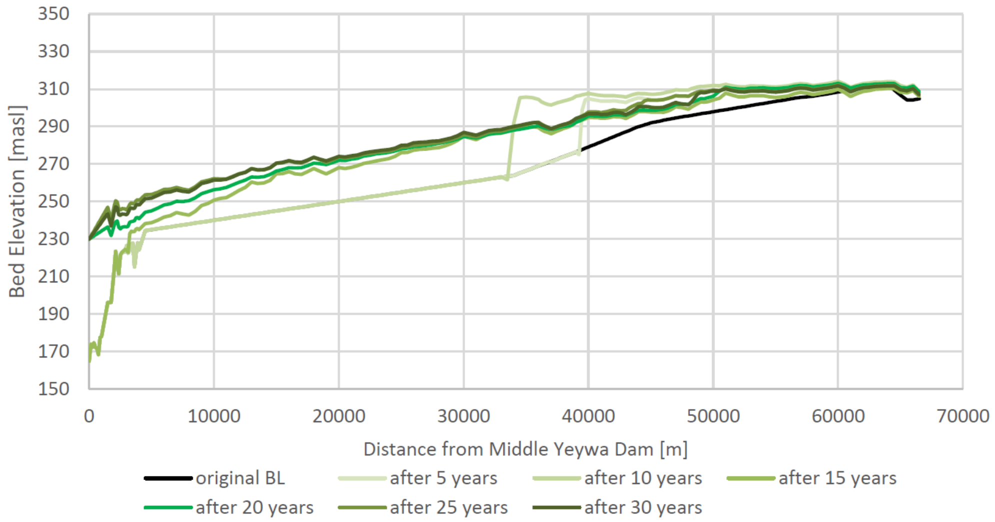


Figure 8-7: Bed level development in the Middle Yeywa reservoir over 30 years with an annual flushing cycle.
Source: Tractebel (2017)

In conclusion, the 4 years flushing cycle is clearly preferable in terms of minimising the number of days without power generation (caused by reservoir drawdown for flushing operation). The long-term average period of loss of power generation at Middle Yeywa HPP is about 3 times shorter when flushing is performed only every 4 years. On the other hand, the accumulation of sediments in the upper reaches of the reservoir is more distinct for this flushing scenario while the annual flushing cycle appears to be less critical with respect to a long-term increase of tailwater elevations at Upper Yeywa.

Tractebel (2017) recommends 4 years flushing cycle due to its economic advantage (increased power generation) while also calling for a flexible strategy that can be adjusted in response to observed sediment deposition in the upper end of the reservoir. If critical deposition of sediments is observed during the operation of Middle Yeywa, either local measures should be implemented to remove sediments from the tail end of the reservoir, or a limited reservoir drawdown can be carried out (in addition to the flushing itself) in order to remobilise the sediments deposited in the upper reach of the reservoir. Since the maximum top elevation of the sediment delta is calculated to be approx. 321.0 masl., a drawdown to MOL in Middle Yeywa – without a discontinuation of power generation – is expected to be sufficient. However, in the worst case, a higher flushing frequency would become necessary.

Mitigation measures:

- Update the sediment management strategy in response to detailed monitoring of sediment transport in the Myitnge River in the years up to commissioning and subsequently of observed sedimentation processes in the Middle Yeywa reservoir;
- If local measures are required in the upper end of the reservoir (e.g. excavations or dredging), then impose strict environmental conditions on the contractor to avoid chemical spills and excessive water turbidity.

Sediment transport in the downstream: The Middle Yeywa dam will significantly reduce the total sediment load in the downstream under normal operation. Combined with the trapping of sediments at Upper Yeywa, the turbine flow (and spills from the dam) will be starved of coarse sediments. This will have the consequence that sand and gravel deposits in the river below the dam will not be renewed from upstream (except during sediment flushing) and the sediment-depleted water below the dam and tailrace will erode and transport sediments downstream, causing channel and bank erosion in river sections with substrate that contains silt and sand. In periods with a high level of the Yeywa reservoir, silt is likely to be deposited shortly downstream the Middle Yeywa tailrace, while in periods of low level of the Yeywa reservoir these sediments are likely to be washed into the downstream reservoir. There is likely to be a net loss of sediments in the section between the Middle Yeywa dam and the Yeywa reservoir.

Riverbank erosion will also be caused by the daily variations in downstream water level (due to hydro-peaking, but depending on the backwater effect of the Yeywa reservoir). When the water level is high during operation, the riverbank will be saturated with water until it has achieved its equilibrium between the water pressure inside the bank and the external pressure exerted by the river water. When the power plant stops, the water level will drop. The external water pressure will disappear while the internal pressure will still be present. This will cause rapid outward directed water movements in the bank, loosening the soil structure in the riverbank surface. When the flow is increasing again, due to start-up of the power plant, the scouring forces of the current will erode part of this loose bank zone. In the long run, this will erode the lower part of the riverbank causing slides, tree-fall and increased sediment load in the river downstream. It should be noted that parts of the river bank consist of steep bedrock or boulders that will not be subject to these processes. Consequently, erosion does not represent a major environmental risk in the downstream reaches and the impacts will remain highly localised.

The fact that the tailrace outlet is located a very short distance upstream of the existing Yeywa reservoir, combined with the trapping of sediments behind the Upper Yeywa dam, suggests that the relative contribution of the Middle Yeywa dam in altering sediment transport in the Myitnge River is relatively less than it would be without those cumulative impacts.

The critical issue in terms of downstream sediment transport is rather associated with the sediment flushing events described above. Irrespective of the flushing frequency (e.g. annual or 4 years cycle), such release of sediments into the downstream environment will cause a short term pulse of high sediment load dominated by fine fractions (mostly silt and clay). These sediments will partly be deposited in the short downstream river reach but mostly be carried into the Yeywa reservoir where they will settle and contribute to sediment accumulation. Sediment accumulation in Yeywa reservoir takes place at present but will be in pulses determined by sediment flushing at Middle Yeywa (if constructed). Without Middle Yeywa, the sediment pulses will be governed mainly by the sediment flushing at Upper Yeywa and floods. Some fine sediments may also remain in suspension all the way down to the Yeywa power station, where they will be released through the turbines or the spillway. It should be noted, however, that the total volume of sediments entering the Yeywa reservoir and further downstream will be significantly less than at present without the upstream dams (Upper Yeywa and Middle Yeywa). The long-term sediment management strategy for the Yeywa HPP is not known, but it is likely that flushing may not be required due to the large size of the reservoir (2,600 Mm^3 compared to 400 Mm^3 for Middle Yeywa) combined with the reduced sediment inflow caused by the planned upstream dams.

Mitigation measures:

- N/A

Conclusion

Phase	Magnitude – Sediment Transport				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation		▲			

8.2.8 Water Quality

Construction Phase

Water pollution: During the construction phase, soil erosion from earthworks, including construction and removal of cofferdams, and runoff of crushed and ground rock material from drilling, blasting, stone crushing, etc. are expected to cause increased sediment load, and hence increased turbidity in the downstream reaches of the river and in the upper end of the existing Yeywa reservoir. As mentioned in Section 8.2.7, sediment releases will also occur as a result of in-stream construction works at the new Myitnge Bridge (and demolition of the old bridge).

In addition, accidental fuel and oil spills from construction machinery, and leaching of ammonia and other nitrogen compounds from the blasting and soil rock deposits, may cause pollution of the river unless effective mitigation measures are put in place. Another source of water pollution is represented by the batching plants and concrete works particularly by the effluent from concrete wash water which consists of wastewater with high pH and contaminants from the concrete additives.

The construction sites and workers' camp will generate sanitary effluents which are potential sources for microbiological and organic pollution of surface and ground water. The workers' camp will also produce domestic waste amounting to an estimated 0.5 kg/capita/day. Unless the waste and wastewater from domestic or construction origin (e.g. scrap metal, wood, plastic, cement bags, used tires and batteries, etc.) is adequately managed, it may result in pollution of both surface and ground water sources. Depending on the exact location of the workers' housing facilities, such pollution may either be localised or enter the Myitnge River.

The risk of tunnelling discharges requires special attention, as tunnelling works generate effluents that are typically high in suspended sediments and can have pH significantly different from receiving surface water bodies (IFC 2018). For example, tunnelling discharges can be strongly alkaline because of the use of standard cement or "shotcrete" in tunnel grouting activities, or strongly acidic because of the presence of acid generating rock, termed Acid Rock Drainage or ARD. The introduction of fine cement particles from cement grouting and shotcreting used to seal the walls of tunnels can result in extremely high pH in the tunnel effluent and receiving water body. The pH and suspended solids of tunnel wastewater discharges, as well as in the Myitnge River, should therefore be mitigated and closely monitored.

Mitigation measures:

- Erosion control practices including timely installation of drainage shall be implemented prior to any major soil disturbance. Activities on the riverbanks require particular measures;

- Sedimentation controls shall be implemented in the form of silt trap fences, sedimentation ponds and drainage channels where appropriate;
- Coffer dams shall be constructed such as to minimise releases of sediments and pollutants to the downstream environment (e.g. avoiding rock material with high content of fine particles whenever possible);
- All the water draining down from tunnelling operations, dam foundations, power house pit, batching plants, crusher plants, etc. shall be led to sedimentation and neutralisation ponds and has to be treated until acceptable water quality is achieved before releasing it to the recipient water body;
- Storage and handling of fuel and hazardous materials shall be kept away from the river;
- Storage areas for fuel and other hazardous materials as well as hazardous waste shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills proving at least 110% volume of the total capacity of the stored materials/waste;
- All storage areas and major construction sites shall have spill kits, sand, dust, and other appropriate absorbent materials;
- Sanitary water treatment facilities shall be installed in the workers' camp;
- A proper waste management system including waste tracking systems and approved waste disposal procedures should be established and implemented;
- Close monitoring of water quality should be undertaken to track changes in water quality and inform decision-making on required changes to mitigation strategies.

Operation Phase

River impoundment: The Middle Yeywa dam will create a reservoir extending about 70 km upstream and with a surface area of approx. 11 km^2 and a total volume of 400 million m^3 (at FSL). The depth of the reservoir will be 135-140 m at the dam and reduce substantially above the rapids about 4 km upstream of the dam site and from there gradually reduce to zero toward the upstream end of the reservoir where a dynamic delta will evolve. The river will thus be converted into an artificial lake with fluctuating water levels in response to the operation of the power station (i.e. daily peaking and inter-annual drawdown for sediment flushing). This change from a free-flowing river into a lentic slow flowing water body will alter many physical, chemical and biological characteristics of the water within and downstream of the reservoir.

In general, the nature and extent of water quality changes depends on the retention (turnover) time of the reservoir – its storage capacity in relation to the amount of water flowing into it – and the pre-impoundment conditions, especially the amount of submerged biomass. The amount of organic material introduced by the main river and tributaries may also influence water quality. Water vegetation, particularly potential invasive species that establish a large biomass, may also influence the water quality.

Possibly the greatest risk is related to reservoir stratification, i.e. the creation of different layers in the water column due to differences in water density. This is usually thermal stratification related to varying densities of water with temperature but can also be related to differences in salinity. Stratification can result in an anoxic zone (water without oxygen) at the bottom layer of the reservoir due to microbial decomposition of flooded vegetation and other organic matter that may accumulate in the bottom layers of the reservoir. Stratification in Middle Yeywa is most likely to occur through density variation with temperature, and it is affected by physical characteristics such as reservoir depth, water retention time, water level fluctuations, atmospheric temperature and factors that can cause mixing of the water masses such as inflowing river and exposure to wind/waves.

In order to evaluate the risk of reservoir stratification and water quality deterioration, the following characteristics of the Middle Yeywa HPP should be taken into account:

- The reservoir has an average retention (turnover) time of 10 days

- The maximum depth of the reservoir is 135 m but the depth will be less than 80 m upstream of the rapids (about 2 km from the dam site) and significantly less towards the middle and tail end of the reservoir;
- The forest within the reservoir area will be cleared prior to commissioning, thus reducing the decomposable biomass;
- The amount of organic matter and nutrients entering the reservoir is not particularly high, will be further reduced due to the Upper Yeywa reservoir and is not expected to create eutrophic conditions.
- Continued conversion of forest areas to commercial agriculture with use of artificial fertilisers could result in increased runoff and increased contributions of organic matter and nutrients.
- Potential establishment of invasive alien plant species in the reservoir could also increase input of organic matter to the reservoir.

The risk of stratification can be evaluated based on limnologic theory (e.g. ***Figure 8-8***). According to the revised classification system for lakes based on mixing (Lewis 1983), the shallow upper part of the reservoir will probably have a “continuous warm polymictic” behaviour, which implies regular full mixing of all water up to 20 m depth or more. As the gradual accumulation of gravel and sand sediment fractions will occur first in the upper part of the reservoir, reducing the depth of free water, the mixing process will become complete and regular for all reservoir levels in the upstream section of the reservoir. Thus, the upper shallow part of the reservoir will be characterised by homogenous conditions for water temperature and water quality.

TABLE 1. Latitude adjustment per 100 m of elevation required to bring a lake to zero elevation for lake classification purposes.

Latitude (Degrees)	Latitude adjustment (Degrees per 100 m elev.)
0	0.27
10	0.31
20	0.34
30	0.39
40	0.46
50	0.54
60	0.68
70	0.89
80	1.3
90	2.4

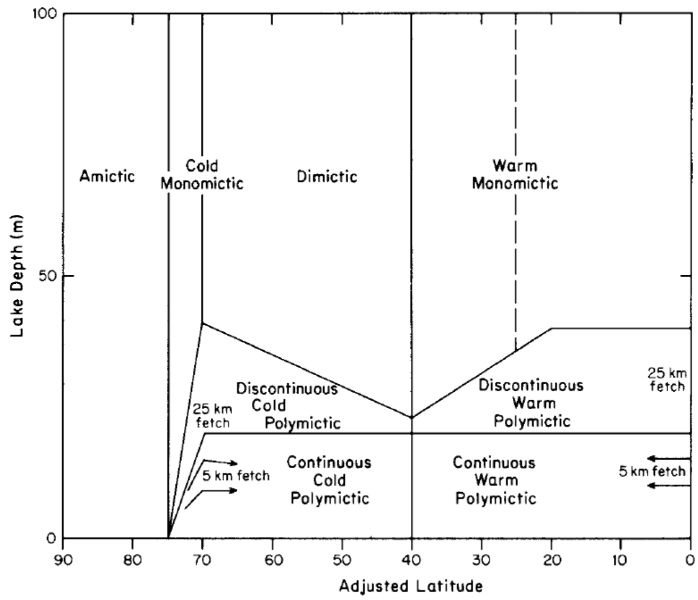


FIG. 2. Estimated distribution of the eight lake types of the revised mixing classification in relation to latitude (adjusted for elevation, see text) and water depth.

Figure 8-8: The revised classification system for lakes based on mixing.
Source: Lewis (1983)

In contrast, the deep part of the reservoir near the dam will be classified as “warm monomictic”. This means there will normally be a full mixing of deep and shallow water layers once per year when the surface water temperature cools below the temperature of the bottom layers and full vertical circulation of water masses occur. There is a possibility that this mixing will not occur every year and not succeed in mixing all pockets of deep water (meromictic). Available information does not provide clarity on the frequency of full mixing or if full mixing is likely to occur at all in the deepest parts of the reservoir.

The deep part of the reservoir (hypolimnion) will be subject to a gradual accumulation of cooler denser water below the stratified layer (thermocline) which will persist for most if not all of the year. This temperature stratification typically prevents replenishment of oxygen in the deeper water mass. It is not possible with the current scarcity of data to predict the depth of the thermocline or to confirm whether anoxic conditions will occur in the bottom layers, but the possibility cannot be excluded even if the retention time of the reservoir is relatively short and pre-impoundment biomass clearing is implemented. Surveys in the downstream Yeywa reservoir could give indications of risks in the Middle Yeywa reservoir and give useful information on what appropriate mitigation and monitoring may consist of.

With an intake at elevation 282 masl. (i.e. 38 m below FSL), there is a risk that the power station will be drawing off water with a deficit of oxygen from the hypolimnion and in the worst case releasing anoxic water downstream with high content of hydrogen sulphide causing foul odours and poor water taste. Such problems have been recorded in many new tropical reservoirs, although mainly in reservoirs with a longer retention time. The risk is particularly high in the initial years after impoundment due to degradation of the newly flooded organic matter. Indeed, there is anecdotal evidence that such impacts occurred after the impoundment of the downstream Yeywa reservoir, probably caused by its much greater water volume and lack of biomass clearing in the reservoir.

The potential problem of releasing anoxic water downstream can be mitigated by installing multi-level withdrawal structures (power intakes) on the dam, or constructing aerating weirs in the tailrace. Before clear recommendations on the likely risks and appropriate mitigation (if needed) can be made, further data collection from the downstream Yeywa reservoir is recommended. Due to the fact that the turbine outflow will be released immediately upstream of the existing Yeywa reservoir – an already modified water body that can act as a water quality buffer zone, there may be less need for design modifications but this can only be assessed based on further information. If the Yeywa reservoir still suffers from anoxic (or hypoxic) conditions, then the release of water with a deficit in oxygen from the Middle Yeywa tailrace may contribute to even worse water quality conditions in the downstream Yeywa reservoir.

Mitigation measures:

- Conduct pre-impoundment vegetation clearing in order to reduce emissions from decay of organic matter in the reservoir.
- Monitoring of water quality in the reservoir to detect undesirable changes and implement appropriate responses as and when needed.
- Potential design modifications based on analysis of information from the Yeywa reservoir on risks of significant water quality changes at different water depths near the dam/intake.

Water pollution: During the operation phase, the risk of chemical water pollution will be reduced as compared to the construction phase. However, accidental fuel and oil spills could still occur with inadequate handling of hazardous materials and failure of spill prevention systems. Volumes of any spills are likely to be moderate or small compared with the water volume of the reservoir.

There is also a risk that water pollution will be caused by the disposal of excavated material (rock spoil) in the reservoir. It is assumed that the tunnels and power house cavern will be excavated by drilling and blasting, potentially causing ammonia and nitrogen contamination from the blasted rocks as well as increased suspended sediment content in the reservoir and downstream.

Mitigation measures:

- Storage and handling of fuel and hazardous materials shall be kept away from the river and bunded with capacity to contain at least 110% of maximum storage volume;

- All storage areas for fuel and hazardous materials shall have spill kits, sand, dust, and other appropriate absorbent materials;
- Test the rock material for heavy metals and consider alternative disposal methods and locations for the excavated materials before a decision is taken to dispose of the rock spoil in the reservoir, alternatively undertake washing of waste rock before disposal in the future dead storage reservoir area;
- Power house and switchyard should have oil and water collection systems leading to oil/water separator systems prior to the release of any water to the environment.

Conclusion

Phase	Magnitude – Water Quality				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation		▲			

8.2.9 Protected Areas

Construction Phase

Protected areas: No protected areas will be directly affected during the construction phase. The dam site, where construction activities will be undertaken on both river banks, is outside the potential forest protected areas referred to in Section 6.9.2.

Operational Phase

Protected areas: Using the World Database on Protected Areas and recent maps of protected areas in Myanmar found in various publications, there is no protected area that will be impacted by inundation or other project activities. However, a map was found that potentially indicated some form of forest protected area on the left bank between the upper tail end of the reservoir and the Nam-kam River approximately 12 km upstream of the dam site. A portion of the river valley will be inundated on the left bank upstream of the Nam-kam River. Should this have some form of protection status, there will be an impact in the form of direct loss of Indaing forest, including a narrow and partly patchy band of riverine forest, on the protected forest area.

Protection objective: In addition to confirming with forest authorities whether there currently is any protection status, it will be important to evaluate the extent to which inundation is in conflict with the objective of any such potential protection status and whether the Project impacts the values for which the protection status was established. Considering the logging undertaken and the large-scale conversion of forest habitat to agriculture in the forest area, the additional loss due to inundation affects a small proportion of the protected forest area. The long-term viability of the area is unlikely to change substantially. However, a formal acceptance from relevant authorities is strongly recommended.

Active management: There appears to be no active management of the forest area by the relevant authorities and the protection status, if it exists, exists only on paper and not on official protected area maps. Without a much more active management (demarcation of boundary, sensitisation of local people, management activities, monitoring, etc.), the forest area with a potential protection status is likely to continue to be converted to agriculture and the forest area management objectives will be compromised.

Mitigation measures (if a protection status is confirmed):

- Clearance of vegetation in the inundation area along the river on the left bank should not involve opening new roads into the left bank forest areas as these may facilitate even further logging and conversion to agriculture.

- Protection and active management of a forest area to compensate for the area inundated should be considered in consultation with relevant authorities and communities.

Conclusion

Phase	Magnitude – Protected Areas				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation		(▲)*	▲		

* Magnitude of impact if the area on the left bank has a protection status that is confirmed by relevant authorities.

8.2.10 Vegetation

Construction Phase

Vegetation clearing: The construction of the hydropower plant will involve vegetation clearance and reduction of woody biomass in most parts of the direct impact zone and especially along the access route to the dam site and within the footprints of all permanent and temporary facilities. Most of the trees that will be cut are common species of the Indaing forest vegetation type with a wide geographical distribution and that are not subject to major conservation risks. The exceptions are the five threatened plant species *(Dalbergia oliveri*, *D. cultrata, Pterocarpus indicus*, *Cycas siamensis*, and *Curcuma alismatifolia*), but even those species are common over a wider area far beyond the project's impact zone.

Mitigation measures:

- Except where vegetation clearing is required for permanent works or excavation operations, all trees and vegetation shall be preserved;
- All disturbed areas that are not required for permanent works shall be restored and replanted with native trees.

Reservoir impoundment: At the end of the construction phase, the vegetation growing within the reservoir area will be submerged and converted into a lake environment. A total of about 816 ha of Indaing forest below the FSL will be lost, including relatively intact forests on the left bank of the Myitnge River. In addition, the seasonal spray zone at the lower Namkam waterfalls will be submerged and lost. Without pre-impoundment clearing, this will result in rapid decomposition of the soft biomass (herbaceous plants, tree leaves, etc.), while large trees will remain for a long time as dead biomass. Among the trees and other plants that will be lost are those of the five threatened plant species mentioned above.

- Conduct pre-impoundment vegetation clearing within the reservoir area;
- Compensate the loss of trees by afforestation/reforestation of an equivalent area outside of the direct impact zone.

Tree cutting by workers and in-migrants: Vegetation clearing may also occur as a result of illegal tree felling by project workers, camp followers and other in-migrants. Road construction and upgrade will improve access to previously undisturbed areas, creating a risk that outsiders will enter to extract illegal timber. The population influx will contribute to increasing the pressure on natural resources and forests.

Mitigation measures:

- Access to project sites shall be controlled to prevent unauthorised access;
- Workers shall be prohibited from cutting trees and collecting firewood;

- Forestry extension officers shall be capacitated to provide monitoring, control and surveillance.

Operation Phase

Establishment of invasive species: One of the effects of disturbance of vegetation and soils (during construction) is the subsequent upsurge of invasive plants (during operation). These have a high potential to suppress the native flora and change the structure and composition of the vegetation as they spread. Exotic and invasive plants may also be introduced to the project area for ornamental reasons.

At least two invasive plant species already exist in the project's impact zone (*Mikania micrantha* and *Mimosa pudica*), both of which have a high potential for spreading further into land disturbed by construction activities. However, as they are already established across a wider area in the project's impact zone, the project will probably not contribute significantly to further increasing their occurrence. Standard protocols for invasive species control should nonetheless be observed.

Mitigation measures:

- Removal of invasive plant species during routine vegetation maintenance;
- Restore disturbed areas immediately after the construction and maintenance works;
- Avoid importation of exotic trees and soil from other places (e.g. for restoration or as ornamentals).

Conclusion

Phase	Magnitude – Vegetation				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.2.11 *Terrestrial Fauna*

Construction Phase

Loss of habitat: Clearing of areas for construction will result in direct loss of habitat for terrestrial fauna. The exact areas required for construction are not yet fully known. Habitat will be lost due to dam construction, camp areas, access roads, borrow pits, contractors' yards and a range of infrastructure required for project construction. A new bridge across the Myitnge River, and a section of new road to link with the existing road, will also be constructed to replace the current bridge that will be inundated. Workers and associated in-migration are likely to lead to illegal tree cutting for timber or energy, which will result in additional habitat loss for a number of species. Should the construction activities result in spreading of invasive alien species (flora or fauna), this may gradually result in loss of habitat as such species spread into new areas. The Indaing forest habitat will be the clearly most affected terrestrial habitat type as this is the habitat dominating the impact zone. This type of habitat is widely spread and common in the region and hence of limited conservation concern. No species of conservation concern are expected to lose significant parts of their habitats.

Disturbance: The construction phase (5-6 years) will be associated with noise, vibration, movement by vehicles and people, dust, light and other forms of disturbance. The sensitivity to such disturbance varies from species to species, but most species will be negatively affected and largely move away from the immediate surroundings of construction areas. Species that are more tolerant to human disturbance, typically opportunistic generalist species, tend to be of limited conservation interest. Species of conservation concern tend to be more sensitive to disturbance and are likely to stay away at least temporarily from a considerably larger area than the footprint required for construction-related activities. The latter includes species such as the Green peafowl, the leopard and other mammals of conservation concern. Fauna populations will be reduced as a result of the construction phase due to habitat loss and to some extent also due to disturbance. For several species, this will be a temporary impact during construction, after which species can return to areas when construction-related disturbance is reduced or removed.

Hunting: The presence of many hundred workers for an extended period, and probably an even larger number of camp followers that seek economic opportunities in relation to the construction phase, also represent a threat to mammal species in particular and partly species of birds. Illegal hunting is likely to increase beyond current levels and more modern and effective means of hunting may be introduced. Species like Muntjac and Red Jungle Fowl may be sought after as sources of food and populations are likely to be reduced at least temporarily during the construction phase.

Pollution: Pollution risks in the form of hazardous materials will be experienced in virtually all construction sites. However, any spills of hazardous materials or hazardous waste are expected to be relatively localised. The construction phase impact area will largely be devoid of any larger species of terrestrial fauna and such species are therefore much more prone to other forms of pollution and disturbance (e.g. noise and light pollution).

Reservoir: The area to be inundated will be cleared for as much woody vegetation as possible. Forest-dependent species will lose parts of their habitat. Subsequent filling of the reservoir towards the end of the construction phase will result in loss of all terrestrial fauna in the inundation area, irrespective of whether species are forest-dependent or not. The riverine forest, which is part of the Indaing forest, will be disproportionately affected by the inundation but no species that rely on this narrow and patchy band of forest along the river were identified. A limited number of bird species prefer nesting in areas of cliffs and boulders along the river, and there may be locations with bat roosting places in the inundation area. There are similar habitats available above the future reservoir level, but these species may experience a population reduction in the project area if availability of nesting places is a limiting factor for their population size, which is unlikely to be the case.

Habitats: Some highly localised habitats that will be inundated were identified. There are small areas of seasonally inundated sand banks scattered along the river. There may be insect species requiring such sand banks to complete their life cycle. Information from local people indicated presence of turtle species along the river though the degree to which this reflected presence in the past rather than at present was not clear. Any species relying on the sand banks will lose their habitats along the river. This habitat may partly be replaced by the delta quickly developing at the upstream end of the reservoir and where large volumes of sand and silt will settle. At the Namkan River, a spray zone will be partly inundated by the reservoir. No unique species were found in this unusual habitat and there are similar spray zones available above the inundation area along the Namkan River.

Mitigation measures:

- Land take during construction should be minimised, required areas demarcated and contractors going beyond the demarcated areas sanctioned.
- Workers' induction and contracts should raise awareness of illegal hunting and workers found violating the requirements should be sanctioned.
- Awareness raising and sensitisation of local communities to minimise illegal hunting and tree cutting should be undertaken.
- Community activities to minimise the impacts of peaking demand of local goods should be undertaken (see Section 8.3 on social impacts).
- Unauthorised access and activities should be controlled and monitored.
- As construction progresses, areas that are not needed any longer should be restored on an ongoing basis.
- Artificial lighting should be minimised to prevent light pollution.
- Hazardous materials and waste should be stored in bunded areas with capacity to contain at least 110% of the maximum storage capacity.
- Invasive alien species should be monitored and removed routinely.

- Waste should be closely tracked and disposed of by licensed waste handlers.
- Following further clarity on the locations of associated infrastructure, a plan to avoid and minimise impacts on wildlife species of conservation concern should be developed as an integral part of the EMP.

Operational Phase

Loss of habitat: Some of the construction phase land take will be permanent while areas required temporarily will be restored. The main land take and loss of habitat for the operation phase will be due to the inundation area (11 km^2) that will be established towards the end of the construction phase. Restored areas are likely to gradually be recolonised by Indaing forest vegetation and subsequently gradually recolonised by fauna in these areas.

New habitat: The reservoir will represent a new habitat available to some species. The baseline surveys showed very limited presence of waterfowl and other wildlife using water bodies as their habitat. The available information indicates that the new habitat will not become important for water fowl or other wildlife species beyond being a permanent source of drinking water.

Disturbance: Levels of disturbance will be gradually but greatly reduced following commissioning of the Project and decommissioning of construction activities. Operation phase disturbance will still be experienced due to the daily activities and traffic associated with project operation but at much lower levels compared to the construction phase. Particularly sensitive species are still likely to avoid habitats nearby areas with disturbance such as the dam and power house area.

Hunting: Illegal hunting is likely to be reduced following commissioning. In the event that construction results in a larger local human population in the longer-term, the hunting pressures are unlikely to return to pre-project levels and hence permanently higher levels of hunting may be experienced unless specific efforts are made to minimise illegal hunting.

Hydro peaking: As per current plans, the Project is likely to be operated in hydro-peaking mode (see Section 8.2.6 above). Terrestrial fauna is not expected to be significantly affected by hydro-peaking as there are very few species that rely on the affected river section between the dam site and the upstream end of the existing Yeywa reservoir. Assuming that a minimum flow is released in off-peak hours, the barrier effect from Myitnge River will be maintained. If there is no minimum flow released from the dam or tailrace, there will be a loss of a natural barrier that will allow previously separated populations of some species to mix and individuals to migrate over longer distances. However, the available information does not indicate any significant environmental impacts of creating such wildlife corridor across the Myitnge River downstream of the Middle Yeywa dam.

Mitigation measures:

- Workers' induction and contracts should raise awareness of illegal hunting and workers found violating the requirements should be sanctioned.
- Awareness raising and sensitisation of local communities to minimise illegal hunting and tree cutting should be undertaken.
- Unauthorised access and activities should be controlled and monitored.
- Hazardous materials and waste should be stored in bunded areas with capacity to contain at least 110% of the maximum storage capacity.
- Waste should be closely tracked and disposed of by licensed waste handlers.
- Invasive alien species should be monitored and removed routinely.
- A continuous minimum flow should be released downstream the dam site. Following further clarity on the locations of associated infrastructure, a plan to avoid and minimise impacts on wildlife species of conservation concern should be developed as an integral part of the EMP.

Conclusion

Phase	Magnitude – Terrestrial Fauna				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation		▲			

8.2.12 Aquatic Ecosystems

Construction Phase

Loss of habitat: Loss of habitat will mainly be experienced in the dam site area in the first stages of construction. The dam foundation and areas required for coffer dams will be negatively impacted to a large extent. The impacts will be felt across all species groups in these areas. Replacement of the bridge across Myitnge River will involve construction activities in and close to the River and associated loss of aquatic habitats in highly localised and small areas.

Disturbance: Disturbance in the form of various types of pollution from activities within the river as well as in the wider construction area will be an important negative impact in areas downstream of the dam site all the way to the existing Yeywa reservoir and probably in the uppermost parts of this reservoir as well during activities like coffer dam construction and coffer dam removal (see Sections 8.2.7 and 8.2.8 above).

Fishing: The presence of a large work force and opportunity seekers may result in a slight increase in fishing efforts. However, the current fishing practices in the river are based on simple technologies and the large river is challenging to fish effectively. No substantial negative impacts are expected unless new methods are introduced by the work force or camp followers.

Migration barrier: From the time of construction of coffer dams, the construction works will be a barrier to upstream fish migration even in the rainy season. This will limit access to upstream river reaches for any fish downstream the dam, including fish from the downstream Yeywa reservoir. The bypass tunnel that will be constructed is unlikely to be passable for fish and will hence not ensure upstream migration. Further considerations on fish migration are included in the section on cumulative impacts (see Section 8.5.7 below).

Reservoir: Towards the end of the construction phase, the reservoir filling will take place. During filling, the river flow downstream the dam will be substantially reduced, and available aquatic habitat will be reduced with short-term negative impacts on aquatic life in this area. Impacts on aquatic habitats in Yeywa reservoir due to filling of Middle Yeywa reservoir are expected to be marginal and short-term due to the large storage capacity of the existing Yeywa reservoir. Upstream of the dam, the aquatic habitats will change from a mosaic of slow and fast flowing river sections (lotic ecosystem) to a less dynamic and more stable lake-like habitat (lentic or lacustrine ecosystem). Species composition across groups will change from species competitive during riverine conditions to species that are more competitive during lake-like conditions. Impacts associated with this major change in habitat characteristics are discussed below.

Mitigation measures:

- Mitigation measures reflected in Sections 8.2.6-8.2.8 above concerning hydrological changes and water quality changes including sediment transport.

Operational Phase

Loss of habitat: Reservoir filling and project commissioning represent the start of project operation with a major transformation of riverine habitats to lake habitats. Species adapted to lotic conditions (flowing water) will largely lose their habitats except in a limited number of tributaries along the reservoir that will provide some riverine habitat, but considerably less than prior to inundation. These tributaries are often seasonal and only short riverine sections are available to fish due to the steep or very steep terrain that creates barriers to upstream fish movement. Flying insects and birds and aquatic animals able to move on land will be able to move upstream of sections that are barriers to fish in such tributaries. The most important tributary is the Gotheik Stream that is perennial and most likely provide riverine habitats for several kilometres upstream for all aquatic groups in river systems. This tributary is on the right bank in the upper part of the reservoir and would benefit from management interventions to prevent destruction of the likely most important refuge for riverine species in the new reservoir system. The short and varying length of river between the Middle Yeywa tailrace and the Yeywa reservoir as well as the short and less varying length of river between the Upper Yeywa tailrace and the Middle Yeywa reservoir will provide a modified riverine habitat. These areas will represent small refuges for riverine species.

Habitat modification: The Developer is considering placement of substantial volumes of rocks in the river for a 1 km distance downstream of the tailrace in order to meet a potential requirement from the Government of Myanmar for a 'free flowing' river section between the Yeywa reservoir and the Middle Yeywa dam. The rationale appears to be a desire to have a minimum of aeration of the turbine discharge before it enters the Yeywa reservoir (in the event of poor water quality in the Middle Yeywa reservoir). Such rock filling will have a short-term impact on water quality during establishment (e.g. increased turbidity) and will alter the river substrate and habitat characteristics for the operation phase. Some of the existing river bed is likely to be rock (bedrock and boulders) and hence rock filling will represent only a moderate change in such areas in the medium to long-term. Other areas are low-energy habitats with sand and silt substrate, and rock filling will greatly modify these habitats. The feasibility of rock filling this river section should be carefully reviewed both in terms of water quality impacts on the downstream Yeywa reservoir (during construction and operation) as well as in terms of habitat impacts for aquatic organisms that are likely to be negatively affected. If such a rock fill is to be implemented following documentation that it serves the desired function in terms of water quality, the rock fill should be designed to create a riverbed with dynamic and heterogeneous habitats for aquatic life.

New habitats: The considerable new lentic environment (relatively still water) will dominate the reservoir. The natural dynamics of the aquatic habitats upstream of the dam will change radically as water depth, water speed and geomorphological processes associated with a flowing river, including concurrent erosion and sedimentation processes that create a dynamic and heterogenous system, will be substantially altered. Over time, a delta will evolve in upstream part of the reservoir with active sedimentation and erosion processes, but this delta system is unlikely to provide a suitable habitat to many species due to the near continuous deposition of sediments and very unstable substrate.

Regulation zone: The riparian zone of the future reservoir will be longer than the current riparian zone along the river. However, the likely daily fluctuation in reservoir level (due to hydro-peaking) combined with wave action are likely to erode the zone between full supply level and the lowest regulated water level. The shallow areas around the reservoir are therefore not likely to be highly productive in terms of vegetation and macro-invertebrates, dependent upon the final size the drawdown zone (currently 0.5 m). The areas below the lowest regulated water level are likely to ensure some productivity in the littoral zone assuming that turbidity of the reservoir water is limited and light can penetrate to areas stable enough to support aquatic vegetation and macro-invertebrates.

Species composition: The typical river species will be largely outcompeted in the reservoir assuming the reservoir will be colonised by species well adapted to a lentic or lacustrine system. Phytoplankton and zooplankton are unable to swim against the current and hence move passively with flow or currents and do not establish large populations in a river system due to the continuous washing out of individuals. In the very slow-flowing reservoir environment, both phytoplankton and zooplankton communities are likely to expand considerably and also provide the basis for an increased biomass of other species that feed on plankton. The fish community will change in species composition towards species favouring lake-like aquatic environments. Given limited information about fish species composition in the river as well as in the downstream Yeywa reservoir, it is difficult to predict the future composition of the fish community, including the extent to which the reservoir can provide a basis for a fishery. Further records on fish and other species from the Yeywa reservoir and the Myitnge River would allow for a more refined analysis of likely changes.

Fishing: Fishing is currently practiced by a limited number of people along the Myitnge and with a strong seasonal variation in the level of fishing activities. Fishing techniques are relatively simple and the deep and at times fast-flowing river makes fishing challenging. Unless new fishing equipment is taken into use in the reservoir, there is likely to be limited scope for fishing for the people currently relying on fishing. Current fishing practices in the river are not likely to significantly impact on aquatic life in the reservoir. Introduction of new fishing techniques could affect the fish communities as well as increase yields from fishing. Surveys of fish communities and fishing activities in the downstream Yeywa reservoir would inform a more detailed analysis of impacts and the scope for future fishing in the reservoir.

Diverted section: There is likely to be a short section between the dam and the tailrace (200 m) where water will be diverted completely (depending on topography of the river bed and backwater effect from the tailrace) except for the periods where there is spilling of water over the dam or the gates are open. While this may effectively remove aquatic life from the short, affected river section, the length of the diverted river section (less than 200 m) is so small that impacts are considered insignificant. Also, when the downstream Yeywa reservoir is full, the reservoir may reach the foot of the Middle Yeywa dam effectively creating a lake-like environment. This also means there are no strong arguments for a release of a continuous minimum flow from the dam itself and a release by running at least one turbine continuously would serve the same ecological purpose assuming there is a functional back-up in the event turbines are not running (e.g. water release through a gate at the dam or a bypass valve in the waterway to the turbines).

Peaking: The Project is likely to be run for hydro-peaking (see Section 8.2.6 above). This will introduce major daily flow variation between the tailrace and the downstream Yeywa reservoir for most of the year. This flow variation will have substantial negative impacts on aquatic life in the short but varying length of affected river section. Complete drying out of the river should be prevented by releasing a continuous minimum flow as well as identifying ramping rates that are acceptable in terms of environmental and safety concerns (avoiding excessive risks of stranding of fish and avoiding risks to people close to the river). As discussed in Section 8.2.6 above, the operation regime has not yet been defined but is likely to be a complex picture of varying water release regimes depending on the inflow to the reservoir and the power demand from the grid. This implies that impacts caused by the flow reduction and peaking operation may be a continuum of impacts ranging from natural or near-natural flow conditions in periods with high inflow to the reservoir, to a highly modified flow regime with major daily fluctuations during periods with low inflow to the reservoir. Thus, the operational regimes may create an unstable and stochastic environment, which may challenge local adaptations among fauna and flora in unpredictable ways.

Migration barrier: The proposed dam will represent a barrier to upstream fish migration. The tall height of the dam means that construction of a fish passage is not considered feasible due to the complications of constructing a fish passage across such a large height as well as due to the uncertainties whether such a tall fish passage will work at all. Long-distance fish migration was blocked with the construction of the Yeywa dam downstream and has recently been further blocked by the ongoing construction of the Upper Yeywa dam. An upstream fish passage is not recommended as it is unlikely to serve any significant ecological purpose given the dams upstream and downstream the Middle Yeywa Project. Further considerations on fish migration are included in the section on cumulative impacts (see Section 8.5.7 below).

Mitigation measures:

- Mitigation measures reflected in Sections 8.2.6-8.2.8 above.
- If the riverbed downstream the tailrace is to be modified to ensure a 'free flowing' section, it should be designed as a varied river section with habitats that serve ecological purposes.
- Based on currently limited available information, introduction of fish species to the future reservoir is not recommended. Should such introduction be considered, a separate impact assessment should be undertaken. Further surveys in the downstream Yeywa reservoir should inform the feasibility of introducing any species and other potential measures to support fishing activities and management of the future reservoir.

Conclusion

Phase	Magnitude – Aquatic Ecosystems*				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation		▲			

* It should be noted that limitations in collection of primary data on aquatic ecosystems introduce significant uncertainty associated with assessment of magnitude of impacts.

8.3 Social Impacts

8.3.1 Approach

In the following, identified social impacts associated with construction and operation of the Middle Yeywa HPP are presented. The assessment is based on the present technical plans and layout of the project as presented in Chapter2 and the social baseline presented in Chapter 7. The impacts on the human environment have been evaluated and categorised according to the general methodology presented in Chapter 3 involving the steps of 1) Assigning a value to the social and environmental component being considered; 2) Assessment of the scale or magnitude of the impact; and, 3) Combination of value and magnitude to arrive at an overall impact on the considered components. For human environment components, it should be noted that the value is by default considered as high, thus making magnitude the decisive factor when it comes to the overall impact. The receptors of social impacts are villages, local communities, households and individual persons.

8.3.2 Local Project Area Economy

The Middle Yeywa HPP is likely to generate possibilities for employment for the local population, both directly and indirectly. At this stage of planning, the number of skilled and unskilled workers is yet to be estimated but based on experience from construction of similar hydropower project in the region it is likely that some 600 to 700 workers will be needed at the peak of construction activities. Up 40-50% of these may be unskilled workers while the rest will be semi-skilled and skilled workers.

Towards the end the construction phase the number of workers will decrease while the share of skilled workers is likely to increase as the electromechanical works gains momentum requiring specialised workers that will be provided by the electromechanical contractor.

In the operation phase, a considerable number of workers for operation and maintenance works, the majority probably skilled, will be needed. Again, no estimates for the number of people needed for operation and maintenance are available but for a project of this size the number of permanently employed staff and workers can be predicted to be somewhere between 50 and 100.

In addition to those directly employed in construction activities, a number of local businesses will benefit from the increase in demand for goods and services that the Project will generate. The number of people employed by the local businesses delivering goods and services such as different types of hardware and food supplies for the workers' canteens is likely to increase as existing businesses have to expand or new businesses are started to meet demand.

In terms of increases in indirect employment, much will depend on the ability of local businesses to seize the opportunity and expand their capacities. The chances that this will happen can be enhanced by timely dissemination of information of what kind of services the Project will be needing so that the local business community can position and prepare themselves to capture contracts and seize on the project related opportunities that will present themselves.

With regard to direct employment, the local population is predominantly employed in the agricultural sector and this may present a constraint on the possibility to employ local people. However, given that employment on the Project is likely to be more attractive for the local workforce due to the fact that the pay is likely to be higher and the employment more steady compared to what can be offered in the agricultural sector, it should be possible to recruit a substantial amount of local workers. The peak labour demands within the agricultural sector, for instance during sugar cane harvesting, is likely to be filled by migrant agricultural workers from outside the project area.

<u>Conclusion</u>

The magnitude of the impact on local economy is assessed as **medium to large positive** for the local population and local businesses in the construction phase and **low to medium positive** in the operation phase.

Phase	Magnitude - Local Project Area Economy -				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction					
Operation					

8.3.3 *Physical Displacement and Resettlement*

At the present stage of planning and project development, the size and accurate location of the project lands has not yet been determined in detail. Establishing an accurate estimate of the number households and project affected people that will be physically displaced by the Project has therefore not been possible. Road No. 41 from Nawnghkio to Taung Shey and further on from the junction on a local unpaved village road down to Yae Twin Gyi is likely to be chosen as the main project access road. Road No. 41 and the local village road passes through a number of villages and a possible improvement and widening of the main access route may lead to some physical displacement of in terms of commercial and residential buildings located close to the road. Some of these buildings may be located within the present road right of way.

From Yae Twin Gyi and down the escarpment to the dam site, an access road will have to be built but it is unlikely that this will lead to any physical displacement as the road will be routed away from and outside of the village. The same applies to the camp and workshop areas which will probably be located within the village territory of Yae Twin Gyi but should be sited away from existing commercial or residential buildings in the village.

With regard to the reservoir, it will be confined within the steep river valley where there are no settlements except for temporary fishing and illegal logging camps. The exact number of shelters in these temporary camps is yet to be confirmed but is not considered significant.

Mitigation measures:

- Minimisation of physical displacement through adaptive planning of roads and location of project components;
- Careful identification of all affected project affected persons (PAPs) and households that will lose residential land and buildings;

- Full compensation at replacement cost for all affected buildings and residential land;
- Option to choose between full monetary compensation and project assisted relocation for project affected persons and households.
- Resettlement of PAPs within their local community if possible

Conclusion

Although the impact of physical displacement and resettlement will be perceived as a large and even traumatic experience for the affected individual households, the magnitude and overall impact will be less on a community level. The magnitude of the impacts in terms of physical displacement and resettlement is therefore assessed as **low to medium negative** during the construction phase and **insignificant** during the operation phase due to the anticipated low number of impacted houses or structures.

Phase	Magnitude of Impacts – Physical Displacement and Resettlement				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.3.4 Economic Displacement and Loss of Livelihoods

As noted above, the size and locations of project lands are yet to be determined in detail. The impact in terms of loss of commercial and productive agricultural land will therefore have to be confirmed at a later stage of the project development and planning process. However, loss of agricultural land that will reduce the available productive resources providing livelihoods to people is expected to be limited in area. This is due to the fact that there seems to be relatively suitable unoccupied and uncultivated land around Yae Twin Gyi where camps and workshops can be located, while the entire reservoir area is uncultivated. Some land may be lost due to the construction of the access roads that will lead from Yae Twin Gyi down the escarpment and to the dam site, but there are good possibilities for routing most of it outside of the productive and permanently cultivated agricultural land surrounding Yae Twin Gyi.

Mitigation measures:

- Minimisation of economic displacement through adaptive planning of roads and location of project components;
- Careful identification of all affected project affected persons (PAPs) and households that will lose commercial land and buildings;
- Full compensation at replacement cost for all affected commercial buildings and land.

Conclusion

The magnitude of the impact in terms of economic displacement and loss of livelihoods is assessed as **low to medium negative** during the construction phase and **insignificant** during the operation phase.

Phase	Magnitude – Economic Displacement and Loss of Livelihoods				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.3.5 Population Influx and Impacts on the Social Fabric

Construction Phase

During construction, there will be a temporary increase in population in the area surrounding the main construction site, including the dam and powerhouse, due to in-migration of workers, job seekers, camp followers, traders, service providers, etc. The exact number of workers to be employed is not known at the current stage, but it may reach 600-700 people at the peak of the construction activities. The villages likely to experience the impacts of population influx are those located closest to the main construction site including Loi Pang, Taung Gyi, Ah Nauk Kone and Yae Twin Gyi. As Yae Twin is located at the end of the existing public road, from where the new access road is likely to be built, this village is likely to experience the most pronounced impacts.

While many of the unskilled and semi-skilled workers will be recruited from the local/neighbouring communities, others will come from outside and be resident in the project area for the duration of the construction period.

Population influx, even though temporary, may put additional pressure on the local infrastructure, services and utilities, especially on community health and sanitation. An increase in population is usually also associated with strains on social cohesion and fabric, norms and local cultural practices. This could potentially result into an increased risk of exposure to HIV/AIDS and other STDs as well as tensions between the resident population and the in-migrants.

Mitigation measures:

- Establish transparent recruitment procedures to avoid camp followers in the form of job-seekers;
- Establish a recruitment policy that gives priority to local residents for less specialised work, conduct skills development training locally in the project area to maximize recruitment potential and provide contractors with lists of qualified local people with appropriate skills;
- Recruitment procedures to be shared with the local authorities for further dissemination;
- Opportunities for sub-suppliers and sub-contractors should be awarded to local firms which in turn employ local labour;
- Consider bussing services to nearby villages to reduce the size of camps and facilitate access to construction areas;
- Establish a workers' housing camp and a site clinic to reduce pressure on local infrastructure, services and utilities;
- Conduct public health campaigns addressing issues of behavioural change, water and sanitation, malaria and HIV/AIDS;
- Provide training and awareness to workers on health risks and prevention, and establish a code of conduct on worker-community relations.

Operation Phase

Out-migration: After the construction phase, the population is likely to be reduced significantly. However, there may be residual impacts of the population influx if the social fabric and local norms have been changed permanently during the construction phase. The out-migration will be partly counteracted by improved infrastructure, services and utilities created during the construction phase, resulting in increased population in or around villages near the construction sites

Conclusion

The magnitude of the impact caused by the anticipated population influx are assessed as **medium negative** for the construction phase and **low negative/insignificant** during the operation phase.

Phase	Magnitude – Population Influx and Social Fabric				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.3.6 Community Safety and Security

<u>Construction Phase</u>

A number of safety issues are likely to occur as a result of the Middle Yeywa HPP construction. These include:

Dust and noise: People living along the access roads will experience higher emissions of dust and noise during the construction phase due to increased traffic, including an increase in trucks and heavy vehicles. This is likely to have a negative on the ambient quality air as well as increasing noise pollution levels along the road. This may have health implications for the roadside population.

Traffic accidents: The construction-related traffic along with the general increase in road traffic associated with the increase in population and economic activities, most notably in the villages closest to the main construction site, are unlikely to lead to congestion problems. However, increased traffic of heavy haulage trucks, busses and smaller vehicles, including motorbikes, is likely to result in an increase in road incidents and serious accidents and injuries, including fatalities, along the main access route which passes through a number of villages between Nawnghkio and Yee Twin Gyi. The risk for traffic incidents and accidents is exacerbated by the fact that people in the villages typically reside immediately adjacent to roadside and in addition probably are unaccustomed to the level of heavy traffic that the project activities will generate. The assumed unawareness of the dangers of traffic may increase the likelihood accidents occurring, for instance in connection with crossing of roads by local people, especially children.

New project related installations and equipment: In connection with establishment of new infrastructure, safety issues often arise due to the novelty of these installations and equipment in the local environment. Community members may for instance sustain injuries when interacting with unsecured equipment, falling into unsecured trenches or climbing fences and new power transmission towers.

Management of waste: If hazardous waste and materials generated in connection with project activities, or activities related to the increased economic activities in the project area, are not appropriately and safely managed, they may be released into the environment and lead to serious contamination and pollution of water sources used by the local population. A number of activities may potentially generate pollution, for instance, accidental oil and fuel spills along the access route and at workshops and fuel depos, as well as the washing of trucks and vehicles in local streams.

Dam safety: The risk of dam failure will be extremely low, but the downstream impacts in case of an unlikely dam breach could be dramatic due to the water storage in the reservoir. It should be point out, though, that there are no people living immediately downstream of the Middle Yeywa dam, but there may be people living in close vicinity to the existing Yeywa reservoir and further downstream. The dam safety aspects, including emergency preparedness and response planning (e.g. flood warning system), will be addressed in the ongoing feasibility study.

Mitigation measures:

- Preparation of an On-site Traffic and Access Management Plan, including speed bumps, safe crossing points and other measures in populated areas;
- Speed limits for different sections of the road network;
- Specification of parking sites for the construction vehicle fleet;
- Preparation of specific plans for hauling heavy loads and hazardous materials;
- Signalling and warning measures;
- Awareness raising to alert the local population of the dangers of increased traffic loads with an especial focus on schools;
- Fencing and control measures to avoid unauthorised access to construction sites and equipment and new installations;
- Refuelling of heavy equipment and machinery by a service vehicle, with appropriate safeguards and protection measures;

- Storage of fuel and hazardous material in special designates proper facilities away from the streams and water sources;
- Collection and treatment of storm water runoff from workshops in hydrocarbon separation pits/tanks.

Operation Phase

For the operation phase, it is likely that an operator's village with good facilities for waste handling and management will be established in the vicinity of the hydropower plant. The operator's village will contribute to the future population increase in the area and also contribute incrementally to the future traffic loads on the local roads. However, compared to the construction phase, these impacts will be limited considering also the general trend of traffic load increases as the economy improves in the area.

Conclusion

The magnitude of the impact on community safety and security is assessed as **medium-negative** during the construction phase, while it is considered **low negative/insignificant** during the operation phase.

Phase	Magnitude – Community Safety and Security				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction		▲			
Operation			▲		

8.3.7 Forest Resource Use

Construction Phase

During the construction phase, some forest resources may be lost due to building of the access road down the escarpment to the main construction site comprising the dam and powerhouse areas. This is unlikely to affect the forest resource use of the nearby villages, including Yae Twin Gyi, due to the fact that the area is too steep and inaccessible to allow for any logging and extraction of timber by villagers who probably acquire timber for building and construction purposes from other area higher up on the slope.

To the degree that there is any hunting taking place in the area affected by the access road, it cannot be ruled out that wildlife will be scared away from the area by the construction activities. However, it is fair to assume that if any hunting is done in this area it is insignificant in terms of income and diet for the local population which has agriculture as their all-important source of income. The same reasoning applies for collection of non-timber-forest-products (NTFPs) which according to village interviews and the socio-economic survey results is an insignificant income source.

Operation Phase

The villages surrounding the Middle Yeywa reservoir rely predominantly on agriculture as their main source of livelihood. According to the results from the socio-economic survey, income from forest based resources on the average accounts for only 4% of the reported income (see also Figure 7-9). Forest resources include timber for construction and firewood and foraged plants and hunted animals for consumption and sale. The village of Thar Si is the village where forest resources provide the highest share of reported total income with 20%. This relatively high share contributes to lifting the average of forest-derived income for the whole group of survey villages. Of the total forest product incomes reported by the surveyed households, timber is the dominant source.

Interviews conducted in connection with the socio-economic survey indicate that the villagers extract forest resources, and especially the timber resources, from the upper and less steep slopes of the Myitnge River valley and not from the steep lower part that will be submerged by the reservoir. As such, it is not likely that the loss of the timber resources in the submergence zone will have any significant effect on the use of the forest resources by the villagers in the area around the reservoir. However, it needs to be noted that illegal logging with extraction of the most valuable commercial timber and tree species is taking place along part of the lower river valley. A few local villagers may be engaged in this activity which normally is organised by outsiders so in this respect submergence of the lower river valley may have an impact for a few individuals.

Another forest resource use is hunting of wild animals which is still fairly common, especially on the left bank which have the most intact forest areas. There is a possibility that this activity and source of wild meat will be affected by the hydropower development as there is reason to believe that the hunting to a large degree is taking place in the steep and forested lower part of the river valley. This assumption is supported by the fact that hunters were actually caught on camera by the camera traps that were deployed at strategic locations in the submergence zone. It needs to be noted though that hunting is more an exciting leisure activity and a dietary supplement for the villagers, than an important source of income.

As collection of NTFPs is not commonly practised by villages and consequently has little economic significance, submergence of the lower part of the Myitnge River valley is unlikely to have negative effect on income levels of the project area village populations.

Mitigation measures:

- Training on forest resource management through the Community Forest Programme
- Establishment of community forest lots.

<u>Conclusion</u>

The magnitude of the impact on forest resource use by the local population is assessed as **low negative** during both the construction and the operation phase.

Phase	Magnitude – Forest Resource Use				
	Large Negative	*Medium Negative*	*Low/Insignificant*	*Medium Positive*	*Large Positive*
Construction			▲		
Operation			▲		

8.3.8 River Resource Use

As noted in Section 7.4.2, the income from fishing appears to be insignificant, constituting less than one percent of the total average income of the surveyed households. However, for some households in the villages surrounding the future Middle Yeywa reservoir, fishing appears to be a source of dietary supplement and for some also a source of income. This is shown by the results of the interviews that were carried out in April 2017 (see Chapter 5, Table 5-3). According to the information provided in the village meetings, there are people that fish for household consumption, most commonly in the fish migration period of March-April. The number of people that practise fishing seems to be limited to less than 20 in most villages. The village where fishing has the largest significance as a source of income for the local population is Yae Twin Gyi which is the village that lies closest to the dam site. Here it was informed that 10-20 people go for fishing, staying for up to 5 days in a fishing camp, located on the riverbank at the rapids close to where the dam has been planned. The catches per fishing trip was said to be 20-30 kg which is brought to local markets for sale or consumed in the village.

Although the impacts on the income levels for the local population caused by the planned hydropower development is likely to be minor at the macro level, it needs to be kept in mind that for some households, perhaps most notably in Yae Twin Gyi, the potential loss of this source of income and dietary supplement can be significant. To what extent it will be possible to establish reservoir fisheries that can replace the income source from the river fisheries remains to be seen. If this is possible, reservoir fisheries may potentially become a source of income for more people than what the situation is today.

Mitigation measures:

- Consider provision of fishing gear and equipment villagers interested to utilize fish resources in the reservoir
- Consider organisation and training of village fisheries groups that can manage the potential fish resources in the reservoir.

Conclusion

The magnitude of the impact on river resource use is assessed **as medium to low negative** both during the construction and the operation phase.

Phase	Magnitude – River Resource Use								
	Large Negative		*Medium Negative*		*Low/Insignificant*		*Medium Positive*		*Large Positive*
Construction				▲					
Operation				▲					

8.3.9 *Archaeological Sites and Cultural Heritage*

As stated in Section 7.5, no archaeological or cultural heritage sites have been recorded in the direct impact zone of the Middle Yeywa HPP. However, it cannot be ruled out that there are intangible sites of spiritual or religious nature that will be directly affected by construction activities and by river impoundment. However, discovery of such site is highly unlikely as the Danu are not originally from this area and thus have limited spiritual connection to the land.

Although no physical and intangible cultural heritage sites have been identified so far it will be important to be prepared to handle chance finds during construction in a proper manner. Possible mitigation measures in this connection is listed below.

Mitigation measures:

- Provide contractor training and awareness programme;
- Establish a chance finds procedure and conduct salvage excavation when required.

Conclusion

On the basis of present knowledge, the impact on archaeological sites and cultural heritage is assessed as **insignificant** in both the construction and operation phase.

Phase	Magnitude – Archaeological Sites and Cultural Heritage								
	Large Negative		*Medium Negative*		*Low/Insignificant*		*Medium Positive*		*Large Positive*
Construction				▲					
Operation					▲				

8.4 Overall Impact Assessment

Table 8-3 summarises the potential impacts of the Middle Yeywa HPP without and with the possible mitigation/enhancement measures. The residual impact that remains with mitigation measures in place is given in the last column ("overall impact with mitigation").

Table 8-3: Summary of impact assessment without and with mitigation/enhancement measures.

Theme	Value/ Vulnerability	Impact Magnitude	Overall Impact	
			Without Mitigation	With Mitigation
CONSTRUCTION PHASE				
Physical Environment				
Topography and landscape	**Medium**	**Low - medium negative**	**–/– –**	**–**
Geology and soils	**N/A**	**Medium negative**	**– –**	**–**
Climate	**High**	**Low negative**	**–**	**0/–**
Air Quality	**High**	**Low - medium negative**		**–**
Noise and vibration	**High**	**Low - medium negative**	**–/– –**	**–**
Hydrology	**N/A**	**Low negative**	**–/– –**	**–**
Sediment transport	**High**	**Low - medium negative**	**–/– –**	**–**
Water quality	**Medium-high**	**Low - medium negative**	**–/– –**	**–**
Biological Environment				
Protected areas	**Low**	**Insignificant**	**0**	**0**
Vegetation	**Medium**	**Low - medium negative**	**–**	**0/–**
Terrestrial fauna	**Medium**	**Medium negative**	**– –**	**–**
Aquatic ecosystems	**Medium**	**Medium negative**	**– –**	**–**
Human Environment				
Local project area economy	**High**	**Low - medium positive**	**++**	**++/+++**
Physical displacement and resettlement	**High**	**Low - medium negative**	**–/– –**	**0**
Economic displacement and loss of livelihoods	**High**	**Low - medium negative**	**–/– –**	**0**
Population Influx and social fabric	**High**	**Medium negative**	**– –**	**–**
Community safety and security	**High**	**Medium negative**	**– –**	**–**
Forest resource use	**High**	**Insignificant - low negative**	**–**	**–/0**
River resource use	**High**	**Low - medium negative**	**–/– –**	**–**
Archaeological sites and cultural heritage	**High**	**Insignificant**	**0**	**0**
OPERATION PHASE				
Physical Environment				
Topography and landscape	**Medium**	**Low - medium negative**	**– –**	**–**
Geology and soils	**N/A**	**Low-medium negative**	**– –**	**–**
Climate	**High**	**Low - medium positive**	**+**	**+ +**
Air Quality	**High**	**Insignificant**	**0**	**0**

Theme	Value/ Vulnerability	Impact Magnitude	Overall Impact	
			Without Mitigation	With Mitigation
Noise and vibration	**High**	**Insignificant**	**0**	**0**
Hydrology	**N/A**	**Low - medium negative**	**–/– –**	**–/– –**
Sediment transport	**High**	**Low - medium negative**	**–**	**0/–**
Water quality	**Medium-high**	**Medium negative**	**– –**	**–/– –**
Biological Environment				
Protected areas*	**Low**	**Insignificant or low negative**	**0 or –**	**0 or –**
Vegetation	**Medium**	**Low negative**	**–**	**0/ –**
Terrestrial fauna	**Medium**	**Medium negative**	**– –**	**– –/–**
Aquatic ecosystems	**Medium**	**Medium negative**	**– –**	**– –/–**
Human Environment				
Local project area economy	**High**	**Low - medium positive**	**+**	**++**
Physical displacement and resettlement	**High**	**Insignificant**	**0**	**0**
Economic displacement and loss of livelihoods	**High**	**Insignificant**	**0**	**0**
Population influx and social fabric	**High**	**Low negative**	**–**	**–**
Community safety and security	**High**	**Insignificant**	**0**	**0**
Forest resource use	**High**	**Low negative**	**0**	**+**
River resource use	**High**	**Medium - Low negative**	**–**	**0**
Archaeological sites and cultural heritage	**High**	**Insignificant**	**0**	**0**

* Assessment depends on confirmation whether parts of the left bank have a forest protection status or not.

8.5 Cumulative Impacts

8.5.1 Introduction

Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones. The magnitude of the cumulative impacts can be equal to the sum of the individual effects (additive effect), or can be an increased effect (synergistic effect) or a decreased effect (antagonistic effect) (IFC 2013).

The assessment of cumulative impacts includes two main components:

- The anticipated future condition arising from the cumulative impacts
- The contribution of the development under evaluation to the cumulative impacts

In order to assess the cumulative impacts, the geographical and temporal scope has to be expanded as compared to the definition of the Middle Yeywa project's area of influence or impact zones. In particular, any developments in the upstream catchment must be considered even if the proposed project has no impact beyond the tail end of the reservoir.

The other existing and planned developments that have been selected for analysis (see below) include those identified by stakeholders to be of critical concern and that have a high relative importance. The cumulative impacts may translate into a wide range of changes in the physical, biological and human environments, but only the most significant issues are dealt with here. Indeed, a full cumulative impact assessment for the concerned river catchments requires a wider scope and would involve more detailed sector studies and wider stakeholder engagement.

8.5.2 Other Planned or Existing Projects

The Middle Yeywa project will be implemented in an environment that is already modified by the downstream Yeywa Hydropower Project and that will undergo further changes due to the Upper Yeywa project currently under construction.

The 790 MW *Yeywa HPP*, commissioned in 2010, is located downstream of the proposed Middle Yeywa HPP. The reservoir has a FSL at 185 masl., a surface area of 59 km^2 and a total volume of 2,600 million m^3, of which 1,600 million m^3 is for active storage. Thus, the Yeywa reservoir is capable of attenuating the daily flow fluctuations from Middle Yeywa HPP without a significant change in the reservoir water level.

The daily operation data series at Yeywa are illustrated in ***Figure 8-9***. Spill flows occur from July after the reservoir has reached its full capacity (FSL is 185 masl.) and last as long as the water level exceeds the FSL. When the inflows exceed the total outflow (via turbines+spillway), the water level increases.

Based on the available hydrological records, the mean annual volume of the flow through turbines of the Yeywa HPP is 10,290 Mm^3 while the spill flow is 5,200 Mm^3 and the inflow is 15,450 Mm^3. On average, the outflows are larger than the inflows between January and May with 280 m^3/s and 185 m^3/s, respectively, due to the seasonal emptying of the Yeywa reservoir. In contrast, the outflows are lower than the inflows between July and September with 704 m^3/s and 954 m^3/s, respectively, due to the seasonal filling of the reservoir.

The 280 MW *Upper Yeywa HPP*, currently under construction, is located about 130 km upstream of the existing Yeywa HPP and immediately upstream of the tail end of the proposed Middle Yeywa reservoir. The power plant will be operated as a daily peaking scheme with FSL at 395 masl and MOL at 385 masl, providing an active storage of about 18.6 Mm^3 (total storage 55 Mm^3). The tailwater level is 323 masl. The dam will be 87 m high and be equipped with a gated spillway and bottom outlets at elevation 334 masl. The construction of Upper Yeywa HPP is ongoing but has suffered major delays and the commissioning date is currently unknown.

It should be noted that a fourth hydropower plant is currently also being planned on the Myitnge River downstream of the existing Yeywa HPP. The project is known as *Deedoke HPP*. It will consist of a 27 m high dam with a run-of-river 77 MW power plant that will take advantage of the river regulation of the Yeywa reservoir. According to the latest information, the proposed Deedoke HPP is scheduled for completion by 2020-21.

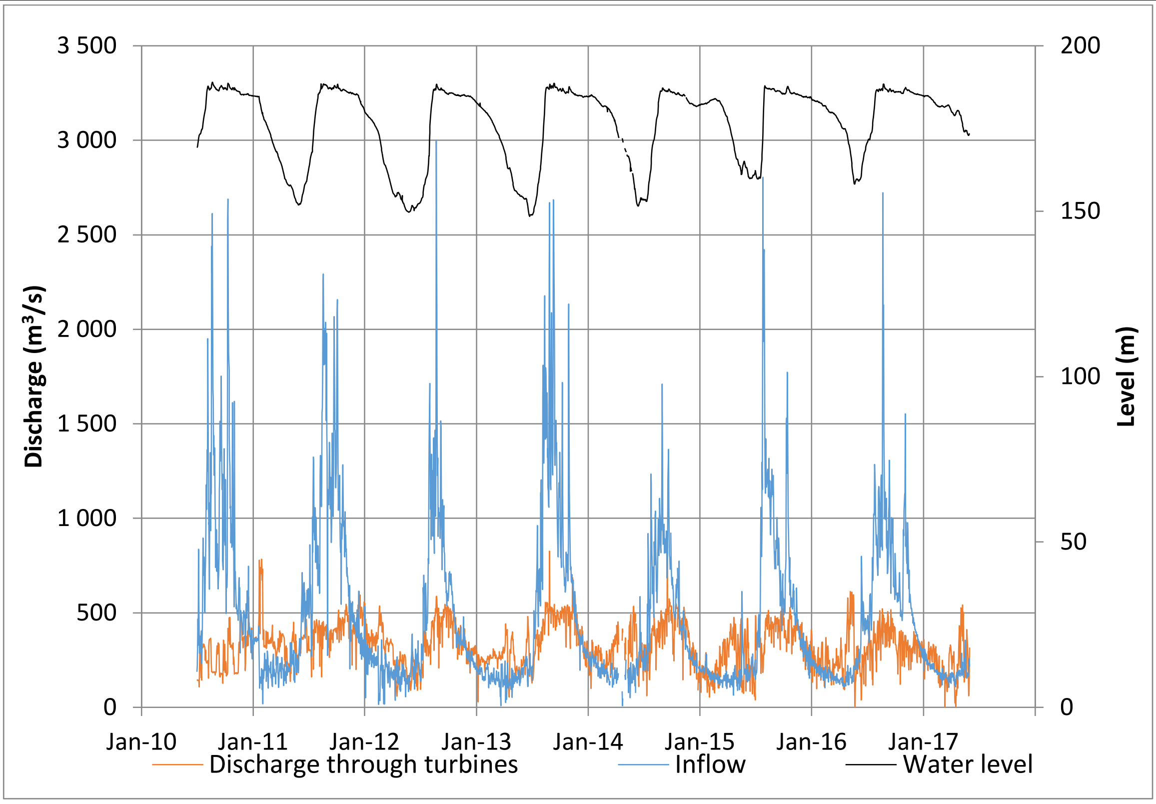


Figure 8-9: Daily operation data series at Yeywa HPP.
Source: Tractebel (2017)

8.5.3 Climate Change

There is little doubt that a changing climate may have significant impacts on the availability of water resources, and hence, on hydropower planning, operation and safety. As explained in Section 6.3.2, the predicted change in rainfall regime in the Myitnge River basin varies with different climate change projections, though an increase in precipitation is more likely than a decrease in precipitation whatever the time horizon.

Tractebel (2017) assessed how the climate change scenarios will affect the inflow at Middle Yeywa. The results are shown in ***Table 8-4*** and ***Table 8-5*** for RCP4.5 (low emissions scenario) and RCP8.5 (worst case scenario), respectively.[20] The main observations are as follows:

- In the near term time horizon, the possible change in runoff does not depend much on the RCP. The 25th, 50th and 75th percentiles of the mean annual runoff are -13%, 2%, 3% for the RCP4.5 and -14%, 4% and 3% for the RCP8.5, respectively.
- In the midterm time horizon, the discrepancies between both RCPs are just slightly more pronounced. The 25th, 50th and 75th percentiles of the mean annual runoff are 0%, 0%, 16% for the RCP4.5 and -3%, -2% and 14% for the RCP8.5, respectively.
- In long term horizon, the discrepancies between both RCPs are pronounced. The 25th, 50th and 75th percentiles of the mean annual runoff are -1%,-3%, 9% for the RCP4.5 and -9%, 6% and 12% for the RCP8.5, respectively.
- Whatever the time horizon and the RCP, the distribution is scattered around 0%. The latter means that the runoff change is uncertain as some climate scenario experiments project a decrease in runoff while some others climate scenario experiments project an increase in runoff.

[20] *RCP = Representative Concentration Pathway*

In conclusion, the change in the mean annual runoff of the Myitnge River is likely to be in the range of -14% to 3% in near term time horizon, -3% to 16% in mid-term and -9% to 12% in long term.

Table 8-4: RCP4.5 – change in runoff.

	2016-2035			2046-2065			2081-2100		
	25%	50%	75%	25%	50%	75%	25%	50%	75%
RCP4.5 Change in runoff (%)									
Dec	-10%	-3%	0%	-4%	-3%	4%	-5%	-7%	4%
Jan	-11%	-4%	-1%	-5%	-5%	2%	-7%	-8%	0%
Feb	-11%	-5%	-2%	-6%	-6%	0%	-8%	-10%	-1%
Mar	-11%	-6%	-2%	-7%	-7%	-2%	-9%	-11%	-2%
Apr	-12%	-5%	-2%	-6%	-7%	0%	-8%	-11%	-2%
May	-15%	0%	1%	-3%	-4%	12%	-5%	-8%	3%
June	-17%	3%	3%	1%	0%	21%	-1%	-4%	9%
July	-17%	5%	5%	3%	2%	25%	2%	-1%	11%
Aug	-15%	6%	5%	4%	3%	25%	3%	1%	12%
Sep	-13%	5%	4%	4%	3%	22%	3%	1%	10%
Oct	-12%	-1%	4%	-2%	0%	12%	-3%	-4%	11%
Nov	-10%	-3%	2%	-4%	-2%	8%	-5%	-6%	8%
Year	**-13%**	**2%**	**3%**	**0%**	**0%**	**16%**	**-1%**	**-3%**	**9%**

Source: Tractebel (2017)

Table 8-5: RCP8.5 – change in runoff.

	2016-2035			2046-2065			2081-2100		
	25%	50%	75%	25%	50%	75%	25%	50%	75%
RCP8.5 Change in runoff (%)									
Dec	-13%	1%	0%	-7%	-5%	3%	-12%	-5%	-1%
Jan	-12%	0%	-1%	-9%	-7%	0%	-14%	-8%	-6%
Feb	-11%	-1%	-2%	-10%	-8%	-2%	-16%	-11%	-9%
Mar	-7%	-1%	-2%	-11%	-9%	-3%	-17%	-12%	-11%
Apr	-5%	-1%	-2%	-11%	-10%	-2%	-18%	-11%	-11%
May	-7%	2%	1%	-9%	-8%	7%	-16%	-3%	0%
June	-14%	5%	4%	-5%	-5%	17%	-12%	7%	13%
July	-18%	6%	5%	-1%	-2%	21%	-8%	13%	20%
Aug	-17%	6%	5%	0%	-1%	21%	-5%	15%	22%
Sep	-15%	5%	4%	1%	0%	19%	-4%	13%	19%
Oct	-13%	4%	4%	-5%	-1%	13%	-9%	4%	12%
Nov	-13%	3%	2%	-6%	-3%	8%	-11%	-1%	5%
Year	**-14%**	**4%**	**3%**	**-3%**	**-2%**	**14%**	**-9%**	**6%**	**12%**

Source: Tractebel (2017)

8.5.4 Physical Environment

The Myitnge River hydropower cascade will cause a dramatic change in hydrological conditions, sediment transport and water quality characteristics. The cumulative impacts on the physical environment have been described as part of the project-specific impacts, especially for hydrology (Section 8.2.6), sediment transport (Section 8.2.7) and water quality (Section 8.2.8). The three hydropower reservoirs will essentially convert the Myitnge River from a free-flowing river with a seasonal flow regime into a fragmented system with standing or slow-flowing water bodies controlled by dams acting as sediment traps and releasing daily fluctuating flows in periods when inflow is lower than turbine capacity. During the months of high flow (periods of the year when there is spilling over the dams or releases through gates), the projects will not affect the flow levels.

At the time of commissioning of the Middle Yeywa HPP, many of these changes will already have occurred as a result of the Upper Yeywa HPP and the existing Yeywa HPP. Indeed, the river discharge, sediment transport and water quality downstream of the Yeywa HPP is already determined by the Yeywa dam and will continue to be so due to the large size of its reservoir and its location as the lowermost hydropower plant in the Myitnge River. In this respect, the incremental impact of the Middle Yeywa HPP is significantly less than it would have been without the two other hydropower dams.

There is currently no information available on how the three hydropower plants will be operated in order to maximise production and meet the daily demands for electricity while also managing sediments to increase the lifetime of the reservoirs. It is expected that Upper Yeywa and Middle Yeywa will be subject to joint/coordinated operation, but this needs to be explored further and be defined in the operating licenses and the Power Purchase Agreement.

8.5.5 Vegetation and Forests

The loss of forest in the Middle Yeywa reservoir will be additional to the loss already caused by the downstream Yeywa HPP and the Upper Yeywa HPP under construction. The cascade of hydropower dams will thus convert a long section of the Myitnge River valley (>200 km) from a forest-dominated ecosystem into a largely aquatic dominated ecosystem surrounded by forest areas.

According to DHPI (2014), none of the threatened plant species recorded in the present EIA report occurs in the impact zone of the Upper Yeywa HPP. However, there is a risk that these species were not reported in the field surveys and that at least some of them also grow upstream of the Middle Yeywa reservoir. Similarly, it is likely that some trees belonging to the threatened species have already been submerged by the large Yeywa reservoir downstream.

Despite such cumulative impacts ("additive effects"), the overall reduction in population size for the threatened species, as well as for other plant species, is not considered to be significant at a national or global scale. Even locally, these plant species will continue to grow and reproduce in the river valley uphill from the three hydropower reservoirs, as they are not confined only to the lower elevation of the river valley.

The major issue in the long term is whether the hydropower developments in the Myitnge River valley will increase pressure on the forests (due to in-migration, conversion of forests to agriculture or other land uses, etc.) or whether the government and other stakeholders will be capable of managing and enforcing more stringent control over the natural forest areas. Indeed, there is a risk that illegal timber extraction will increase, at least during the construction period of Middle Yeywa HPP, although this is largely a project-induced impact and not so much a cumulative impact (as the two other power plants will already be in operation at that time, with less population influx).

8.5.6 Terrestrial Fauna

Loss of habitat, various forms of disturbance and hunting are likely to increase pressures on a range of fauna species in the project area. The species found in the Middle Yeywa impact zone are generally spread throughout a much larger areas, including in the Lower and Upper Yeywa project areas. The baseline surveys did not document species that rely only on the habitats impacted by the Middle Yeywa Project. These species are generally found in large areas within Myanmar and beyond in the region. However, the combination of loss of relatively unaffected areas in the steep river valleys between Yeywa and Upper Yeywa (including the impact zone of the Middle Yeywa) and substantial conversion of forest on the surrounding plateaux will result in a cumulative fragmentation of habitats and habitat loss that are likely to reduce populations of many forest-dependent species. Species requiring large habitats and species sensitive to human disturbance are most vulnerable. These include the some of the cats, some of the primates and some of the bird species of conservation concern. Maintaining a minimum of habitats in the wider landscape and maintaining corridors between these habitats are likely to be important to prevent local extinction of such species. Even if none of the species are likely to be severely impacted by the Middle Yeywa HPP in isolation, the gradual fragmentation and cumulative loss of habitat are resulting in reduced populations of species of conservation concern. There appears to be no landscape-wide planning for the management of sufficiently large and connected habitats for species of conservation concern. In the face of climate change, the connectivity between habitats may become vital for the robustness of the species populations within a mosaic of habitats. The Middle Yeywa HPP can play a role in facilitating sustainable management of areas around the reservoir that play a positive role in maintaining important habitats in a larger landscape and thereby mitigate cumulative impacts from multiple developments. It is recommended that the plans to compensate for forest loss (reservoir clearing) are strategically targeted to also play a useful role in mitigating landscape-wide cumulative impacts by ensuring good quality habitats that support connectivity in the wider landscape.

8.5.7 Aquatic Ecosystems

The aquatic ecosystems are probably the ecosystems most affected by cumulative impacts even if the contribution from the Middle Yeywa HPP will be relatively small considering the existence of the Yeywa dam and reservoir and the ongoing construction of the Upper Yeywa dam. The Myitnge River probably had comprehensive two-way connectivity with the greater Ayeryawady River system prior to the construction of the Yeywa HPP though it should be noted that the potential presence of natural barriers to upstream fish migration remains unknown to the Consultant. At present, upstream migration of species such as fish and shrimps has been blocked by the downstream Yeywa dam. Further dam development upstream of the existing Yeywa will not alter the connectivity with the larger Ayeryawady River system significantly. However, if there is local migration of some fish species within the Myitnge River, or between the Yeywa reservoir and upstream areas, such migration patterns will be impacted first by the Upper Yeywa HPP and then the Middle Yeywa HPP. The limited available information on aquatic ecology and fish migration patterns does not allow for any refined analysis of this issue.

There are likely to be a range of aquatic species that complete their life cycle within the Myitnge River and hence do not rely on connectivity with the greater Ayeyarwady river system. Those species are adapted to riverine conditions and will, because of the cumulative impacts from Yeywa, Middle Yeywa and Upper Yeywa HPPs, see the majority of riverine habitats lost between the Yeywa and Upper Yeywa HPPs. This may result in local extinctions and it is recommended that these risks are further studied prior to constructing the Middle Yeywa HPP. Some riverine species may survive in the limited river sections between the reservoirs, in the limited number of tributaries flowing into the reservoirs as well as in the reservoirs themselves unless the species are outcompeted or heavily predated upon by species better adapted to a lake environment.

Along the Myitnge River, there is a large number of small sand banks. These sand banks may be an important habitat for various insect species and possibly turtle species of conservation concern. The cumulative loss of river sections with sand banks may also result in local extinction of such species. Some sand banks will be created at the upstream ends of the Middle Yeywa reservoir and these may substitute for lost sand banks but probably only to small extent due to the limited size compared to the large number of sand banks along the inundated river section. Further consideration should be made of species of conservation concerns.

8.5.8 Local Project Area Economy

The Upper Yeywa HPP is the only major infrastructure project that may possibly add to the social impacts created by the Middle Yeywa HPP. Although construction of the Upper Yeywa HPP has already started, delays in the construction schedule could result in the possibility that the construction phases of the two projects could overlap. If this happens, this may add to the increased economic activities and employment opportunities that are likely to result from the Middle Yeywa HPP. This may lead to increased demands for local goods and services as well as for locally recruited labourers. A result from this economic boost may be an incremental increase in local prices on goods and services that would not have happened if the two projects did not overlap. However, it is still too early to know whether this will actually happen but the possibility cannot be ruled out at this stage.

8.5.9 Population Influx and Social Fabric

In the wider project area, an overlap of the construction phases of the two hydropower projects could also trigger a larger in-migration into the area in the form of camp followers and people seeking to benefit from the increases in demands for all kinds of services.

8.5.10 Community Safety and Security

Along with the more general increase in road traffic on National Highway No. 3 that runs through Nawnghkio, an increase in construction related heavy traffic though the township may occur in the case of a concurrent construction of the Upper and Middle Yeywa hydropower projects. This may in turn lead to an incremental increase in the number of traffic incidents, including fatal accidents along National Highway No. 3. During operation, road traffic will decrease in terms of heavy construction traffic.

9 ANALYSIS OF ALTERNATIVES

9.1 Introduction

This chapter describes and examines the alternatives to the proposed Middle Yeywa HPP in line with the requirements of IFC Performance Standard 1 (Assessment and Management of Environmental and Social Risks and Impacts) which states that "*For greenfield developments or large expansions with specifically identified physical elements, aspects and facilities that are likely to generate potential environmental or social impacts, the client will conduct a comprehensive ESIA, including an examination of alternatives, where appropriate.*"

While only one project alternative was examined in detail in Chapter 8, different technical alternatives have been considered in the pre-feasibility and feasibility study stage.

Generally, a comparison of alternatives can help to determine the best method of achieving project objectives while minimising environmental and social impacts. Alternatives should be evaluated and compared on the basis of their potential environmental and social impacts, costs and feasibility.

9.2 Project Need and Alternative Sources of Energy

According to ADB (2015), the total primary energy supply for Myanmar was about 18 million tons of oil equivalent energy (MTOE) in 2012–2013 (ADB, 2015). More than half (54% or 9.7 MTOE) of Myanmar's energy supply was from biomass, followed by 17% (3 MTOE) from hydro, 15% (2.8 MTOE) from oil, and 12% from gas. Coal accounted for only a small share (3%).

Myanmar has over the last years seen a growth of the Gross Domestic (GDP) by 6 to 8%. For 2018, a growth of 8% has been forecasted by ADB (2017). Strong economic growth is also expected for all sectors of the economy for the years to come with a most likely growth scenario of around 7% (ADB 2014). To fuel this economic growth, total energy demands will be increasing rapidly. According to the Myanmar Energy Master Plan (ADB 2015), the electricity demand within Myanmar is estimated to increase to 25.8 TWh in 2021 and 57.7 TWh in 2030. The hydropower share of the total electricity supply is expected to decline from around 70% in 2012 to 57% in 2030 while electricity from coal fired plants is expected to increase from around 2% to 30% over the same period. The planned strong expansion of rural electrification is one of the main drivers behind the high electricity demand growth.

Table 9-1: Forecasted electricity demand in Myanmar.

	2012	2015	2018	2021	2024	2027	2030
INPUT (mtoe)	1.97	2.22	2.21	2.52	4.22	5.45	7.54
OUTPUT Electricity (GWh)	10,364	14,398	19,446	25,763	33,904	44,238	57,654
Electricity output shares (%)							
Hydro	69.7%	65.0%	56.5%	74.1%	64.0%	65.7%	57.1%
Solar PV	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%	5.2%
Wind	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Natural gas	28.1%	33.4%	38.9%	22.4%	12.7%	8.3%	8.2%
Oil	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Coal	2.2%	1.6%	4.6%	3.4%	23.3%	24.0%	29.5%

Source: Myanmar Energy Master Plan

If built, the Middle Yeywa HPP will contribute to meeting the future demands for electricity supply presented in Table 9-1. The "No Development Alternative" will imply that other electric energy sources and projects may have to be developed in order to realise the ambitious plans for rural electrification and providing electricity for businesses and future industrial projects. Coal appears to be the most likely alternative electric energy source, as other sources, such as solar power, are only expected to provide 5% of the supply in 2030. Considering that the Middle Yeywa HPP in the long run will be a better alternative than coal from a CO_2 emissions and climate change perspective, it can be seen as the preferable alternative for addressing future electricity demands.

9.3 Assessment of Hydroelectric Alternatives

According to the Baseline Assessment Report prepared in connection with the Strategic Environmental Assessment of the Hydropower Sector in Myanmar (MOEE and MONREC 2016), there are 29 existing hydropower plants already in operation ranging from 10 to 790 MW with a total installed effect of 3298 MW. Six other hydropower projects are currently under construction, including the 280 MW Upper Yeywa, the 51 MW Keng Tawng, the 111 MW Thahtay, the 42 MW Buywa, the 30 MW Baluchaung and the 1050 MW Shewli 3 hydropower plants.

In addition to the projects under construction, 69 other hydropower and multipurpose projects are in various stages of planning, including those that have yet only been identified as potential hydropower development projects. Among these 69 identified hydropower development projects, there are a number of projects that match and exceed the size of Middle Yeywa HPP with most of them located in the Ayeyarwady River Basin. The largest of these is the controversial and now suspended 6000 MW Myitsone HPP located on the upper Ayeyarwady mainstream followed by 3400 MW Chipwi HPP located in the Nmae Hka sub-basin. However, these projects are located relatively far north in Myanmar, far from Yangon and Mandalay where the largest increases in the electric power demand is expected. In the Myitnge Sub-basin, where Middle Yeywa is located, there are no other planned hydropower projects of a similar size in terms of installed capacity (MW) and annual energy generation (GWh/yr). The table below shows the planned hydropower projects in the Myitnge sub-basin.

Table 9-2: Key data for hydropower projects planned in the Myitnge sub-basin.

River	Project	Installed Capacity (MW)	Generation (GWh/yr)	Dam Height (m)	Total Storage (hm^3)	Reservoir Area (km^2)	Reservoir Length (km)	Retention Period (days)	Type (#)	Export (%)
Myitnge	Middle Yeywa	700	3,253	160	454	11	70	NP	NP	0%
	Deedoke	77	338	27	NP	NP	19	NP	NP	0%
Nam Tu/Myitnge	Nam Tu	100	410	114	NP	NP	4	NP	NP	0%
Tributaries to Myitnge	Nam Hsim	30	NP	NP	NP	NP	NP	NP	NP	0%
	Nam Lang	210	NP	NP	NP	NP	NP	NP	? NP	0%
Sum		**1,117**	**4,001**		**>454**	**>11**	**>93**	**NP**		

Source: MOEE and MONREC (2016)
NP: not provided

In the smaller Ma Gyi Chaung sub-basin located to the west of Myitnge Sub-basin, the Ministry of Agriculture, Livestock and Irrigation is planning to build a multipurpose dam upstream of the existing 25 MW hydropower project. The project will include a 64 MW hydropower plant with a 24 km^2 reservoir.

The only project that is planned in the Paung Laung sub-basin, which is located south of the Myitnge sub-basin, is the 100 MW Middle Paung Laung HPP. It is scheduled for completion in 2021.

In terms of other hydropower development projects that will have the capacity to provide electricity to fulfil ambitious rural electrification targets and meet future demands in large population centres such as Mandalay, it appears that Middle Yeywa HPP represents one of the best choices given its size and favourable and central location in relation to future load centres.

9.4 Comparison of Design Alternatives

The pre-feasibility study considered a number of alternatives for hydropower development on the around 70 km long section of the Myitnge River between the existing Yeywa HPP and the planned Upper Yeywa HPP (Pöyry 2015). Different layouts for a development in one or two stages were considered. The alternatives were evaluated on the basis of topographical, hydrological and geological conditions as well as site access. The different design parameters of the considered alternatives are presented in the table below. For location of the different alternatives, see Figure 2-6 in Chapter 2.

Table 9-3: Features and design parameters of considered alternatives.

Alternative	FSL (masl.)	MOL (masl.)	TWL (masl.)	Discharge (m^3/s)	MW	Dam
1	320	305	276	540	200	55 m high RCC dam with a vertical upstream face and a downstream slope between 0.80:1 and 0.85:1
2	320	300	256	550	300	75 m high RCC dam with a vertical upstream face and a downstream slope between of 0.85:1
3	256	236	185	560	400	85 m high RCC dam with an upstream slope of 0.1:1 and a downstream slope of 0.85:1
4.1	276	256	185	560	500	105 m high RCC dam with an upstream slope of 0.1:1 and a downstream slope of 0.85:1
4.2	276	260	185	560	500	50 m high RCC dam with vertical upstream face and a downstream slope between 0.80:1 and 0.85:1
5.1	320	300	185	560	690	150 m high RCC dam with an upstream slope of 0.1:1 and a downstream slope of 0.85:1
5.2	320	300	185	560	690	95 m high RCC dam with an upstream slope of 0.1:1 and a downstream slope of 0.85:1

Source: Pöyry (2015)

The location of Alternatives 1, 2, 3, 4.1 and 4.2 were chosen to allow for a development of the river in two stages with construction of the different dams as far upstream or as far downstream as possible while achieving an installed effect of 400 MW or more. The following combination of alternatives were considered:

- Alternative 1 (circa 200 MW), followed later by Alternative 4 (circa 500 MW).
- Alternative 2 (circa 300 MW), followed later by Alternative 3 (circa 400 MW).
- Alternative 3 (circa 400 MW), followed later by Alternative 2 (circa 300 MW).
- Alternative 4 (circa 500 MW), followed later by Alternative 1 (circa 200 MW).

Cost estimations show that a two stage development is likely to be significantly more expensive than a one stage development as shown in the table below.

Table 9-4: Comparison of cost between a one and a two stage development of Middle Yeywa HPP.

Alternatives	**Alt.1+4.1**	**Alt. 1+4.2**	**Alt. 2+3**	**Alt. 5.1**	**Alt. 5.2**
Installed capacity (MW)	660	650	660	690	690
Total costs (Million USD)	970.8	1,008.4	1,055.6	720.6	724.3
Cost per kW installed (USD/kW)	1,471	1,523	1,407	1,075	1,114

As mentioned in Chapter 2 (Section 2.9.1), the project developer has decided at this stage of project planning to go further with Alternative 5.1 for full feasibility study due to cost considerations and the fact that this alternative allows for exploitation of the entire available head while maximising the installed capacity.

From an environmental and social perspective, Alternative 5.1 is acceptable compared to a two-stage development in terms of concentrating the construction works to a single dam site and to a single period. Assuming that the entire head between the existing Yeywa HPP and the Upper Yeywa HPP will eventually be developed, the proposed Alternative 5.1 is acceptable. However, if the alternative was to develop only parts of the available head, then such an approach would reduce the overall environmental and social impacts. On the other hand, the pristine nature of the Myitnge River would in any case be undermined by the existing Yeywa HPP and the dams further upstream even if parts of the river reach was left untouched. This also applies to the “no project alternative” as it cannot prevent that the Myitnge River becomes heavily modified due to the cumulative impacts of the Yeywa HPP (acting as the main barrier to river connectivity) and the Upper Yeywa HPP (controlling the flow of water and sediments into the Middle Yeywa reaches).

10 OVERVIEW OF THE SOCIAL AND ENVIRONMENTAL MANAGEMENT PLAN

10.1 Introduction

This Chapter presents an overview of the Environmental and Management Plan (EMP) along with the Social Management Plan (SMP) presented in detail in the two following chapters. The organisational set-up and staffing that will be necessary for implementing the management plans is also presented in this chapter.

The EMP and the SMP aim to fulfil the requirements of the Performance Standards of the International Finance Corporation (IFC) as well as the Environmental Health and Safety (EHS) Guidelines of the World Bank Group and the Good Practice Note on EHS Approaches for Hydropower Projects. At a national level the EMP and the SMP aim to comply with the requirements for Environmental Management Plans as set out in the Environmental Impact Assessment Procedure (Notification 616/2015) issued by the Ministry of Natural Resources and Environmental Conservation (Chapter VII)

The EMP and the SMP are based on the information available at this stage of project planning and it needs to be noted that the further planning process, especially when it comes to the design and location of associated infrastructure, may change the project impacts and accompanying mitigation strategies. This will require revision and updating of the EMP and SMP, most notably with respect to the construction phase activities

10.1.1 Overall Goals and Objectives

The overall goal of the EMP is to identify and describe effective mitigation measures for environmental and social impacts likely to be caused by the Middle Yeywa Hydropower Project. More specifically the main objectives of the EMP is to:

- Formulate actions and measures that will avoid and mitigate the negative impacts on the physical and biological environments that have been identified;
- Identify measures to enhance the value of environmental resources where feasible;
- Provide a structure for monitoring of the negative impacts as well as evaluation of the effectiveness of the implemented mitigation measures.

The overall goal of the SMP is to safeguard the interests of stakeholders and to prescribe mitigation measures that minimises social impact of the Project as far as possible. One important objective to achieve this is to carry out a comprehensive consultation process that provides all stakeholders with an opportunity to express their views and concerns so that potential social impacts can be identified and addressed.

10.1.2 Overall Coordination and Roles and Responsibilities

In relation to the requirements from international funders and national environmental authorities, SN Power will have the overall responsibility for implementing and coordinating all social and environmental mitigation activities and programmes. With regard to construction related impacts, the contactor carries the main responsibility to implement effective measures as described in the EMP and SMP for the Project. SN Power will through its project organisation and in cooperation with local and local environmental authorities monitor the environmental and social performance of the contactor and make sure that contactors maintain compliance with environmental standards.

Local government institutions and NGOs are likely to play a role in the implementation mitigation programmes but further project consultations and meetings will be necessary to identify eligible implementation partners more closely.

SN Power's own environmental and social performance with regard to implementation of the EMP/SMP and compliance with international and national standards will be monitored by the Ministry of Energy and Electricity as well as the Ministry of Natural Resources and Environmental Conservation. In addition, the lenders will nominate a Lenders Technical Advisor that will monitor the environmental and social performance of SN Power throughout the construction phase and in the first part of the operation phase.

10.2 Overview of the EMP Programmes and Activities

10.2.1 Construction Management Plan

The Construction Management Plan addresses a number of environmental issues in connection with construction activities and describes best practises for managing these issues. Measures are described for spoil disposal, sediment management, waste water treatment and dust and noise control.

For controlling dust and noise emission the Construction Management Plan the most important measures are frequent watering of dirt roads, limiting blasting operations to daytime and fitting construction machinery with noise control devises.

10.2.2 Water Quality Monitoring Plan

The most important construction phase water quality issues include discharge of hazardous chemicals, discharge of domestic wastewater and sewage from work sites and camps, and sediment loads from construction activities. The Water Quality Monitoring plan prescribes monitoring of a number of parameters for water quality, including important parameters such as turbidity, nitrogen and phosphate concentration, chemical and biological oxygen demand and total suspended solids. Compliance levels will be determined with reference to ASEAN classification and the World Bank Group effluent water standards.

The plan recommends continuing with the same quality monitoring stations as in the EIA study while the recommended monitoring frequency is bi-monthly during construction.

10.2.3 Aquatic Ecology and Fisheries Management Programme

The overall goal of the Aquatic Ecology and Management Programme is to avoid and minimise impacts on the aquatic ecosystems through project design modifications, mitigation, enhancement measures, and monitoring. Important activities include:

- Develop and implement measures that reduce impacts on the aquatic ecosystems, and the people who rely on its ecosystem services, to acceptable levels;
- Monitor and document changes in aquatic ecosystem dynamics, species composition and abundance, and ecosystems services provided, in particular the opportunities for fishing;
- Use monitoring results to inform decision-making on adjustments to project operation, mitigation and enhancement measures and future monitoring;
- Assess the feasibility of supporting sustainable fishing activities in the reservoir. If considered feasible, develop and implement a fisheries management plan.

The programme activities will focus on the proposed reservoir area, the river section between the Middle Yeywa dam and the downstream Yeywa reservoir as well as the Gohteik tributary on the right bank in the upper section of the Middle Yeywa reservoir.

10.2.4 Reservoir Clearance and Filling Plan

The objectives of the biomass clearance are to:

- Reduce the amount of biomass, thereby reducing the risk of poor water quality and greenhouse gas (GHG) emissions from decay of organic matter in the reservoir;
- Reduce the amount of wood debris floating on the reservoir and/or getting into the trash racks;
- Reduce the number of dead trees standing in the water which would become an aesthetic nuisance and an obstacles for possible boat transport and fishing in the reservoir;
- Salvaging valuable timber resources, which would otherwise be submerged and lost.

Selective logging will be carried out to harvest accessible standing timber with a commercial value. The logging and transport of timber will be completed in advance of the full clearing operations. It is assumed that the value will exceed the cost of the salvage logging operation.

Following the harvesting of commercial timber, one or more contractors shall be appointed by SN Power to carry out biomass clearance of selected areas within the reservoir.

During initial and final reservoir filling, it will be necessary to clear the water of logs and organic debris by using booms placed above the intake and spillway structures.

10.2.5 Biodiversity and Conservation Protection Plan

The overall goal is to avoid and minimise impacts on biodiversity through project design modifications, mitigation and enhancement measures, and monitoring.

Specific activities under the Biodiversity and Conservation Protection Plan will include protection of important habitats and catchment areas, conservation of selected species and biodiversity monitoring.

Priority will be given to areas with important habitats that to a limited extent have been have changed by land conversion and other human activities. The areas that are most interesting in this regard are the steep river valley areas towards the reservoir and the plateau on the left bank, including the proposed Naung Lon Reserve Forest.

10.2.6 Community Forest Programme

The overall goal of the Community Forest Program is to compensate for the loss of forest in the Middle Yeywa reservoir by restoring priority forests outside of the project’s direct impact zone.

The Community Forest Program will focus on areas that already have been identified as interesting in a conservation perspective. One potential area is located in the catchment of the existing Yeywa reservoir, a short distance downstream of the proposed Middle Yeywa dam site. This area has been prioritised by the Forest Department and consists of the Pyin Oo Lwin Wildlife Sanctuary, a highly degraded habitat that is not properly protected, and the Mehon (Doke-hta Wady River) Key Biodiversity Area (KBA), which is home to the Endangered Green Peafowl (Pavo muticus). In addition, the Naung Lon Reserve Forest on the left bank of Myitnge River will be considered for community forest activities.

A number of interventions will be proposed and may include:

- Sustainable management of existing forests where villagers are allowed to extract firewood, posts and poles in accordance with established by-laws;
- Assisted regeneration of trees involving nurseries to raise seedlings;
- Agro-forestry practices on land that already has been converted to agriculture.

10.3 Overview of SMP Programmes and Activities

10.3.1 Stakeholder Engagement Plan

The overall goal of the Stakeholder Engagement Plan is to establish a platform and structure for an effective and continuous dialogue with all stakeholder groups. The consultative process in the villages will in the pre-construction and the construction phase will be focused on the planning of the community development initiatives (CDI), including access road improvement and grid connection.

For local businesses that are interested to utilize the increased market opportunities created by the Middle Yeywa HPP, public meetings will be arranged to inform them about the project planning process and in particular what kind of services and goods that will be required by the Project.

10.3.2 Compensation for Lost Land, Production and Fixed Assets

All affected assets, including building infrastructure and residential and agricultural land, will be surveyed and fully compensated. It is expected that the project components that to the largest degree will trigger compensation payments are the access roads from Nawnghkio to Yae Twin Gyi and further down to the dam site. Analysis by Google Earth has identified a total of 137 structures that may have to be relocated because of the widening of the access road. The analysis also indicate that losses of agricultural land largely can be avoided as the access road from Yae Twin Gyi to the dam site can be routed along an existing track across the agricultural fields on the plateau. However, some agricultural land may still have to be taken for the road construction while camps and project facilities may add to the loss of agricultural land. Preliminarily the he loss of agricultural land has been estimated at around 3.0 ha.

10.3.3 Social Management for Construction Areas

It is assumed that in-migrants and people who are seeking some kind of business opportunity in connection with the Project will seek accommodation in villages in the project area rather than settling in unmanaged camps close to the workers' camps.

Depending on the actual influx of people, there may be a need to improve water supply and sanitary conditions in the villages that receive in-migrants as well as organising an effective waste collection and disposal system. In addition, there will be other issues such as monitoring of births, mortality and illness.

10.3.4 Community Development Initiatives (CDI)

Community Development Initiatives, including upgrading existing village access roads and rural electrification, will be prosed by the Project. The main project access road from Nawnghkio to the project construction site via Yae Twin Gyi will be upgraded to a width of 5.5 m. In addition, access roads sections for the following right bank impact zone villages will be upgraded and improved:

- NR 41 to the village of Nawnghkio Gyi via several other village sites;
- NR 41 to Nawng Lin, Yae Maung Tan, Meh Poke and Nawnghkio Kone.

On the upper left bank the Project will consider improving and upgrading the access road from NR 41 to the village of Pin Ping via Thar Si.

In the lower left bank impact zone area, the section from Kyauk Ku on Road NR 41 to the village of Hpet Yin Kone via Tawng Hkan will be proposed for upgrading and improvement. Other villages along the road will also be able to benefit from this upgraded section.

The rural electrification program that will be part of the Community Development Initiatives will largely be focused on the same villages as those that will benefit from the upgraded village access roads. The villages that are proposed to be included in the rural electrification programme include:

- *Right Bank:* Ma Gyi Yae, Nawnghkio Gyi and villages along improved access roads, including Hpar Thun, Nyang Taw and Nawng Lin (1), Nawng Lin (2), Yae Maung Tan, Meh Poke, Nawnghkio Kone and Yae Twi Gyi;
- *Upper Left Bank:* Thar Si and Pin Ping;
- *Lower Left Bank:* Tawng Hkan and Hpet Yin Kone.

10.3.5 Workforce Recruitment and Employment

The goal of the workforce recruitment strategy is to ensure that the local population benefit from the employment opportunities created by the Middle Yeywa HPP. In order to ensure that are local workers are hired by the contractor the main measures to be implemented will include:

- A requirement in the tender documents and in the construction contact that the contractor should give preference to local labour over labour from outside the region, and also commit to a target of recruiting at least 30% of the total workforce locally;
- Compilation of lists of skilled and semi-skilled village and local able-bodied workers for presentation to the contractor.

The Project will also link up with the Human Resource Unit of the Department of Border Affairs and Development of National Races in Taunggyi to further explore possibilities of arranging skills training for trades such as carpentry, brick laying and rebar work. English skills training courses will also be considered.

10.3.6 Occupational Health and Safety

The overall goal of the occupational health and safety (OHS) measures is to safeguard the health of the workers and to prevent accidents leading to injuries. The contactors will have the responsibility for training all workers in work safety routines and provide them with the necessary personal protection equipment (PPE). The contractors will be required to prepare Occupational Health and Safety (OHS) plans for approval by the Developer, and to provide initial and refresher OHS training for all workers. The contractors will also be required to put in place emergency preparedness and response measures, including first-aid stations, fire-fighting equipment and evacuation plans in case of emergencies and serious accidents.

10.4 Implementation Team -Organisational Set-up and Staffing

10.4.1 Organisation and Objectives

In the project organisation of the Developer an Environmental and Social Unit (ESU) will be created to carry out the following activities and functions:

- To implement preventative measure to protect the environment as a result of the Middle Yeywa HPP;
- To recruit and employ skilled and experienced personnel to be responsible for organizing and overseeing all mitigation and benefit sharing programs;
- Be a channel for providing and controlling funds for the implementation of mitigation and benefit sharing programs;
- Carrying out environmental monitoring and supervision during the construction phase in cooperation with the contractor;

The ESU will be headed by an expatriate Environmental and Social Manager who will report directly to the Project Manager. A national Deputy Environmental and Social Manager will assist the

Environmental and Social Manager in the day-to-day implementation of the social and environmental programmes for the Middle Yeywa HEPP. The Deputy Environmental and Social Manager will have a special responsibility for following up and managing the national staff of the ESU. A separate Administration Team headed by a Senior Administrator that will ensure the smooth running and operation of the ESU.

The ESU will include five separate teams that will take responsibility for implementing the different mitigation activities and programmes described in in the EMP and SMP. Each of the teams will have a Team leader who will be assisted by 3- 4 specialists. The organisational set-up and composition of the SEU is illustrated in the figure below.

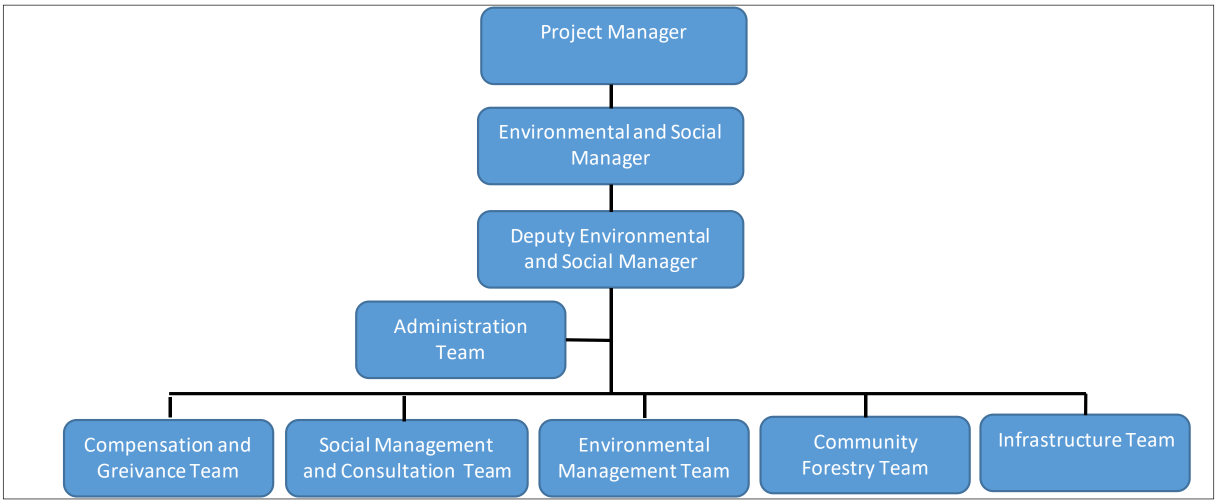


Figure 10-1: Set-up of the Social and Environmental Unit

10.4.2 Personnel Budget

The ESU will have to be established well ahead of the start-up of construction activities although recruitment of some professional staff may continue into the construction phase. It is assumed that the infrastructure team can be phased out after three years while the Community Forestry team can be recruited and formed one year later than the other teams. The table below presents the ESU budget for the operation phase. The total personnel budget amounts to 2 859 600 USD.

Table 10-1: ESU budget for the construction phase

	Personnel Category	Pre-constr.	Construction phase						Total
		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	**Environmental and Social Manager**	**120 000**	**120 000**	**120 000**	**120 000**	**120 000**	**120 000**	**120 000**	**840 000**
2	**Deputy Environmental and social Manager**	**60 000**	**60 000**	**60 000**	**60 000**	**60 000**	**60 000**	**60 000**	**420 000**
3	**Administation Team**	**30 000**	**30 000**	**30 000**	**30 000**	**30 000**	**30 000**	**30 000**	**210 000**
3.1	*Senior Administrator*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*84 000*
3.2	*Admin. assistants /secretaries (x3)*	*18 000*	*18 000*	*18 000*	*18 000*	*18 000*	*18 000*	*18 000*	*126 000*
4	**Compensation and Grievance Team**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**319 200**
4.1	*Teamleader*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*84 000*
4.2	*Specialists*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*235 200*
5	**Social Management and Consultation Team**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**319 200**
5.1	*Teamleader*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*84 000*
5.2	*Specialists*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*235 200*
7	**Environmental Management Team**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**319 200**
6.1	*Teamleader*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*84 000*
6.2	*Specialists (x4)*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*235 200*
8	**Community Forestry Team**	**-**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**45 600**	**273 600**
8.1	*Teamleader*	*-*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	*72 000*
8.2	*Specialists (x4)*		*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*33 600*	*201 600*
9	**Infrastructure Team**	**52 800**	**52 800**	**52 800**	**-**	**-**	**-**	**-**	**158 400**
9.1	*Teamleader (building / civil engineer)*	*14 400*	*14 400*	*14 400*	*-*	*-*	*-*	*-*	*43 200*
9.2	*Engineers / technicians (x4)*	*38 400*	*38 400*	*38 400*	*-*	*-*	*-*	*-*	*115 200*
	Total ESU Personnel	**399 600**	**445 200**	**445 200**	**392 400**	**392 400**	**392 400**	**392 400**	**2 859 600**

In the operation phase it is assumed that the Deputy Environmental and Social Manager will replace the expat Social and Environmental Manager while a social management specialist is retained to deal with upcoming issues. The Environmental Management Team along with the Community Forestry Team will continue to work with water quality management and follow-up and monitoring of biodiversity conservation and community forestry activities that are schedules to continue into the operation phase. It is expected that the staffing on the teams can be slightly reduced. The table below shows the budget for the operation phase.

Table 10-2: ESU budget for the operation phase

	Personnel Category	Operation phase					Total
		Year 1	Year 2	Year 3	Year 4	Year 5	operation
1	**Environmental and Social Manager**	**60 000**	**60 000**	**60 000**	**60 000**	**60 000**	**300 000**
2	**Administation Team**	**24 000**	**24 000**	**24 000**	**24 000**	**24 000**	**120 000**
2.1	*Senior Administrator*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	60 000
2.1	*Admin. assistants /secretaries (x2)*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	60 000
3	**Social Management Officer / Specialist**	**12 000**	**12 000**	**12 000**	**12 000**	**12 000**	**60 000**
4	**Environmental Management Team**	**37 000**	**37 200**	**37 200**	**37 200**	**37 200**	**185 800**
4.1	*Teamleader*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	60 000
4.2	*Specialists (x3)*	*25 000*	*25 200*	*25 200*	*25 200*	*25 200*	125 800
5	**Community Forestry Team**	**37 000**	**37 200**	**37 200**	**37 200**	**37 200**	**185 800**
51	*Teamleader*	*12 000*	*12 000*	*12 000*	*12 000*	*12 000*	60 000
5.2	*Specialists (x3)*	*25 000*	*25 200*	*25 200*	*25 200*	*25 200*	125 800
	Total ESU Personnel	**170 000**	**170 400**	**170 400**	**170 400**	**170 400**	**851 600**

10.4.3 Government of Myanmar Budget for Monitoring and Capacity Building

The Government of Myanmar (GOM) will be following up the Project through regular visits and meetings at site to monitor the progress of the construction activities and to discuss any upcoming issues. The visits will include annual high-level delegation visits from key ministries and departments at Union and State level.

The Project will also be committed to build capacities of key government staff at Union and State level through training workshops. The subject matters for the training workshops will be determined through further discussions with GOL.

Costs for per-diems, hotels, transport and meeting allowances have been stipulated as shown in the table below. The tentative GOL budget amounts to 298 100 USD

Item	Pre-constr.	Construction phase						Total
	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
Transportation costs for Meetings and site visits (Union, State and township officials)	6 500	6 500	6 500	6 500	6 500	6 500	6 500	45 500
Per diem for all GOM staff site visits and meetings at site	10 200	10 200	10 200	10 200	10 200	10 200	10 200	71 400
Overnight costs for Union and State official visits (reduced after camp accommodation completed)	9 600	9 600	4 800	4 800	4 800	4 800	4 800	43 200
Training and Workshops at Union Level (rental of facilities)	6 000	6 000	6 000	6 000	6 000	6 000	6 000	42 000
Training and Workshops at State Level	6 000	6 000	6 000	6 000	6 000	6 000	6 000	42 000
High-level delegation visits (ca. 15 people for one overnight visit) - food and fuel costs	12 000	12 000	6 000	6 000	6 000	6 000	6 000	54 000
Total GOL budget	**50 300**	**50 300**	**39 500**	**39 500**	**39 500**	**39 500**	**39 500**	**298 100**

10.4.4 EMP and SMP Budget Summary

The total costs for implementing the EMP and SMP, including personnel and GOM costs will amount to 13 261 450 USD as shown in the table below.

No	Item	Pre-constr	Construction Phase						Total
		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	Pesonnel Costs - ESU	399 600	445 200	445 200	392 400	392 400	392 400	392 400	2 859 600
2	Government of Myanmanr Costs	50 300	50 300	39 500	39 500	39 500	39 500	39 500	298 100
3	Environmental Management Plan Costs	130 000	100 000	100 000	110 000	265 000	265 000	185 000	1 155 000
4	Social Management Plan and Community Initiatives	492 000	1 853 000	2 418 750	1 987 500	1 002 500	1 002 500	182 500	8 938 750
	Total EMP/SMP Costs	**1 071 900**	**2 448 500**	**3 003 450**	**2 529 400**	**1 699 400**	**1 699 400**	**799 400**	**13 251 450**

11 ENVIRONMENTAL MANAGEMENT PLAN

11.1 Introduction

11.1.1 Overall Goals and Objectives

The overall goal of this Environmental Management Plan (EMP) is to prescribe a programme implementation of effective environmental mitigation measures, including:

- Formulating actions and measures that will avoid and mitigate the negative impacts on the physical and biological environments that have been identified and described during the EIA studies (see chapter 7 of this report);
- Identify measures to enhance the value of environmental resources where feasible;
- Provide a structure for monitoring of the negative impacts as well as evaluation of the effectiveness of the implemented mitigation measures;
- Provide a structure for monitoring to uncover unexpected negative impacts so that mitigation strategies can be modified to address such potential impacts;
- Identify roles and responsibilities for the implementation of the EMP.

The EMP is based on the information available at the present stage of project planning. In the detailed project planning phase, introduction of new elements and changes in the project layout or proposed operation may necessitate a revision of this EMP accordingly through more detailed action plans.

11.1.2 Roles and Responsibilities

SN Power as the Developer will have the overall responsibility for making sure that the EMP is implemented in an appropriate manner. However, mitigation activities may be carried out fully or partly by other organisations/institutions such as the contractors, local government agencies and non-governmental organisations (NGO), in agreement with SN Power.

11.1.3 Staffing and Organizational Aspects

As presented in Chapter 10, the Developer will establish an Environmental and Social Unit (ESU) with an Environmental Management Team that will be implementing some selected mitigation measures and in addition have a monitoring function vis-à-vis the contactors and any other implementing partners, acting in agreement with the Developer. The Environmental Management Team will be staffed by a Team Leader and 3 to 4 environmental officers with different specialisations.

11.2 Construction Environmental Management Plan

11.2.1 Roles and Responsibilities

With regard to implementation of construction related mitigation measures, the main contractor will be responsible for avoiding or minimising environmental impacts. The contractor will develop and implement detailed management and monitoring plans for specific construction activities (hazardous materials management, hazardous and non-hazardous waste management, pollution spill contingencies, erosion control, emergency preparedness and response, spoil management, blasting management, river diversion management, etc.) to be approved by the Developer.

11.2.2 Staffing and Organisational Aspects

The contractors will be required to hire environmental officers/specialists in environmental engineering for the controlling, monitoring and reporting on the implementation of mitigation activities under the contractor’s responsibility. The contractors’ environmental officers will work in close collaboration with the Environmental Management Team of the ESU.

11.2.3 Obligations in the Tender Documents

Contactors that intend to bid for the Middle Yeywa HPP construction contracts will be required to respond to the environmental obligations as specified in the tender documents, including those set-out in the EIA Report (EMP and SMP) and any subsequent additional requirements defined by lenders or authorities in Myanmar. In particular, bidders will have to provide details on how they will operationalise and in practical terms, safeguard the environment at the construction sites and to avoid or minimise all negative environmental impacts that are associated with construction of the hydropower plant including associated infrastructure.

In particular, the prospective contractors will be required to describe how they will:

- Provide the Developer with adequate information for ESU disclosure and public consultation activities with the local population relating to environmental (or social) matters pertaining to the Works;
- Implement and comply with the environmental (and social) requirements specified in the EIA;
- Ensure that the subcontractors implement and comply with the specified environmental requirements;
- Carry out the supervision and monitoring of construction activities, including the activities that are undertaken by sub-contractors;
- Assist the Developer in establishing an effective mechanism for storing and communicating environmental information;
- Report all grievances to the ESU in order to record all complaints from affected groups of persons and local communities and the measures to be taken by the contractor to address and/or mitigate the complaints;
- Provide training to their own and the subcontractor’s employees and personnel on the environmental requirements of the EMP.

11.2.4 Specific Activities

Spoil Disposal

The objectives for spoil disposal and management during construction of the Middle Yeywa HPP are to maximise re-use of spoil and to minimise potential adverse impacts of spoil disposal on air and water quality.

The excavation will result in the generation of large amounts of spoil (material from tunnelling and excavation). It is expected that some of the spoil can be used for construction purposes but this will be limited. Depending on the content of the spoil it may in some cases also be used as coarse aggregate for concrete.

Environmental issues associated with spoil disposal include:

- Loss of land to allow placement of stockpiles;
- Erosion and sediment transport from stockpiles;
- Wind erosion of fine particles from stockpiles affecting air quality in their surroundings;
- Impacts on visual amenity making the landscape less aesthetically attractive;
- Impacts on water quality resulting from low pH in the surface runoff and drainage from the spoil stockpiles and deposits.

The day-to-day management of spoil disposal will primarily be the responsibility of the contractor, but spoil disposal (or storage) site selection and potential reuse of spoil will be the responsibility of the Developer. The following measures are recommended to minimise the impact of spoil disposal:

- Maximise re-use of spoil in construction activities;

- Clearly mark spoil disposal areas on maps at the construction sites and keep them displayed throughout the construction period;
- Remove top soil from spoil disposal areas and stockpile to be used in later revegetation and rehabilitation work;
- Locate spoil disposal areas away from flood zones;
- Appropriately contour and compact spoil disposal piles to prevent erosion and sediment transport; and
- Install appropriate drainage around spoil disposal areas to ensure that run-off is captured to allow monitoring and treatment, if necessary, prior to release to the environment.

In addition to the above, measures mentioned in sections of the EMP with regard to sediment management, air quality and site erosion and sediment control (see below) will be implemented at spoil disposal areas.

There is a possibility that the rock spoil will be disposed of behind the dam in the future reservoir area. In that case, the rock material from the excavations (drill and blast) shall be tested for heavy metals and ammonia/nitrogen contamination before such decision is taken. Washing of the waste rock prior to disposal shall be considered, if deemed necessary based on test results.

Sediment Management

All the water draining down from tunnelling operations and quarry sites needs to be lead to sedimentation and neutralisation ponds with sufficient retention time and has to be treated before releasing it to the recipient water body. Similarly, all the waters from the batching plants, the concrete mixer washing facilities and the crusher plants needs to be collected and treated before releasing to the environment.

Sedimentation controls shall be implemented in the form of silt trap fences, sedimentation ponds and drainage channels where appropriate. These shall be built prior to the start of the activity and shall be maintained until the completion of that activity. All structures including silt fences, bunds and sediment basins need regular maintenance to remove silt.

Desilting of sedimentation ponds or silt trap shall be initiated when 75% of the total storage is filled through sediment build-up. The silt trap shall have the design capacity accordingly to the requirement. Ineffective drainage during wet weather shall be promptly corrected. Any discharge from the silt trap to the existing drainage system and rivers shall be less than 50 mg/l of TSS.

For in-stream works, isolation techniques such as berming or diversion shall be used during construction to limit the exposure of disturbed sediments to moving water. The duration and timing of in-stream activities shall be restricted to periods that are not critical to biological cycles of valued flora and fauna (e.g., migration, spawning, etc.). During in-stream construction periods, water turbidity immediately downstream shall be monitored.

Coffer dams shall be constructed such as to minimise releases of sediments and pollutants to the downstream environment (e.g. avoiding low flow periods and rock material with high content of fine particles).

Quarry Management

The objective of the managing the quarrying operations is to minimize adverse effects in terms of noise, sediment runoff and air quality. Management plans for quarry sites for aggregate and borrow pits for sand will have to be prepared prior to operation, including assessment of mitigation measures and procedures for closure of the quarries. Specification for the use of quarries and borrow areas will be incorporated into the construction contracts.

The management plans for the quarry sites will:

- Describe the measures taken to minimize the quarry and borrow areas and the efforts needed to reduce the visual impacts.
- Specify the measures needed to re-establish vegetation and re-establish natural water courses and drainage pattern at the sites.

The contractor will be responsible for the management of the quarries and borrow areas in accordance with the provisions of the management plans.

Chemical Waste and Spillage

The contractor shall develop a detailed Chemical Waste and Spillage Management Plan for collection, transport and handling/storage of construction waste. The plan will also include implementation and monitoring of the use of waste. Materials and chemicals that will be used during the construction such as explosives, fuel and oils, paints, sol-vents, acids and concrete additives will be included in the plan.

Some of the requirements in the plan will be:

- Strict conditions on handling and storage of fuel, explosives and other chemicals should be imposed on the contractors and suppliers to prevent accidental pollution and injury;
- The contractor shall keep a detail log of all chemical materials and waste materials to be audited regularly by ESU and HSE inspection teams;
- Storage areas for fuel and other hazardous materials as well as hazardous waste shall be roofed and have a concrete floor with a bund for secondary containment and collection of spills proving at least 110% volume of the total capacity of the stored materials/waste;
- All storage areas and major construction sites shall have spill kits, sand, dust, and other appropriate absorbent materials;
- Facilities have to be constructed for collection of waste oil products. The locations for machinery and vehicles repair, maintenance and washing should be equipped with concrete floors and provided with oil skimmers and collection facilities. The oil collected in this manner should be disposed of or re-used safely;
- The diesel shall be stored in a standard skid tank with concrete bunker, which provided 110% volume of the total capacity of the tank. The skid tank shall be located at least 100 meter away from any watercourse;
- The contractor shall establish a standard procedure for loading the diesel into the skid tank to prevent any oil spillage and soil contamination from occurring. The site supervisor or engineer shall regularly monitor and check the skid tank to ensure that the diesel is handled in accordance with the specification and no spillage occurrence;
- Spent oil or used oil generated from the workshop maintenance yard shall be categorized as hazardous waste. This type of hazardous waste is to be stored in containers, with proper bunds, which are able to prevent spillage or leakage into the environment;
- The containers of the scheduled wastes shall be clearly labelled in accordance for identification and warning purposes;
- The contractor shall engage a licensed contractor to collect, transport and dispose of all the waste oil and other hazardous waste generated at the project site;
- The oily waste should not be allowed to be used for uncontrolled burning or heating or the workers camps, or to be spread on roads or dumpsites for dust control.

Emergency Plan for Hazardous Materials Handling and Disposal of Hazardous Wastes and Materials

The main contractors will prepare an Emergency Plan for hazardous materials used or stored on site. The Emergency Plan will cover:

- Procedures for immediate actions specified for all relevant hazardous materials used in the construction processes;
- Complete list of equipment available for use in emergency situations;
- Procedures for neighbours and downstream warning in cases of accidental release of hazardous substances;
- Procedures for immediate warning and notification in case of discharges and standards for reporting irregular events.

Camp and Site Waste Management

The contractor must develop a detailed Household Waste Management Plan for collection, transport and handling/storage of household waste to minimise the pollution associated with handling and disposal of domestic waste at the construction sites and camps in order to avoid water pollution, spreading of diseases by vectors.

Some of the requirements in the plan will be:

- Waste collection containers should be placed at regular intervals at the project site and in workers camps. These containers should be marked with clear labels for 'organic', 'paper' and 'other waste' for sorting waste collection;
- Garbage shall regularly be collected and disposed at designated sites;
- Waste disposal sites shall be located above the 20 year flood levels and at least 2 km from the nearest village;
- The disposal sites should be protected from contaminating groundwater by an impermeable membrane or clay. Leachate shall be collected and properly treated before released into water courses.

Once a week the disposal sites shall be compacted and covered with soil. At closure the site shall be covered with at least 1.5 m of topsoil.

Waste Water Management

The contractor will develop a Wastewater Management Plan with the objective of properly managing liquid waste from construction activities.

Wastewater from the camps and offices must be collected and properly disposed of. The sanitary water and the grey water (used household water) should be kept separate. The grey water should be infiltrated in the ground at sites with soils of suitable filtering capacity and minimum 500 m away from water courses and water supply springs in the area.

The sanitary water should be treated by Compact Treatment Units or by septic tanks before infiltration. Such units shall be installed at each short term work site employing 5 workers or more. At least one chemical portable toilet shall be installed for each 20 workers. The contractors shall maintain the toilets in a clean and sanitary manner.

All wastewater shall be treated in such a way that the discharged effluent meets the requirements specified in the table below.

Table 11-1: Sanitary Sewage Discharge Standards.

Indicative Values for treated Sanitary Sewage Discharges		
Pollutants	**Unit**	**Guideline Value**
pH	pH	6-9
BOD	mg/l	30
COD	mg/l	125

Indicative Values for treated Sanitary Sewage Discharges		
Pollutants	**Unit**	**Guideline Value**
Total nitrogen	mg/l	10
Total phosphorus	mg/l	2
Oil and grease	mg/l	10
Total suspended solids	mg/l	50
Total coliform bacteria	MPN/100 ml	400

Source: World Bank Group EHS Guidelines (2007)

Emission, Dust and Noise Control

The objective for the management of air quality, noise and vibration during the construction phase of Middle Yeywa HPP is to prevent nuisance and health and safety effects on the workers and on nearby communities and to limit as far as possible the adverse impacts on the natural environment due to poor air quality and potential noise impacts associated with the construction activities.

Poor air quality caused by dust and exhaust fume emissions from construction traffic and operation of heavy machinery as well as elevated noise levels from the construction activities will inevitably cause disturbance to local communities and reduce the quality of life of inhabitants of these communities. The closest sensitive receptors for potential air quality and noise impacts include villages along the access roads and the village of Yae Twin Gyi which is the village nearest to the dam construction site.

The main construction activities that are likely to generate dust and noise emissions include:

- Vegetation stripping and subsequent wind erosion from exposed areas;
- Use of excavators, loaders and bulldozers;
- Compacting, concreting;
- Quarrying, drilling and blasting;
- Concrete mixing and batching plant;
- Dumping spoil and waste;
- Vehicle movement on construction access roads;
- General domestic noise from the project campsites.

An Emissions, Dust and Noise Control Plan will be prepared by the contractor and shall be based on international standards for ambient concentrations of particulate matter. The plan will identify all relevant places for dust control and monitoring. This include roads, quarry sites, crushing and concrete batching sites, earthworks, waste burning sites, etc.

Air quality: For the local communities along the access roads dust generated by construction related traffic is likely to be the main air quality issue but emissions of exhaust gasses containing noxious and toxic substances, such as carbon monoxide (CO) and hydrocarbons from incomplete combustion, nitrogen oxides (NOx) and particulate matter (mostly soot) will add to the air quality problems. Dust can potentially result in health impacts by exacerbating existing respiratory conditions, such as asthma or respiratory infections. Dust emissions on access roads can also create a safety risk by decreasing visibility. Dust deposition may also lead to decreased crop yields and productivity. Air quality impacts will be most pronounced in the dry season and affect villages or people living within a 500 m of the unpaved access roads and tracks.

The following activities should be implemented to limit and reduce the air quality impacts associated with construction related traffic and construction activities:

- Seal roads or water dirt roads using water carts to minimise the generation of dust;

- The frequency of water spraying shall be fixed 2 to 3 times per day for normal weather conditions. The water spraying frequency shall be increased to about 4 to 6 times a day during dry and windy seasons;
- Obsolete roads to be ripped and re-vegetated unless to be made available for community use;
- Impose and enforce speed limits through villages and speed bumps to reduce traffic in populated areas, especially in the vicinity of schools;
- Keep land clearing and topsoil removal to a minimum and rehabilitate cleared land, as soon as practicable;
- Where possible, do not undertake activities such as loading and dumping of topsoil and spoil during high winds;
- Conduct topsoil stripping at times when soil moisture can be expected to be optimal to minimize dust formation while minimising erosion risks, such as after moderate rains or after sprinkling of water;
- Regularly maintain vehicles with tires kept at the recommended pressure;
- Access tracks used for topsoil stripping and spoil transport equipment to be watered in the dry season during their loading and unloading cycle;
- Long term topsoil stockpiles (not used for over 6 months) to be re-vegetated;
- Contour and revegetate spoil disposal areas to minimize erosion of exposed surface areas;
- Use of dust aprons during drilling;
- Drills to be equipped with dust extraction cyclones, or water injection systems;
- Water injection or dust suppression sprays to be used when high levels of dust are being generated;
- During the construction phase, it is recommended that dust monitoring be undertaken at sensitive receptors (villages) to assess the effectiveness of management and mitigation measures.

Recommended measures to minimise harmful vehicle emissions include:

- Regular maintenance of vehicles (in accordance with the vehicle manufacturer's instructions);
- Regular review of tyre air pressure;
- Vehicles will be prohibited from idling in residential areas and engines must be turned off when the vehicle is parked near residences, offices or eating areas;
- Use of low-lead / unleaded fuels;
- Provide proper driving instructions and increasing the awareness of engine maintenance to drivers and operators;
- Management of traffic through residential areas to prevent vehicles from making sudden stops and starts.

Ambient air quality monitoring of the particulate matter in the air shall be carried at villages where construction traffic is passing through and at constructions sites and stone crushing plants where workers will be are exposed to dust emissions and high dust levels in the air. It is recommended that at least As Particulate Matter (PM10) levels are monitored as this particle size is easily inhaled and lodged in the lungs.

The air quality at construction sites shall comply with the guidelines for particulate matter issued by the WHO. If the air quality monitoring shows that the particulate matter values recurrently exceeds the guidelines then additional measures shall be taken by the contactor to bring the PM10 values down. The WHO guidelines are shown in the table below.

Table 11-2: WHO Standard for Particulate Matter.

WHO Ambient Air Quality Guidelines		
	Averaging Period	**Guideline Value in µg/m³**
Particulate Matter (PM_{10})	1-year 24-hour	20 50
Particulate Matter ($PM_{2.5}$)	1-year 24-hour	10 25

Source: World Bank Group EHS Guidelines (2007)

Noise: From a noise perspective, the construction of the Middle Yeywa dam and power house will be located at the lower parts of the narrow Myitnge River valley and therefore some noise attenuation from the steep forested hillsides is likely. The only sensitive noise receptors are the villages located along the access roads. Recommended measures for avoiding and minimizing generation of noise in connection with the construction activities include:

- Combine noisy operations to occur during the same time period, if possible;
- Construction activities in populated areas (along the roads) shall be limited to day time and evening hours (06:00 to 22:00);
- Noise control devices such as silencers and mufflers to be fitted to exhausts, radiators, compressors and fans;
- Speed limits to be enforced through villages and the application of speed bumps;
- Locate noise sources to less sensitive areas to take advantage of distance and shielding (if possible);
- Monitor noise at sensitive receptor areas (villages, built up area) to assess the effectiveness of management and mitigation measures;
- Identify and enforce a blast exclusion zone (approximately 400 m diameter around the blast area);
- Blasting to be conducted during the daytime;
- Implement access controls along construction roads, prior to blasting to ensure that no unauthorised vehicles or pedestrians are present in the exclusion zone.

The plan for noise and vibration control and monitoring will be based on international standards as shown in the table below.

Table 11-3: WHO Noise Level Guidelines.

Noise Level Guidelines		
	One Hour L_{eq} (dBA)	
Receptor	**Daytime 07:00–22:00**	**Night time 22:00-07:00**
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Source: IFC EHS Guidelines (2007)

Noise and vibration level monitoring shall be carried out at the rock quarrying site and diversion tunnel areas due to the activities involving rock blasting. Monitoring shall also be carried at villages with heavy construction traffic.

Noise level measurement shall be carried out quarterly. However, if the noise levels exceed the permissible limits recommended by WHO or when there are complaints from the public, then the monitoring frequency shall be increased. This may occur along the access roads where noise level measurements shall be done on a weekly basis.

Traffic and Access Management

An On-site Traffic and Access Management Plan will be prepared by the contractor with the objective of avoiding traffic accidents and reducing the risk for construction traffic incidences.

The plan will include:

- Speed limits for different sections of the road network;
- Speed bumps in populated areas;
- Specification of parking sites for the construction vehicle fleet;
- Specific plans for hauling heavy loads and hazardous materials;
- Control measures to avoid unauthorised access to construction sites;
- Signalling and warning measures.

As a minimum, the plan must comply with the following requirements:

The Contractor and Sub-contractors shall make sure that their vehicles will not be operated unless:

- Vehicle is fit for purpose, inspected and confirmed to be in safe working order;
- System for annual inspection and control of all vehicles is in place;
- Number of passengers does not exceed manufacturer's specification for the vehicle;
- Loads are secure and do not exceed manufacturer's design specification or legal limits for the vehicle;
- Seat belts are installed and worn by all occupants.

The Contractor and Sub-contractors shall make sure that drivers are not authorised to operate the vehicle unless:

- They are trained, certified and medically fit to operate the class of vehicle;
- They are not under the influence of alcohol or drugs, and are not suffering from fatigue;
- They do not use hand-held cell phones and radios while driving.

The contractor shall take every possible precaution to prevent its operations from damaging public roads in the vicinity of the project area. Moreover, the contractor shall implement a maintenance program for access roads carried out before rainy season (cleaning gutters, improvement of the road if necessary, etc.).

The Developer will in cooperation with the local road authorities be responsible for adequate signage, warnings and controls, including speed limits. The contractor will be responsible for e ensuring that all vehicles, equipment and materials that are required to pass through urban areas and villages are operated and loads transported safely without endangering these communities. Special caution has to be taken in front of schools where children suddenly cross the street. In the villages, animals and pedestrians have the right of way.

All loads are to be secured and all loads with fugitive dust producing materials (e.g. excavated soil and sand) are covered with tarpaulins.

The contractor shall ensure that drivers have reasonably timed delivery schedules so as to allow them to operate within government mandated speed limits.

The contractor shall develop specific procedures for moving special loads, such as hazardous material, or heavy loads. Maximum load restrictions shall be developed and enforced.

The contractor when entering into any sub-contract for the execution of any part of the construction works or the supply or transport of heavy loads, materials or spoil shall incorporate in any such subcontract provisions requiring the sub-contractor or supplier to comply with the traffic and transportation safety requirements.

Reinstatement of Camp and Construction Sites (Landscaping and Restoration)

The contractor will prepare a Landscaping and Erosion Protection Plan encompassing the construction areas, camps, access road, etc. The objective will be to reshape the landscape and the vegetation for erosion control and for the visual amenity and landscape aesthetics. Remediation under this plan shall be implemented as soon as possible after the different construction activities have ended so that bare soil will not be exposed during the wet season.

The plan will be based on the following:

- All land where the natural vegetation has been destroyed or damaged shall be restored as far as possible to its initial status with original drainage patterns restored;
- Spoil heaps shall be profiled to allow for future use and erosion protection;
- Excavated topsoil shall be stockpiled and used for landscaping and construction site reinstatement;
- Only indigenous and preferably local plant species shall be used for replanting and erosion control.

11.2.5 Budget and Schedule

Recruitment of requisite staff and specialists for landscaping and erosion control will be part of the costs for the contractor and the sub-contractors and the implementation arrangements to be approved by the Developer. The costs for implementation of the Construction Environmental Management and Monitoring Plan will be integrated in the overall construction costs. A separate budget has therefore not been indicated as implementation of the mitigation measures and the monitoring activities will be part of the environmental requirements specified in the tender documents which the prospective contractors will have to take into consideration in their pricing of their bids for the construction contract.

The scheduling of the implementation of mitigation activities will be determined by the progress of the construction activities.

11.3 Water Quality Monitoring Plan

11.3.1 Overall Goals and Objectives

The purpose of the water quality monitoring program will be to document the water quality changes resulting from the Middle Yeywa project, including those resulting from the construction phase activities and those that are a consequence of the establishment of the reservoir and the operation of the power plant. This will be closely integrated with the aquatic ecology and fisheries management plan.

The construction phase water quality issues include:

- Risk of discharge of hazardous chemicals;
- Discharge of domestic wastewater and sewage from work sites and camps;
- Sediment loads from construction activities;
- Water quality changes caused by decomposition of organic materials during filling of the reservoir.

The operational phase water quality issues include:

- Downstream changes in sediment transport and associated water quality characteristics.

- Risks of eutrophication and oxygen depletion in parts of the reservoir and release of oxygen deficient water downstream in the event that strong reservoir stratification in the water column develops combined with extensive decomposition of organic matter;
- Downstream changes in water temperature;

The mitigation measures related to the issues above are dealt with in other sub-EMPs including the Construction Environmental Management Plan and the Reservoir Clearance and Filling Plan. The main objective of the water quality monitoring is to provide checks on the performance of those mitigation measures, to uncover potential unexpected developments and to identify corrective measures if needed.

11.3.2 Roles and Responsibilities

SN Power will be overall responsible for the water quality monitoring and will enter into an agreement with an accredited water quality laboratory in Myanmar for analysis and interpretation of water quality samples throughout the construction and operation phases of the Project.

The results of the water quality monitoring and, if relevant, reports on accidental pollution events, will be summarised in bi-monthly reports and made available to relevant GoM agencies. In the unlikely event of dramatic developments and pollution incidents (oil spills, development of massive oxygen depletion, etc.), the regulatory agencies will be notified without delay by SN Power.

11.3.3 Staffing and Organisational Aspects

The water monitoring sampling and assessment will be carried out by the Environment Management Team, with support from specialised entities, which will be staffed with at least one officer with competence and experience within the field of water quality sampling and assessment. Additional staff should be trained in sampling, storage and transportation techniques of water samples as needed. The Environmental Management Team together with contracted specialised entities will be adequately equipped with all means necessary to carry out the monitoring programmes. This includes:

- Sampling equipment;
- Field measurements and field testing kits;
- Storage and transportation material;
- PC for data storage and processing;
- Transport (car, boat, etc).

11.3.4 Specific Activities

Methodology and Quality Control

Any water quality monitoring system has to be specifically responsive to types of parameters to be measured and desired outcomes of the testing. Water quality monitoring will provide reliable data that can be used to inform decision-making concerning mitigation strategies.

The water quality monitoring objectives for this EMP would be:

- Detecting trends;
- Monitoring critical conditions (annual maximum or minimum values of certain water quality constituents);
- Monitoring any violation of standards.

The objectives will determine sampling sites, frequency, duration of monitoring and the need for specific up-front recipient studies.

Quality assurance is vital to all monitoring systems. A system of quality control has to include (i) technical manuals describing in detail the procedures of water sampling, sample transport and storage, analytical methods, "metadata" requirements, and (ii) an inter-calibration procedure for laboratories involved in the monitoring activities. Monitoring protocols and programs should be established as soon as possible in order to improve the water quality baseline, for better to assess the changes caused by the power plant.

Water Quality Monitoring Stations

Construction phase:

- As much as possible the same stations as for the EIA study (see map in Figure 6-24 above) but complemented with high risk sites in light of contractors facilities and work plans.

Operation phase:

- Upstream of the tail end of the Middle Yeywa reservoir (surface water);
- Gotheik Tributary
- Myitnge bridge (surface water + 3 depths);
- Middle Yeywa dam (surface water + 5 depths);
- Downstream of tailrace outlet (surface water);
- In addition: collaborate with operator of Yeywa dam and Upper Yeywa to collect water samples from the respective reservoirs (surface + 3 depths).

Water Quality Parameters – Frequency and Compliance Levels

The water quality parameters recommended for inclusion in the monitoring system are indicated in Table 11-4: List of proposed monitoring parameters (methods may be revised later). The parameters include standard pollution indicators as well as parameters relevant to the oxygen and the eutrophication situation in the reservoir and a few other parameters not relevant for the project's impacts but of interest for contributing to a more comprehensive picture of the water quality situation in the basin as a whole. The construction phase parameters and the operation phase parameters will be slightly different in order to reflect the unique risks for the specific phases. The list of parameters may be revised in light of water quality test results to ensure that the most important issues are well covered.

Table 11-4: List of proposed monitoring parameters (methods may be revised later).

Parameter	Symbol	Unit	Method	Measured
Temperature air	T_{air}	ºC	SM 2550 B	On site
Temperature water	T_{water}	ºC	SM 2550 B	On site
pH	pH		SM 4500 –H B	On site
Turbidity		FTU	ISO 7027	In laboratory
Dissolved Oxygen	DO	mg/l	SM 4500-O G (Probe)	On site
Saturation Oxygen	Sat O_2	%	YSI Probe	On site
Nitrite + Nitrate Concentration	$NO_2 + NO_3$	mg/l	SM 4500-NO3 E	In laboratory
Total Nitrogen Concentration	Tot – N	mg/l	SM 4500-Norg(Macro-Kjeldahl)	In laboratory
Orthophosphate Concentration	PO_4 – P	mg/l	SM 4500 – P E	In laboratory
Total Phosphorus Concentration	Tot – P	mg/l	SM 4500 – P B+E	In laboratory
Chemical Oxygen Demand	COD	mg/l	Permanganate method	In laboratory
Biological Oxygen Demand	BOD	mg/l	Permanganate method	In laboratory
Faecal Coliform		no/ml	SM 9222 B (Membrane filter)	Within 24 hours
Alkalinity (as CaCO3)	Alk	mg/l	SM 2320 B	In laboratory

Parameter	Symbol	Unit	Method	Measured
Calcium Concentration	Ca	mg/l	SM 3500 – Ca-B	In laboratory
Magnesium Concentration	Mg	mg/l	SM 3500 – Mg-B	In laboratory
Sodium Concentration	Na	mg/l	SM 3111 B	In laboratory
Potassium Concentration	K	mg/l	SM 3111 B	In laboratory
Chloride Concentration	Cl	mg/l	SM 4500 – Cl C	In laboratory
Electric Conductivity	EC	Ms/m	SM 2519	On site
Total Suspended Solids	TSS	mg/l	SM 2540 D	In laboratory
Chlorophyll	Ch-a	Ms/m	Acetone extraction/ spectrophotometer	In laboratory
Algae	Algae	No./ml	Microscope counting	In laboratory

Compliance levels will be determined with reference to ASEAN classification (***Table 11-5***) and the World Bank Group effluent water standards (***Table 11-1***).

Table 11-5: Classification of river water (adopted by ASEAN).

Parameter	Class I: Potable Water	Class II: Recreation	Class III: Commercial Fisheries	Class IV: Irrigation
pH	6-9	6-9	5-9	5-9
BOD (mg/l)	5	5	10	10
COD (mg/l)	30	30	100	100
Amm – N (mg/l)	0.3	0.3	1	3
TSS (mg/l)	50	50	150	300
DO (mg/l)	5	5	3-5	3
Faecal Coliform (counts/100) ml)	-	1000	-	-

Monitoring frequency:

- Bi-monthly during construction;
- Semi-annually during early operation.

In addition, more frequent and targeted monitoring will be carried out in conjunction with high risk activities during the construction phase.

Possible Mitigation Interventions

In the case of accidental or planned pollution events during construction or operation, including releases of large quantities of anoxic water from the reservoir or sediment flushing, such incidents have to be registered and reported, and timely notification given to any affected water users in the downstream.

11.3.5 Budget and Schedule

The cost for the water quality program has been estimated at 10 000 USD per year in the construction phase and the first two years of operation, and 5000 USD per year in the subsequent early operation phase. With an estimated construction time of 6 years the total cost of water quality monitoring will be 60 000 USD for the construction phase.

11.4 Aquatic Ecology and Fisheries Management Program

11.4.1 Introduction

During the construction phase, the aquatic ecosystem of the Myitnge River will be impacted in localised construction areas and immediately downstream. The aquatic ecosystem will effectively be transformed over a 70 km section after filling of the reservoir and moving into the operation phase. In addition, the short but varying length of river section between the Middle Yeywa dam site and the downstream Yeywa reservoir will experience significant impacts due to peaking and later also intermittent sediment flushing from the Middle Yeywa reservoir. The Developer is considering placement of substantial volumes of rocks in the river for a 1 km distance downstream of the tailrace in order to meet a potential requirement from the Government of Myanmar for a 'free flowing' river section between the Yeywa reservoir and the Middle Yeywa dam. This can potentially cause further negative impacts unless the works are purposely designed to serve ecological functions.

Importantly, the riverine ecosystem has already been profoundly impacted by the downstream Yeywa Hydropower Project, its dam and its large reservoir. The Upper Yeywa Hydropower Project is currently under construction immediately upstream of the proposed Middle Yeywa Project and is also having significant impacts on the river system prior to the potential construction of the Middle Yeywa Hydropower Project.

This Aquatic Ecology and Fisheries Management Programme outlines the goal and objectives, summarise the main adaptations in project design to avoid and minimise impacts as well as the proposed mitigation and monitoring measures. Division of roles and responsibilities is described along with staffing and organisational aspects. The main activities and indicative budgets are summarised.

The limited available information on the affected aquatic ecosystems means that the programme should be updated following further clarifications on project design and further aquatic ecology data collection. Ideally, further data collection should include the existing Yeywa reservoir that can give valuable indications about the likely future developments in the Middle Yeywa reservoir.

11.4.2 Overall Goal and Objectives

The overall goal is to avoid and minimise impacts on the aquatic ecosystems through project design modifications, mitigation and enhancement measures, and monitoring.

The objectives of the Programme are:

- Develop and implement measures that reduce impacts on the aquatic ecosystems, and the people who rely on its ecosystem services, to acceptable levels;
- Monitor and document changes in aquatic ecosystem dynamics, species composition and abundance, and ecosystems services provided, in particular the opportunities for fishing;
- Use monitoring results to inform decision-making on adjustments to project operation, mitigation and enhancement measures and future monitoring;
- Assess the feasibility of supporting sustainable fishing activities in the reservoir. If considered feasible, develop and implement a fisheries management plan.

The programme will focus on the proposed reservoir area, the river section between the Middle Yeywa dam and the downstream Yeywa reservoir as well as the Gotheik tributary on the right bank in the upper section of the Middle Yeywa reservoir. For the purpose of detailing this programme, surveys are also recommended in the existing Yeywa reservoir. It should also be noted that future analysis of cumulative impacts along the Myitnge River may provide information for the Myanmar Government in terms of wise operation of the cascade including Upper, Middle and Lower Yeywa Hydropower Projects. Regimes for cascade operation may necessitate a revision of this programme.

The Aquatic Ecology and Fisheries Management Programme will be closely coordinated with the Reservoir Clearance and Filling Plan, the Construction EMP, the Water Quality Monitoring Plan and the

Compensation/Livelihood Restoration Plan for project affected persons (PAPs) having their fishing activities impacted by the Project.

11.4.3 Roles and Responsibilities

SN Power, through the ESU, will be overall responsible for the implementation of the Aquatic Ecology and Fisheries Management Programme. Specialised tasks are likely to be outsourced to national and/or international experts with the SN Power remaining ultimately responsible, including to provide updates and reports to stakeholders. The detailed roles and responsibilities will be developed as part of establishing the ESU for the Project.

11.4.4 Staffing and Organisational Aspects

The team implementing this programme will likely be an integrated team working on the Water Quality Monitoring Programme, which will have critically important linkages to the Aquatic Ecology and Fisheries Management Programme. Specialists involved, most of whom are likely to be short-term consultants, will likely include a fish biologist, a macro-invertebrates expert, a micro-invertebrates expert and an aquatic vegetation expert, in addition to experts from the water quality team. In the unlikely event of an invasion by aquatic weeds in the new reservoir, an additional expert on aquatic weeds management may have to be involved. Laboratory services will be sourced from within Myanmar. Technicians and various other national support staff will also be needed.

11.4.5 Specific Activities

Further Pre-construction Data Collection

The EIA team recommends further data collection on aquatic ecology and fisheries in the Myitnge River and the Gotheik tributary as part of further project development. In addition, it is recommended to undertake data collection in the downstream Yeywa reservoir to provide important information about the likely transformation of aquatic biodiversity and water quality in the future Middle Yeywa reservoir as well as input to assess the feasibility of developing fisheries in the future reservoir. The recommended surveys include:

- Additional sampling of aquatic biodiversity using a diversity of field equipment and methods to establish a robust baseline for Myitnge River and Gotheik tributary.
- Water quality sampling to strengthen the baseline for Myitnge River and Gotheik tributary.
- Sampling of aquatic species composition and abundance in the Yeywa Reservoir.
- Water quality sampling to establish key water quality parameters in the Yeywa Reservoir including the degree of stratification of the water column in areas with considerable water depth.
- Surveys of the riverbed between the Middle Yeywa tailrace and the Yeywa reservoir to review the feasibility of designing and implementing a river rock fill as a riverine habitat in this section.

Methodology and Quality Control

A number of shortcomings in the previous aquatic surveys illustrate the need for careful planning and quality assurance of future aquatic surveys. The EIA team therefore recommends further surveys.

Aquatic vegetation has been documented qualitatively in the supplementary EIA studies in 2017 but systematic surveys of aquatic vegetation were not undertaken. Potential future baseline surveys should include the river section between the proposed Middle Yeywa dam site and the Yeywa reservoir, including establishment of a limited number of monitoring plots than can be re-surveyed during the construction and operation phases.

Micro-invertebrates (phytoplankton and zooplankton) and macro-invertebrates should be sampled in the Myitnge River and the downstream Yeywa reservoir to establish a baseline for the project’s direct impact zone and provide indications or likely invertebrate communities in the future reservoir. Standardised sampling methods for micro-invertebrates and macro-invertebrates in river and lake environments should be applied, including fine mesh nets as well as specialised traps to collect samples at specific depths.

Fish species sampling in Myitnge River, Gotheik tributary and Yeywa reservoir should be based on several methods, including gill nets in standing and slow-flowing waters, seine and different sizes of baited minnow traps that can be used under a range of conditions. Fishing gear available to local fishermen will also be used opportunistically. Electrofishing equipment is unlikely to be available.

A boat or raft will be required to sample some sections of the Myitnge River and the Yeywa reservoir where access from land is unfeasible.

Potential fishing opportunities in the Middle Yeywa reservoir will be considered by analysing likely changes in the fish community, potential fishing gear likely to be available to local people, and potential market opportunities for the fish. This can only meaningfully be analysed following information collection and analysis from the downstream Yeywa reservoir. Deliberate introduction of new species to the Middle Yeywa reservoir is discouraged as a precautionary measure and should, if considered, be subject to a detailed EIA.

Identification of Monitoring Points

Specific aquatic ecology monitoring points will be established for the Myitnge River, the Gotheik tributary and the Yeywa reservoir and these will be aligned with monitoring points for water quality. The location of the points will be selected to ensure a sound coverage given available resources and will be identified to cover representative areas of the project's direct impact zone while considering efficiency in access to sampling sites in an at times very challenging terrain. Relevant sampling sites include (see also Figure 6-24 for baseline sampling sites):

- The Myitnge River: i) close to the Gotheik tributary, ii) close to the Myitnge bridge, iii) between the cascade and the Middle Yeywa dam site (deepest part of reservoir), iv) between the dam site and the Yeywa reservoir, and v) between the Upper Yeywa dam and the Middle Yeywa reservoir;
- The Gotheik tributary above the future full supply level of Middle Yeywa reservoir;
- The downstream Yeywa reservoir close to the Yeywa dam in areas with close to maximum reservoir depth.

Indicators for Aquatic Species and Fish Monitoring

Further surveys will identify the most appropriate indicators for monitoring aquatic species and potential fisheries. The indicators will be established in conjunction with indicators under the Water Quality Monitoring Programme and the Compensation/Livelihood Restoration Plan. Based on available information it seems likely that micro-invertebrates, macro-invertebrates and selected fish species should be monitored, including fish species of particular interest for fisheries. Indicators could include:

- Phytoplankton
- Zooplankton
- Benthic macro-invertebrates (insects living on the river/reservoir bottom)
- Fish species such as the Gangetic Loach (*Botia rostrata*), the Tor Barb (*Tor tor*) and the Butter Fish (*Wallago attu*). Species living both along the river/reservoir bottom and in the main water body of the reservoir should be covered, including fish species of particular interest for local fishermen.

Possible Project Design Modifications, Mitigation and Enhancement Measures

Project design has sought to avoid and minimise negative impacts through design modifications and mitigation and enhancement measures, including measures listed for the construction environmental management plan. In addition, the following measures are recommended:

- Release of a continuous minimum flow during reservoir filling (including filling after sediment flushing) as well as during any periods when there is no release through the turbines (e.g. during power station outage or grid failure);
- Release on a continuous minimum flow during the project operation through the turbines to ensure water for the river section between the dam sites and the Yeywa Reservoir;
- Carefully consider the ramping rates to reduce downstream environmental and social impacts;
- If the riverbed downstream the tailrace is to be modified to ensure a 'free flowing' section, it should be deliberately designed as a varied river section that ensures a dynamic and heterogenous set of habitats that are also able to withstand both peaking and large floods. As a supplementary or as an alternative measure, river habitats may be designed between the Middle Yeywa reservoir and the Upper Yeywa dam;
- Sensitise local communities to avoid catching any threatened species, avoid use of harmful or unsustainable fishing methods (e.g. poison, dynamite), and promote sustainable fishing practices.

11.4.6 Budget and Schedule

The recommended surveys prior to construction can be done in parallel with further project development and has been estimated at approximately USD 40,000.

Monitoring during the construction phase is estimated at an average annual cost of USD 10,000 except the final year prior to commissioning when the reservoir will be filled, and expanded surveys are recommended bringing the annual budget to USD 15,000.

Costs for potential support to establishing fisheries activities in the future reservoir have not yet been estimated due to the uncertainties of the potential for such fisheries and the scope of related work. The budget is assumed to be 50,000 for the first three years, highly dependent upon the scope of the work to be undertaken. Budgeting for these activities will be coordinated with the Compensation/Livelihood Restoration Plan as fisheries can play a role in restoring livelihoods for a limited number of affected people.

During the operation phase, monitoring will be most intense during the first few years as the new lake ecosystem undergo considerable ecological transformation and the same is likely to be the case for the river section between the Middle Yeywa dam and the downstream Yeywa reservoir. The average annual budget for aquatic ecology monitoring is expected to be approximately USD 20,000 for the first three years, after which it is likely to be reduced.

11.5 Reservoir Clearance and Filling Plan

11.5.1 Overall Goals and Objectives

The Middle Yeywa reservoir will cover a surface area of about 11 km^2 submerging mainly forestland on steep valley slopes. Experience from other dam projects in tropical countries show that it is important to remove or reduce the amount of biomass in the reservoir before inundation. Indeed, pre-impoundment biomass clearing has become international best practice in hydropower although it can involve significant costs and technical challenges.

There is no doubt that clearing of trees in some places along the Myitnge River will be extremely difficult, if not impossible, due to the steep topography and associated safety hazards. However, until such cases have been confirmed by those responsible for the reservoir clearance, SN Power shall aim at removing as much woody biomass as is feasibly possible below the FSL.

The objectives of the biomass clearing include:

- Reducing the amount of biomass, thereby reducing the risk of poor water quality and greenhouse gas (GHG) emissions from decay of organic matter in the reservoir;
- Reducing the amount of wood debris floating on the reservoir and/or getting into the trash racks;
- Reducing the number of dead trees standing in the water which would become an aesthetic nuisance and an obstacle for possible boat transport and fishing in the reservoir;
- Salvaging valuable timber resources which would otherwise be submerged and lost.

11.5.2 Roles and Responsibilities

SNP Power will be responsible for the implementation of the Reservoir Clearance and Filling Plan through the following:

- Provision of management and planning control through its Environmental and Social Unit (ESU);
- Engaging one or more contractors with appropriate technical and management expertise to clear the reservoir;
- Arranging timber salvage to be executed by a qualified contractor or State Enterprise
- Provide training, if an appropriately qualified contractor is not available, in operational methods, health and safety and environmental awareness.

11.5.3 Staffing and Organisational Aspects

Detailed planning will decide the division of tasks between the ESU staff, managerial and technical specialists engaged for the planning and supervision and sub-contracted companies or teams.

The public information campaigns related to the reservoir clearance and filling will be carried out by ESU staff, including the consultation team with its community liaison officers, as part of their regular duties.

Similarly, SN Powers environmental, health and safety inspectors will be responsible for providing oversight and compliance monitoring of the logging contractors.

The entire operation will be headed by the Environmental and Social Manager, who will be responsible for all contractual matters related to the sub-contracted companies.

11.5.4 Specific Activities

Demarcation

It is important that the pre-impoundment vegetation clearing is confined to below the FSL, such that existing vegetation along the shores of the reservoir is protected. For this reason, the perimeter of the clearance area shall be marked in the field to indicate the inundation limit. This task will be carried out either by the contractor assigned to clear the reservoir, or by a separate contractor at an earlier stage. The marking methods should be determined by the contractor after a detailed investigation of the topographic conditions and as part of a bidding process.

Harvesting of Commercial Timber

Following the reservoir demarcation, a contractor or State Enterprise will be requested to harvest all merchantable standing timber (selective logging). The logging and transport of timber should be completed in advance of the full clearing operations.

Logs are probably best transported on the river downstream instead of pulling them up the steep valley slopes. The logs can be collected at various pool areas with access in the upstream part of the Myitnge River (sites currently used for illegal timber harvesting) or transported down to the Yeywa reservoir from where it can be transported out of the project area by timber trucks.

The value of the salvaged timber cannot be estimated at this time. It is however assumed that the value will be such that the logging can be carried out without need of any subsidies from SN Power.

Clearance of Selected Area and Controlled Burning

Following the harvesting of commercial timber, one or more contractors shall be appointed by SN Power to remove the remaining biomass within the demarcated reservoir area. The work will benefit from the opening up of the forest caused by the timber extraction. On the other hand, cutting of trees may in some places be impossible due to the steep topography and associated safety hazards.

The contractor(s) will be expected to employ local people to carry out the clearing and burning, provided that they are given personal protective equipment (PPE) and safety training. Local people should also be allowed to make use of the wood.

The reservoir area will be divided into operational blocks, each with a dedicated team of professionals and local villagers responsible for clearing and burning. The teams will cut all non-commercial trees (not removed by the contractor) and stockpile the wood for collection by villagers. The clearing should start from the riverbanks towards the reservoir perimeter so that animals can escape into the right direction.

Thereafter, each block will be “back-burnt” in a controlled manner. It should be noted that burning is a widespread management practice in the project area, both for shifting cultivation (on the plateau) and to keep the forest open for access by people (e.g. for hunting) and livestock as well as to replenish the soil nutrients for better pasture (in the valley). The controlled burning will be done in the last dry season before filling the reservoir. This will minimise the establishment of secondary growth vegetation in cleared areas prior to impoundment.

Residue Collection and Removal

The logging and clearing teams should try to minimise the amount of wood and large branches that might be flushed downstream by the river or left floating in the future reservoir. However, it is inevitable that some wood will be remaining even after burning. Large softwood logs that comprise “soft biomass “ that are not completely consumed by fire will float as the water level rises, while any durable hardwood material remaining will not float with very minor decomposition occurring.

During initial and final reservoir filling, a team will be organised to clear the water of logs and organic debris using booms placed above the intake and spillway structures. A heavy duty boat will be available to haul the material into collection ramps.

Erosion Control Measures and Spill Prevention

The contractors shall be instructed and required to minimise soil erosion and avoid any spillage of fuel or other oil products in accordance with the requirements specified in the Construction Environmental Management and Monitoring Plan (see above).

Safety Measures during Filling

The reservoir filling procedure will be defined once the detailed design has been completed and in compliance with strict dam safety requirements. SN Power will, as part of its ongoing stakeholder engagement, carry out public information campaigns in the neighbouring villages prior to impoundment. People will be warned about the safety risks and will be instructed to stay away from the river and the Myitnge valley during the filling period. SN Power will also deploy a large team of safety inspectors to enforce control over the reservoir area at this critical time.

11.5.5 Budget and Schedule

The reservoir clearing shall commence at least two years before impoundment, and the controlled burning shall be done in the last dry season. Detailed planning is required in order to estimate the total time period needed for the reservoir clearance.

The cost of vegetation clearing cannot be estimated in detail at this early stage, but experience in Lao PDR and western Africa indicates that the unit rate would be about 500 to 1000 USD/ha (Salignat *et al.*, undated). For preliminary planning, three potential clearing areas have been identified with a total area of 420 ha (4.2 km^2) (***Figure 11-1***). Highest priority is the area behind the dam in the deepest portion of the inundation zone (area no. 1), but the two other areas also have thick vegetation cover combined with relatively easy access which would make the clearing operations technically feasible.

Thus, for the purpose of preliminary budgeting, we have assumed that the commercial timber will be extracted at no cost while the clearance and burning will be restricted to the three areas shown in ***Figure 11-1*** at a unit cost of 1000 USD/ha. The total cost of vegetation clearing is then estimated at USD 420,000.

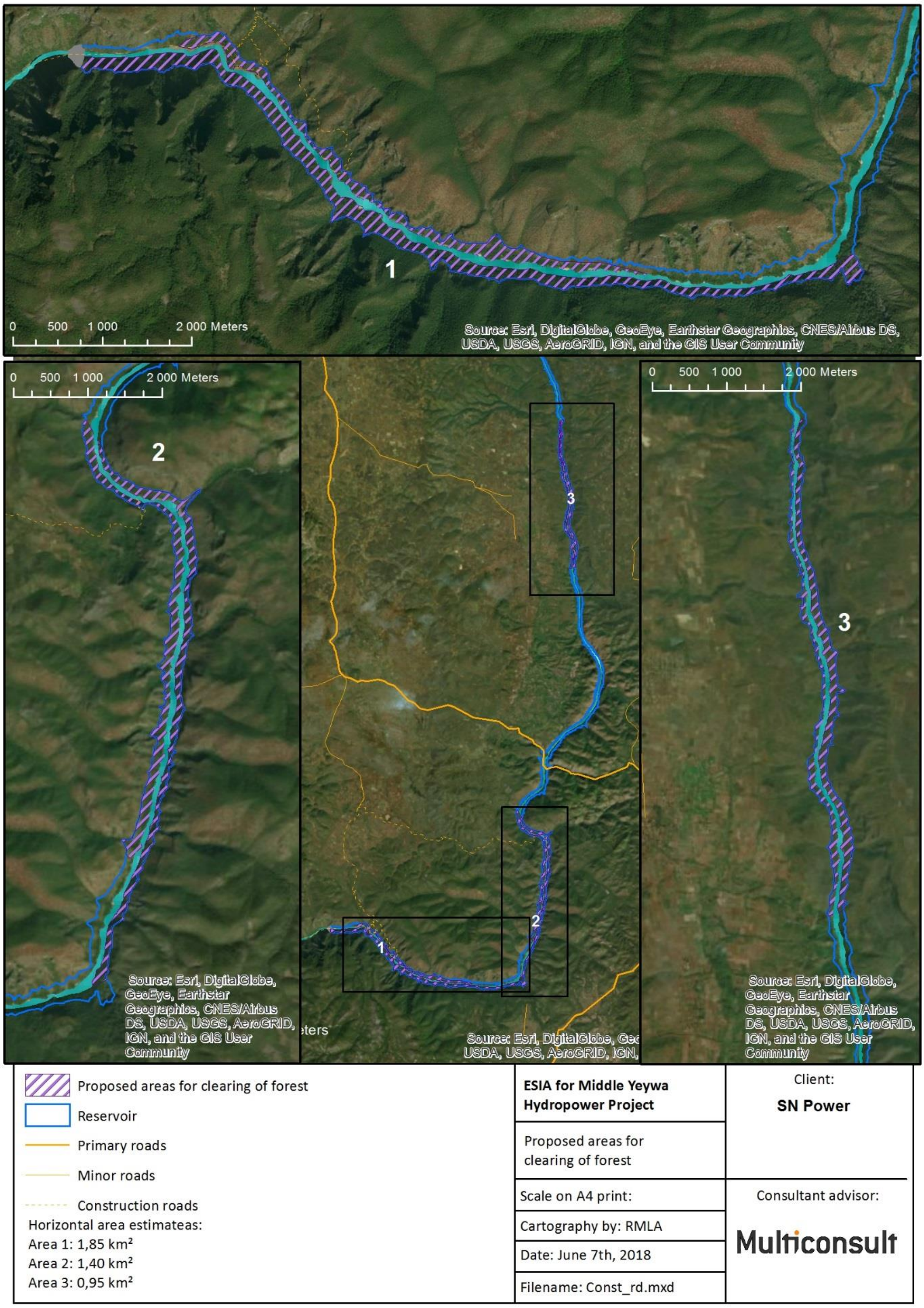


Figure 11-1: Proposed areas for pre-impoundment biomass clearing.

11.6 Biodiversity and Conservation Protection Plan

11.6.1 Introduction

The biodiversity values in the project's direct and indirect impact zones are moderate. An unconfirmed reserve forest has been identified on the left bank while the nearest protected area recorded in the World Database on Protected Areas is Pyin Oo Lwin Wildlife Sanctuary located approximately 35 km west of the dam site. The nearest key biodiversity area (KBA) is called Mehon - Doke-hta Wady River and is located between the dam site and the Pyin Oo Lwin Wildlife Sanctuary. This KBA is an International Bird Area (IBA MM023) and does not have a legal status in Myanmar. The delineation of this KBA appears indicative and is based on the presence of one bird species, the endangered Green Peafowl (*Pavo muticus*). There are also a limited number of other threatened species recorded, most of which are forest-dependent species. The project area is under severe land pressure with rapid conversion of natural habitats to agricultural areas except the steep river valley towards the Myitnge River. Without additional measures for conservation or sustainable use of the project area, most of the significant biodiversity values are likely to disappear in the next 2-3 decades.

11.6.2 Overall Goal and Objectives

The overall goal is to avoid and minimise impacts on biodiversity through project design modifications, mitigation and enhancement measures, and monitoring.

The objectives of this plan are as follows:

- Develop and implement measures that reduce impacts on the biodiversity, and the people who rely on ecosystem services, to acceptable levels, including avoiding a net loss of key biodiversity values;
- Monitor and document changes in biodiversity and terrestrial ecosystem dynamics, species composition and abundance, and ecosystems services provided;
- Reduce the pre-project level of illegal logging and illegal hunting;
- Reduce and eventually stop degradation of forest habitats;
- Restore important habitats degraded prior to the project and habitats affected by the construction phase;
- Minimise soil erosion in the immediate reservoir catchment and subsequent sedimentation of the reservoir;
- Use monitoring results to inform decision-making on adjustments to project operation, mitigation and enhancement measures and future monitoring.

The programme will focus on the reservoir area and its surroundings as well as areas impacted directly or indirectly by associated project infrastructure. During further project development, areas beyond the project area will also be considered where biodiversity protection measures for threatened species, or particularly important habitats, can be implemented more cost-efficiently in the wider landscape rather than in the project area.

Analysis of cumulative impacts may indicate that some areas of conservation interest may at present not be viable in the longer-term and hence guide biodiversity management measures towards areas in the wider landscape that are not affected negatively by the project or likely future cumulative impacts arising from other developments.

It should be noted that this Biodiversity and Conservation Protection Plan focuses on terrestrial biodiversity while the Aquatic Ecology and Fisheries Management Programme focuses on aquatic biodiversity. The plan will be closely coordinated with the Reservoir Clearance and Filling Plan, the Construction EMP, and the Community Forest Programme. Furthermore, where areas outside the project's impact zones are covered, the plan should be aligned with other management plans developed or implemented by government or non-government stakeholders, for instance forest management plans or protected area management plans.

11.6.3 Roles and Responsibilities

SN Power, through the ESU, will be overall responsible for the implementation of the Biodiversity and Conservation Protection Plan. Specialised tasks are likely to be outsourced to national and/or international experts or organisations with SN Power remaining ultimately responsible, including to provide updates and reports to stakeholders. The detailed roles and responsibilities will be developed as part of establishing the Environmental and Social Unit (ESU). Authorities at local, regional and national levels will be consulted as will national and international NGOs working on biodiversity and forest conservation.

11.6.4 Staffing and Organisational Aspects

Most of the team involved in this programme will likely be short-term consultants, including a mammal expert, a bird expert, an amphibian and reptile expert, and possibly an insect expert. A protected area specialist may also be required. Laboratory services will be sourced from within Myanmar. Technicians and various other national support staff will also be needed.

11.6.5 Specific Activities

Protection of Important Habitats and Catchment Areas

In consultation with forest authorities, local authorities and communities, SN Power should consider establishment of one or more forest protected areas around the reservoir on both river banks. Priority should be on areas with important habitats that still have limited degrees of land conversion and other pressures from the local communities as well as potential hotspots for erosion and sedimentation. This will likely cover most of the steep river valley towards the reservoir currently not used for any form of cultivation but subject to selective logging of high-value timber species, hunting, burning and in some grazing areas. In addition, the plateau on the left bank, including the proposed Naung Lon Reserve Forest which could be extended to the dam site, will be considered and discussed with forest authorities. According to the Forest Department in Taunggyi the procedure for establishing a forest reserve area is as follows.

- Preparation of a proposal to the Union Government with a 60 day period to the public for claims on land use;
- An MOU is issued for preparation of a detailed management plan for the forest reserve;
- MoNREC reviews the management plan and submits it to State officials for comments before final approval
- Claims for compensation are negotiated and settled.

The forest reserve will then be protected against logging and other uses of the forest, except by local villages for non-commercial purposes. Any harvesting of timber by villagers needs approval by the forestry department.

The Forestry Department will assign a minimum of two staff to supervise the area. Patrolling is done in three ways:

- Patrolling the area and then dealing with illegal issues as they are discovered;
- Acting on information to investigate an issue;
- Surprise road checks

Assessing the feasibility and extent of protection of the immediate reservoir catchment areas should build on existing EIA documentation and further include:

- Further mapping of forest extent, consultations with local communities on legal and illegal resources use as well as formal and informal rights in these forest areas, and consultations with local authorities on village boundaries;
- Dialogue with forest and energy authorities on the most appropriate legal provisions for protecting such forest catchment areas and the relevant guidance for implementing such provisions;
- Dialogue with forest authorities and protected area authorities on their priorities for protected areas in the project area, if any;
- Assessment, in consultation with relevant authorities, of alternative areas for protection and associated form of protection, including requirements for community involvement in management of the protected area or buffer zones;
- Development of a simple management plan for the protected catchment area in consultation with stakeholders at local, regional and national levels. While it is anticipated that natural regeneration of high-value timber species is the most feasible approach, active restoration efforts should be considered as part of developing the management plan. Active restoration works are particularly relevant in areas affected by construction activities including potential access roads for reservoir clearing;
- Participatory demarcation of boundaries for the protected area;
- Establish monitoring plan for a limited number of key indicators (e.g. presence and abundance of species of particular conservation concern, forest cover, erosion), including baselines;
- Establish a functional management unit in cooperation with relevant authorities and local communities.

No physical displacement is anticipated for the purpose of establishing the catchment forest protected area. Where feasible, community forest management will be integrated in the catchment forest protection; however, active forest management measures by communities (e.g. agro-forestry) is unlikely to be feasible for sensitive species.

Conservation Activities for Protection of Selected Species

The project's impact zones partly overlap with the Mehon - Doke-hta Wady River Key Biodiversity Area (KBA) that has been delineated based on the anticipated habitat of the endangered Green Peafowl (*Pavo muticus*). The KBA has no formal protection status in Myanmar. Expected project impacts on this species and its habitat are limited, yet the project will seek to avoid any net loss of habitat for the species and the KBA. In addition to potentially establishing a protected catchment forest around the reservoir, the Project will consider supporting improved management of important habitats for the Green Peafowl with priority on areas within the KBA that are part of, or connected to, habitats for this species of significant size. The figure below shows the KBA but potential focal areas for support for improved habitat management within the KBA have not been identified yet.

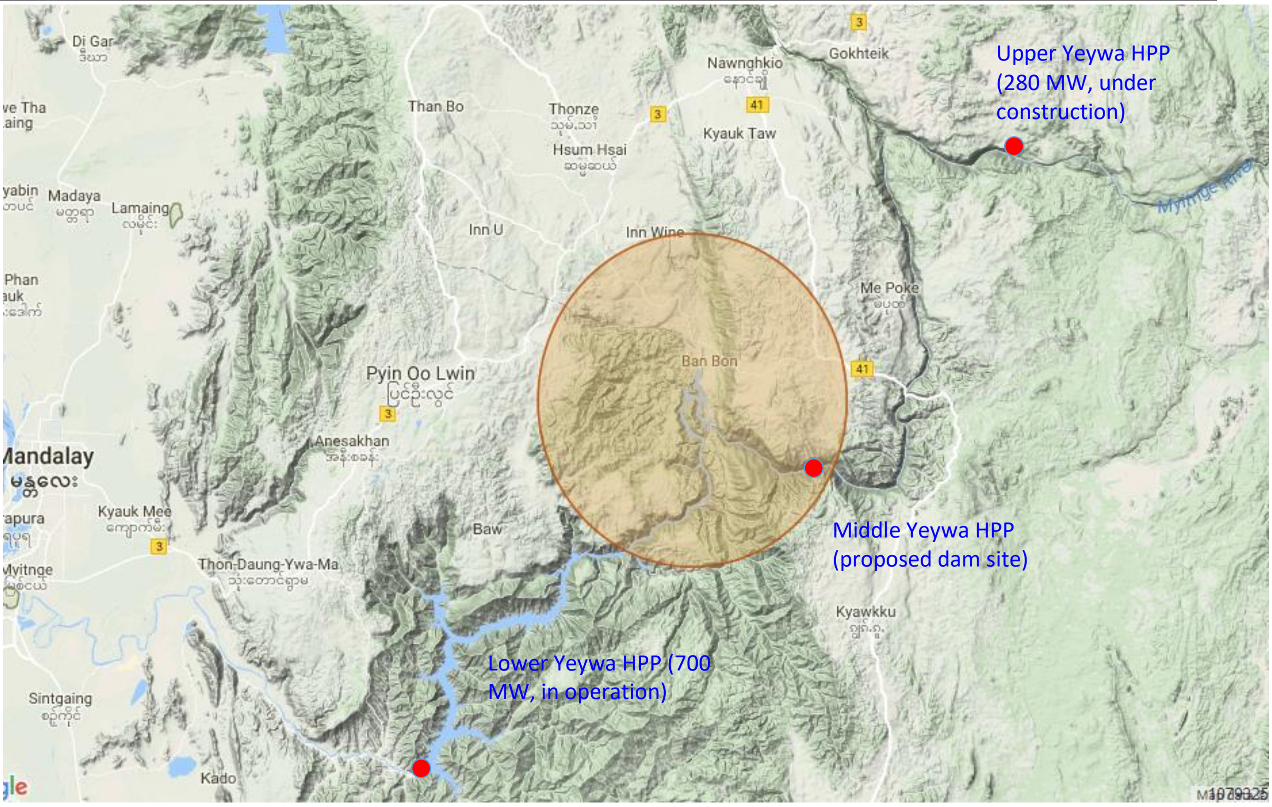


Figure 11-2: Map showing the location of the Mehon - Doke-hta Wady River key biodiversity area west of the Middle Yeywa project area.

Maintaining Connectivity

The biodiversity impacts of Middle Yeywa Hydropower Project seen in isolation are moderate. However, at landscape level the cumulative impacts from establishing three large hydropower projects (Lower, Middle and Upper Yeywa Projects), combined with large-scale conversion of forest to agriculture and settlement areas, will undoubtedly result in substantial loss of habitat and increased fragmentation of remaining habitats.

Establishing a catchment forest protected area around the Middle Yeywa reservoir will contribute to maintaining connectivity, particularly for forest-dependent species or species moving between habitats via such forest areas that provide corridors in a landscape largely converted to agriculture and settlements, particularly on the right bank. Activities to avoid a net loss of habitat for the endangered Green Peafowl and the KBA may also contribute to maintaining connectivity in a wider landscape. Identifying areas for catchment forests or Green Peafowl habitat will seek to optimise the contribution to connectivity in the larger landscape and avoid creating isolated habitat patches through project-related habitat conservation efforts.

Monitoring Program

The biodiversity monitoring will cover presence and abundance of selected species, quantity and quality of important habitats as well as levels of illegal activities in important biodiversity areas. This will also provide input to assessing actual impacts on ecosystem services and potential measures required to mitigate negative impacts on these services.

The baseline surveys identified several species of conservation interest, most of which are forest-dependent species. Project impacts during construction and operation will be monitored to document the level of impacts experienced, to evaluate the effectiveness of mitigation and enhancement measures, and to inform decision-making in terms of changes to construction practices, operation regime, mitigation strategies, enhancement measures and future monitoring. The monitoring will cover habitat quality and quantity for key habitats and key species and will bring together three main components to a coordinated biodiversity monitoring programme:

- Monitoring integrated in the management plan for the catchment forest protected area;
- Monitoring as part of habitat support for the Green Peafowl or the KBA to avoid a net loss;
- Monitoring focussing on the construction and operation phases in other areas.

Levels of illegal activities (logging and hunting) will be monitored primarily in the catchment forest protected area. Monitoring during the construction phase will focus on the catchment forest areas near the construction sites while the operation phase monitoring will be less intensive but cover the wider catchment forest areas and supported Green Peafowl habitats and KBA.

11.6.6 Budget and Schedule

Further work prior to construction start will include developing a fully-fledged Biodiversity Management Plan including initial work to map potential habitats that can be supported to avoid a net loss of Green Peafowl habitat and KBA. Preliminarily, the work is budgeted at USD 50,000.

Monitoring during the construction phase will focus on the areas close to the construction sites including monitoring of illegal activities and filling gaps in baseline information. An average annual cost of USD 20,000 is estimated except the final year prior to commissioning when the reservoir is likely to be filled and additional surveys are recommended during the filling period, which bring the annual budget figure that year to USD 40,000.

Costs for potential support to Green Peafowl habitats and the KBA have not yet been estimated due to the uncertainties of whether support outside the catchment forest areas is likely to be required and feasible. The budget is assumed to be approximately 50,000 for the first three years, highly dependent upon the scope of the work to be undertaken and the arrangement with government or non-government implementation partners.

During the operation phase, monitoring will be most intense during the first few years as the reservoir will be a new habitat, important catchment forest activities will be undertaken and there will potentially be start-up of activities to support Green Peafowl habitats and KBA in a location of the wider region (outside the project area). The average annual budget for biodiversity monitoring is expected to be approximately USD 25,000 for the first five years, after which it is likely to reduce.

An indicative budget for the Naung Lon Reserve Forest on the left bank, should this reserve be confirmed, is USD 10,000 for stakeholder engagement and awareness raising, USD 5,000 for boundary demarcation, USD 25,000 for development of a management plan with zonation for multiple use, and annual costs of USD 10,000 for the first three year of establishing an active management regime.

11.7 Community Forest Program

11.7.1 Overall Goals and Objectives

Background

Myanmar suffers significant annual deforestation due to over-exploitation, illegal logging, shifting cultivation, governance and institutional issues, and expansion of urban and agricultural lands (IUCN 2018). The Middle Yeywa HPP will contribute to forest loss on a local scale, especially related to the pre-impoundment clearing of the reservoir.

An opportunity to compensate for the project-induced deforestation is through forest landscape restoration, which has gained momentum in Myanmar in recent years. In 2016, the government launched a 10-year National Reforestation and Rehabilitation Program in Myanmar (NRRPM) aimed at not only restoring degraded and deforested landscapes, but also improving economic and environmental conditions of local communities.

In 2017, the Forest Department, supported by IUCN and The Nature Conservancy, conducted a multi-criteria spatial analysis which identified opportunities for restoration. Forest loss areas in the country (from 1990) and Key Biodiversity Areas (KBA) were analysed. Based on the results, watershed protection near medium population density areas was identified as a priority. The analysis also identified over 713,000 hectares of degraded land as a priority for restoration action (***Figure 11-3***).

One of the selected areas is located in the catchment of the existing Yeywa reservoir, a short distance downstream of the proposed Middle Yeywa dam site. This priority area consists of the Pyin Oo Lwin Wildlife Sanctuary, a highly degraded habitat that is not properly protected, and the Mehon (Doke-hta Wady River) Key Biodiversity Area (KBA), which is home to the Endangered Green Peafowl (*Pavo muticus*).

Forest landscape restoration in Myanmar is implemented mainly through community forestry programmes. The Community Forestry Instruction (CFI) was issued in 1995, and initiated the promotion of community forestry across the country with the support from international donor projects (e.g. UNDP / JICA / DFID) as well as through the Forest Department, and in some cases self-organisation by communities. The CFI law states that community forestry certificates can be issued to a Forest User Group (FUG) for 30 years lease. To qualify for such certificate, a FUG must commit itself to manage the forest sustainably and systematically according to the forest management plan that they develop. As of 2011, there are 572 FUGs with certificates, managing more than 100,000 acres of forest in Myanmar. Many of these certificates have been issued in Shan State under UNDP project support.

According to Shan State forestry officials, there is also a reserve forest on the left bank of Myitnge River extending all the way from the Upper Yeywa HPP down to the Nam-kam tributary in the lower reaches of the proposed Middle Yeywa reservoir. This reserve forest is known as the Naung Lon Reserve Forest but no programmes are presently implemented due to security reasons. However, with improved government control over the area, this reserve forest can be selected for community forestry interventions.

The Shan State Forest Department has already conducted training activities in the Middle Yeywa project area, including the left bank. The approach is in line with MoNREC's new regulation called the 9-steps which involves management by villagers within 5 km of the designated community forest areas. The scope of education and forestry training programmes is currently restricted by funds.

Objectives

The Community Forest Program will consist of both natural and assisted regeneration of tree species as well as protection of existing forests and promotion of agro-forestry practices. The objectives are as follows:

- Compensating for the loss of forest in the Middle Yeywa reservoir by restoring priority forests outside of the project's direct impact zone;
- Contributing to watershed management and biodiversity conservation whilst also improving the communities' access to ecosystem services through sustainable community-led forest management.

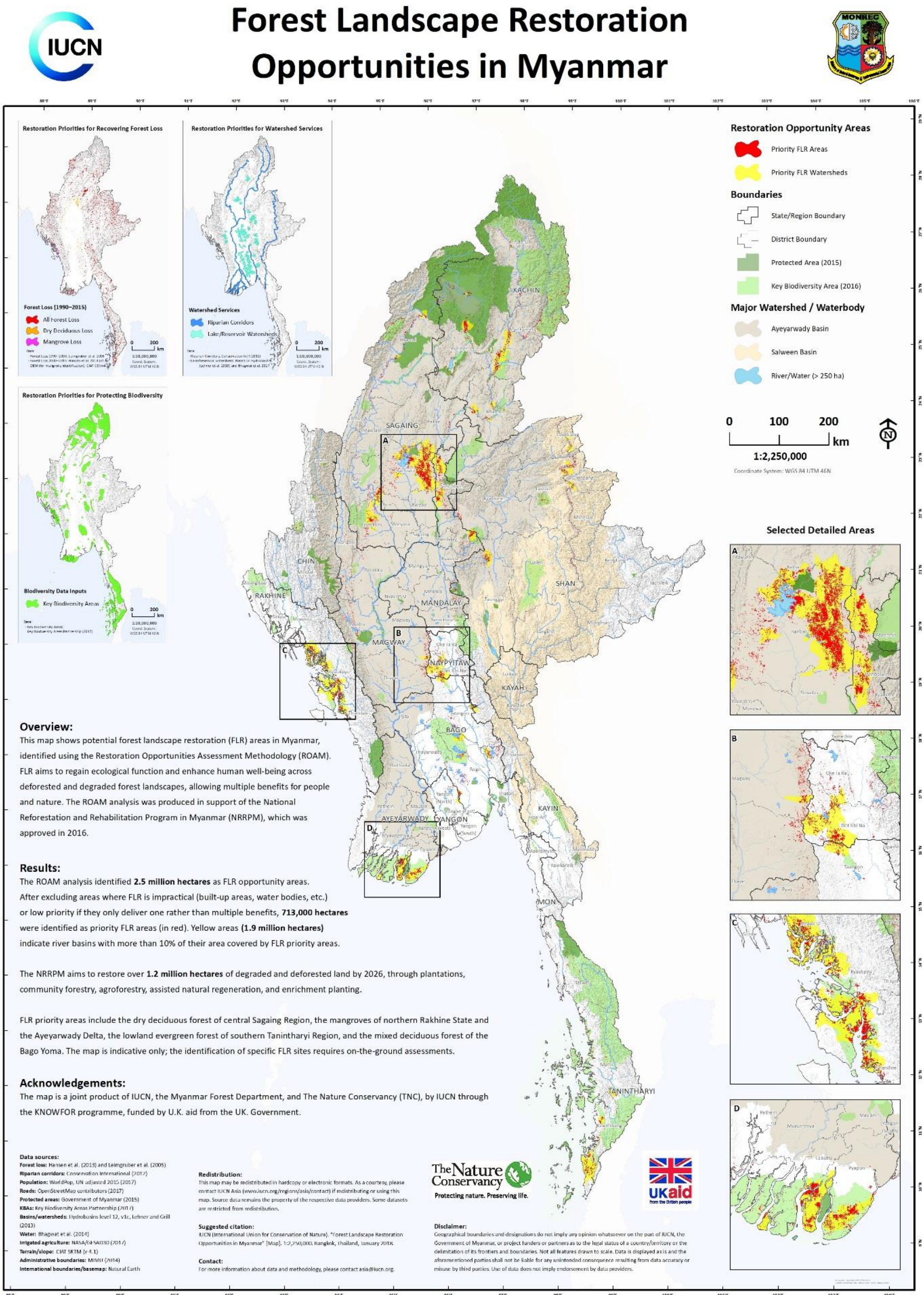


Figure 11-3: Forest landscape restoration opportunities in Myanmar.

Source: IUCN (2018)

11.7.2 Staffing and Organisational Aspects

The Community Forest Program should rely on the services of the Forest Department in Shan State (and possibly Mandalay Region) while also exploring the opportunities for creating partnerships with NGOs and seeking co-funding from international donors in the forestry sector. At this early stage, it is premature to define the organisational set-up and staffing requirements for the community forestry interventions. However, it is envisaged that the project's Environmental and Social Unit will have a Community Forestry Team staffed with at least two forestry advisors who will work together with government staff (and possibly NGO personnel).

11.7.3 Roles and Responsibilities

SN Power will be responsible for the implementation of the Community Forest Program through the following:

- Provision of management and planning control through its Environmental and Social Unit;
- Technical backstopping services by its own personnel (forestry advisors);
- Ensuring support from the Forest Department, possibly including secondment of government staff to the project's Environmental and Social Unit;
- Partnership arrangements with NGOs working in the communities with forest restoration and management.

The roles and responsibilities of third-party institutions will be agreed during the detailed design of the Community Forest Program.

11.7.4 Specific Activities

Identification of Potential Restoration/Reforestation Areas

Based on the identification of priority areas for restoration of forest landscapes in the Pyin Oo Lwin Wildlife Sanctuary and the Mehon (Doke-hta Wady River) Key Biodiversity Area (KBA), as well as the need to strengthen law enforcement in the Naung Lon Reserve Forest, SN Power through its Environmental and Social Unit shall facilitate the Forest Department and other relevant government offices to select exact locations for restoration/reforestation activities within these wider areas. The total size of the land should be equivalent to that lost due to dam impoundment (approx. 8.2 km^2). Detailed maps (GIS and hard copy) will be produced for each of the selected forest restoration/reforestation sites.

Local Communities Participation and Communication Plan

The communities within or near the selected restoration/reforestation areas will be consulted in order to determine the type of interventions suitable at each site. Experience from other programmes shows that failure is often caused by the villagers not gaining a clean and detailed understanding of the community forestry concepts during the early stage. It is therefore important to conduct a thorough and meaningful consultation process to ensure full participation and commitment by the local communities. The communities will be encouraged to establish Forest User Groups (FUGs) in line with government policies and regulations.

It is envisaged that a range of interventions will be proposed including outright protection to conserve important forest habitats and catchment areas and to promote natural regeneration of valuable tree species; sustainable management of existing forests where villagers are allowed to extract firewood, posts and poles in accordance with established by-laws; assisted regeneration of trees involving nurseries to raise seedlings; and agro-forestry practices on land that has already been converted to agriculture. The trees selected for protection or reforestation may include timber species (e.g. *Tectona grandis, Gmelina arborea*) as well as trees under conservation threat (e.g. *Dalbergia oliveri, D. cultrata, Pterocarpus indicus, Cycas siamensis*).

Nurseries and Reforestation Implementation Programme

The growing of seed stock for reforestation often requires a long period of time. Seeds from suitable species need to be collected from the surrounding forested areas, prepared for planting, and then grown to a suitable maturity for transplanting. This can take up to two years for some species. Therefore, in the long term forest regeneration plan, the development of nurseries and the growing of saplings should be addressed in the very first phase of implementation.

One option is to establish a central nursery in conjunction with a forestry research centre being planned by the Shan State Forest Department downstream of the Middle Yeywa dam. Regeneration trials could begin there as a pilot phase before the full scale regeneration operation when seedlings are distributed to the various FUGs. There is also the option of establishing smaller nurseries in villages to provide employment.

Monitoring and Protection Measures

SNP will be responsible for continued monitoring of all community forest activities, including survival rates of seedlings until reaching maturity as well as compliance with protection by-laws and overall progress of forest cover from year to year.

11.7.5 Budget and Schedule

The Community Forest Program will require a dedicated team within SN Powers Environmental and Social Unit. This Community Forestry Team will consist of SN Power personnel as well as staff seconded from the Forest Departments in Shan State and possibly Mandalay Region.

For the purpose of preliminary costing, we have assumed that the average of cost of tree planting is around USD 2,000 per hectare all inclusive (based on experience from other projects). More investigations and negotiations with the government will be necessary to determine the total area that shall be covered by the Community Forest Programme. The tentative budget for the construction phase has been stipulated to USD 240 000 while the budget for the first 5 years of the operation phase has been stipulated to USD 120 000.

11.8 Operation Phase Environmental Management Framework

11.8.1 Overall Goals and Objectives

The overall goal of the Operation Phase Environmental Framework is to provide a programme for safeguarding the biodiversity in the project area on the long term and throughout the concession period for the Middle Yeywa HPP. One additional objective is to monitor the long term impacts of the hydropower development as well as the effectiveness and outcomes of the different mitigation programmes so that adjustments can be made if necessary.

11.8.2 Roles and Responsibilities

SN Power will have the responsibility for maintaining the mitigation programmes into the operation phase. When the programmes are well established the responsibility will be gradually handed over to implementing partners such as NGOs and the relevant government agencies.

11.8.3 Staffing and Organisational Aspects

In order to manage the different mitigation activities and programmes early in the operation phase SN Power will retain the Environmental and Social Unit with sufficient staffing to ensure an effective implementation of all activities. These staffing requirement will to some degree depend on the detailed planning for the mitigation programmes and to what degree implementing partners can be found. It is expected that the staffing of the ESU can be gradually reduced as the mitigation activities are either phased out or handed over to implanting partners. However, SN Power will be required to maintain an environmental and social staffing in an organisational form and at a level that ensures implementation and monitoring of long term mitigation and enhancement activities.

11.8.4 Specific Activities

Operation Phase Environmental Management Plan

An Operation Phase Environmental Management Plan should be developed by the Middle Yeywa HPP well ahead of the start of the operation phase. The plan and should build on the different mitigation programmes initiated in the construction phase and should tentatively cover the following environmental issues:

- Waste Management and pollution control (routines for handling accidental oil spills, household waste and waste generated by the operation of the hydropower plant);
- Water quality monitoring;
- Fisheries management and aquatic ecology monitoring
- Conservation protection activities;
- Community forest management.

Emergency Response Plan

SN Power will be required to develop an Emergency Response Plan for dam rupture and unexpected floods with detailed manuals specifying schedules and responsibilities for taking managerial actions and mobilise technical mitigation measures as well as specific instruction for rapid communication with downstream settlements and village and local authorities.

Close cooperation with village and local authorities is needed for preparing realistic emergency procedures. With the plan in place it will be necessary to arrange training and drills in the emergency procedures for managerial and operational staff at regular intervals.

11.8.5 Budget and Schedule

The budget for the first five years of the operation phase has been estimated at totally USD 320 000 with the Biodiversity and Conservation Protection Plan and the Community Forest Programme being the largest budget items with USD 125 000 and USD 120 000 respectively. The annual budgets for each of the operation phase programmes are shown below.

Table 11-6: Estimated budget for the operation phase environmental management framework.

Item		Operation Phase					Total
		Year 1	Year 2	Year 3	Year 4	Year 5	
1	Water Qyality Plan	5 000	5 000	5 000	5 000	5 000	25 000
2	Aquatic Ecology and Fisheries Programme	20 000	20 000	10 000			50 000
3	Biodiversity and Conservation Protection Plan	25 000	25 000	25 000	25 000	25 000	125 000
4	Community Forest Programme	30 000	30 000	20 000	20 000	20 000	120 000
Operation Phase Environmental Management Fr.		**80 000**	**80 000**	**60 000**	**50 000**	**50 000**	**320 000**

11.1 Summary of EMP Budget

Table 11-7 below summarises the budget for the Environmental Management Plan for the operation phase for the Middle Yeywa HPP. The Reservoir Clearance and Filling Plan is largest cost item with USD 420 000. The total SMP budget amounts to USD 1 155 000.

Table 11-7: Summary of the EMP budget

Item		Pre-constr.	Construction Phase						Total
		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	Water Qyality Plan	-	10 000	10 000	10 000	10 000	10 000	10 000	60 000
2	Aquatic Ecology and Fisheries Programme	40 000	10 000	10 000	10 000	10 000	10 000	15 000	105 000
3	Reservoir Clearance and Filling Plan					175 000	175 000	70 000	420 000
4	Biodiversity and Conservation Protection Plan	90 000	60 000	50 000	50 000	20 000	20 000	40 000	330 000
5	Community Forest Programme		20 000	30 000	40 000	50 000	50 000	50 000	240 000
Total Environmental Management Plan Activities		**130 000**	**100 000**	**100 000**	**110 000**	**265 000**	**265 000**	**185 000**	**1 155 000**

12 SOCIAL MANAGEMENT PLAN

12.1 Introduction

12.1.1 Overall Goal and Objectives

The overall goal for the Social Management Plan (SMP) is to mitigate project impacts and to enhance benefits for the stakeholders in the Middle Yeywa Hydropower Project. A first step in achieving this overall goal is to make sure that social mitigation is built into the project design so that negative social impacts are avoided or minimised as far as possible. To this end, a comprehensive consultation process is necessary, giving all stakeholders an opportunity to contribute with their knowledge of local conditions and to express their views and concerns. For the potential negative social impacts that are unavoidable, this plan aims to identify and formulate activities and programmes that reduce the impacts to acceptable levels.

12.1.2 Roles and Responsibilities

As the Developer, SN Power will have the overall responsibility for implementing the SMP. Parts of the SMP will be implemented by the Environmental and Social Unit (ESU) while some activities and programmes may be outsourced to organisations that have the necessary capacity and expertise to implement them. These organisations, to be engaged by SN Power, may comprise both NGOs and government agencies. Through further detailed planning and project development, potential implanting partners will be identified.

12.1.3 Staffing and Organisational Aspects

As set out in the overview of staffing in Chapter 10, the ESU will have a number of specialised teams that will be charged with implementing and monitoring the mitigation programmes. There are two teams in the ESU that first and foremost will have the responsibility for implementing and monitoring the SMP, i.e. the Compensation and Grievance Team and the Social Management and Consultation Team. Each of these teams will be headed by a team leader and be staffed with 3 to 4 specialists with the necessary qualifications. In the event that implementation of the SMP programmes are outsourced, these teams will also function as the main interface between the implementing partners and the Project.

12.2 Stakeholder Engagement Plan

12.2.1 Overall Goals and Objectives

The overall goal of the Stakeholder Engagement Plan is to establish a platform and structure for an effective and continuous dialogue with all stakeholder groups. This will provide greater transparency and enhance project sustainability by creating acceptance and local ownership of the Project. Other important objectives include:

- Ensuring that the views and perceptions of people who may be affected by the Project are taken into account;
- Minimisation of project impacts through stakeholder inputs into design and implementation;
- Keeping potentially affected people and communities informed about project planning and the implementation process;
- Enable potentially affected people to understand their rights so that they may become aware of their entitlements and submit claim through the Project’s grievance mechanism, if necessary.

12.2.2 Roles and Responsibilities

The Environmental and Social Unit Manager (ESU Manager) and the Social Management and Consultation Team will be directly responsible for the detailed planning and implementation of the Stakeholder Engagement Plan. As needed, technical expertise will attend consultation meetings and assist with the presentation of technical plans. It may also be necessary for the Project Manager to participate in the consultation process if more high level and policy issues are presented and discussed.

12.2.3 Stakeholder Consultation Methodology

The stakeholder consultation methodology will comprise of different tools and approaches and will be adapted to the characteristics and composition of each stakeholder group. In the following, the prospective methodologies that may be applied for the different stakeholder groups are briefly described.

Villagers and Village Leadership

The consultative process in the villages has already commenced in the pre-feasibility and feasibility phases, and this will continue to be carried out in a systematic manner by using different approaches and techniques, including qualitative methods of investigation and evaluation. The focus in the pre-construction and the construction phase will be more on the planning of the community development initiatives (CDI), including access road improvement and grid connection, that SN Power will be funding.

The consultation approaches in the next phases are likely to include:

- Moderated village meeting where as many as possible of the village population attend (care will be taken to choose a timing that assures a good attendance);
- Semi-structured interviews with key persons in the village, including the village leadership;
- Focus group discussions with vulnerable groups that will require special attention to help them express their concerns and identify any constraint with respect to benefitting from project supported interventions.

The semi-structured (conversational) interviews will continue to be conducted in a flexible manner by the use of a questionnaire with a limited number of pre-set questions. This technique aims to keep the focus on selected topics while at the same time allowing enough flexibility so that participants can introduce and discuss any topic they see as important.

Focus group meetings will also continue to be conducted in a semi-structured way with small groups of four to twelve participants plus the moderator. Focus group discussions aim to ensure that attitudes, feelings and preferences of people within a specific group are taken into consideration and will be applied as needed with respect to vulnerable groups and others that are perceived to require special attention.

Gender analysis will also be applied as a cross-cutting theme in the village consultations and will focus on understanding the differences in gender roles with respect to project interventions and support programs. Both gender-segregated semi-structured interviews and focus group discussions will be used to ensure women’s voices can be heard during the village consultations.

Local Businesses and Contractors

For local businesses that are interested to utilize the increased market opportunities created by the Middle Yeywa HPP, public meetings will be arranged to inform them about the project planning process and in particular what kind of services and goods that will be required by the Project. The meetings will be held well ahead of the start-up of construction activities to allow local businesses enough time to prepare and plan for delivering services and goods to the Project. These meetings will be held at different strategic venues to allow the business community in a wide circle around the project area an opportunity to attend the information meetings.

District and Township Governments

Some preliminary meetings have been held with local government as part of EIA planning. In the future, information and consultation meetings will be held with the general administrative departments of the two districts and three townships whose territories the Project directly touches on. The meetings will be held according to the formal protocol that the government requires. It is expected that these meetings also will be attended by representatives of government line agencies such as the health and agriculture offices at district and township level. At the meetings, Project representatives will inform about the currents state of the project planning and invite feedback that can be incorporated and taken into consideration in the further planning process. The meetings will also present an opportunity to explore possibilities for cooperation between the Project and local government institutions with regard to implementation and monitoring of Environmental Management Plan/Social Development Plan activities.

State Government

The information and consultation meetings that will continue to be arranged with the Shan State Government in Taunggyi will build on the meetings and discussions already held with the Chief Minister and ministers for the different line ministries, including the Ministry of Electricity and Energy and the Ministry of Construction (see Section 5.4.3). Important topics for discussion will be possibilities for integrated planning and joint implementation of Environmental Management Plan/Social Development Plan programmes, including possible support for village electrification and improvement of road infrastructure (see Section 12.7 below).

12.2.4 Budget and Schedule

It is anticipated that the next phase of the consultation process will start at least one year ahead of the construction activities and continue throughout the whole construction phase. For the operation phase, it is expected that the power company's public relations and Corporate Social Responsibility (CSR) staff will continue consultations as needed. The budget for the operation phase consultations will therefore be part of the annual budgets for the public relations and CSR activities.

For the pre-construction consultations, it is estimated that the consultation activities will require a budget of totally 10,000 USD (not including salaries and allowances of ESU staff) for materials and organizational costs. It is assumed that the construction phase will last for six years and that an annual budget of 5,000 USD will be needed for the first three years, while the annual budget for the next 3 years will be around 2,500 USD. The total consultation budget for the pre-construction and the construction phase will thus amount to 32,500 USD.

12.3 Compensation for Lost Land, Production and Fixed Assets

12.3.1 Overall Goals and Objectives

The objectives for the compensation programme is to survey, record and fully compensate for all affected residential, agricultural and forest land areas as well infrastructure that are affected by the Middle Yeywa HPP. The compensation will be based on full market prices and on the principles of replacement values for all affected assets. In addition to the compensation at replacement value for assets, a disturbance allowances will also be paid as a compensation for the disruption caused by relocation of building infrastructure for project-affected persons/households and for general disturbance due to noise and traffic. The overall goal for the compensation programme is thus to keep all affected persons/households free from harm in an economical sense.

12.3.2 Roles and Responsibilities

SN Power will have the direct responsibility for ensuring that all affected persons/households, businesses and organisations are properly identified are compensated according to their entitlements as described in the Projects compensation policy. Throughout the whole compensation process, the relevant government offices will be consulted to make sure that due process is followed with respect to the legal requirements for land acquisition and compensation for fixed assets and crops.

12.3.3 Staffing and Organisational Aspects

The asset surveys for affected land and buildings will be carried out by the Compensation and Grievance Team of the ESU. The team leader will be in charge of the survey and valuation of assets, supported by a team of 3 to 4 survey and valuation specialists. The Compensation and Grievance Team will work in close collaboration with village authorities and coordinate with local government authorities as needed. In addition, the Social Management and Consultation Team will assist the Compensation and Grievance Team in their work as needed, and especially in connection with negotiations and complaints about compensation awards raised through the projects grievance mechanism.

12.3.4 Specific Activities

Development of a Compensation Policy with Rates and Prices

The Compensation and Grievance Team will initially carry out a survey of the current market rates for land, agricultural commodities and house construction materials. A review of the official government compensation rates will also be carried out to assess whether they reflect market prices. A detailed Project Compensation Rate Policy with prises for different types of land, crops and building infrastructure will subsequently be prepared. Care will be taken to make sure that the rates for all items covered by the policy are equal to or above current market rates to make sure that the rates reflect the actual replacement costs. The policy will be shared and discussed with the local government authorities will to get their approval before it is put into effect.

Land Areas and Fixed Assets Surveys

As soon as detailed technical project planning has progressed to a stage where impacts in terms of loss of land, crops and building infrastructure can be identified with a high degree of certainty, land and fixed asset surveys will be carried out in all project affected areas. The Compensation and Grievance Team will cooperate with the technical planners and surveyors to make sure that all affected assets are correctly identified. All asset surveys will be done in the presence of the land and property owners while the village authorities will be asked to act as witnesses. Identified assets will be recorded on an inventory form and countersigned by all parties present. A copy of the same record will be given to the property owner for future reference.

It is expected that the project components that to the largest degree will trigger compensation payments are the access roads from Nawnghkio to Yae Twin Gyi and further down to the dam site. In addition, land for camp and workshops areas within the Yae Twin Gyi village territory may impact on agricultural land which subsequently will need to be compensated. The types of land and assets that are most likely to be impacted include:

- Residential land ;
- Commercial land;
- Residential buildings/ houses;

- Commercial buildings;
- Agricultural land;
- Forest land

To allow for transport of wide and heavy loads on the access roads, improvement and widening of the road from Nawnghkio to the village of Yae Twin Gyi will be necessary. The impact in term of loss of residential land and need for relocation of building structures caused by the access road improvement, will depend on the final routing of the access road. There may be opportunities for avoiding and minimising loss of land and displacement of structures by using alternative routings around the most narrow and densely populated road sections.

Relocation of Buildings At this stage of project planning it is only possible to give a rough estimate of the costs associated with compensation for loss of residential land, building structures. This estimation has been done using Google Earth satellite pictures to count building structures that appear to be lying within a 20 m (10 m on both sides of the centreline) wide road corridor along the access roads (see ***Figure 12-1***). The result of this analysis indicate that 137 structures may have to be relocated if a 20 m is applied as the minimum required width of the access road corridors. To arrive at an estimate for compensation of buildings, including residential/commercial land, a stipulated value of 3 000 USD per building was used. This stipulated cost is assumed to cover compensation for land, building structures, disturbance allowances as well as compensation for other fixed assets such as trees. By using this approach the actual compensation needs for building structures and properties will probably be overestimated as it does not take into consideration the possibilities to divert from the existing roads. Using the above figures the total budget for compensation caused by widening of the access road will be 411 000 USD.

Loss of Forest Land Regarding forest land, which is owned by the Government, the 1995 Community Forestry Instructions (CFI) gives legal backing to rural communities for sustainable management and exploitation of forests. If access roads and camp areas impacts on community forest land that is managed and exploited by the villagers, compensation for the loss of forest resources may have to be paid. However, an analysis done by Google Earth indicate that the assumed access road alignment from Yae Twin Gyi down to the dam site is unlikely to affect any forested area near the village (see ***Figure 12-2***). Some forest will inevitably be affected by the damsite access road but these forested areas are concentrated at the lover part of the valley and will probably be limited to around 10 ha. It is assumed that no compensation will have to be paid for the government owned forestland.

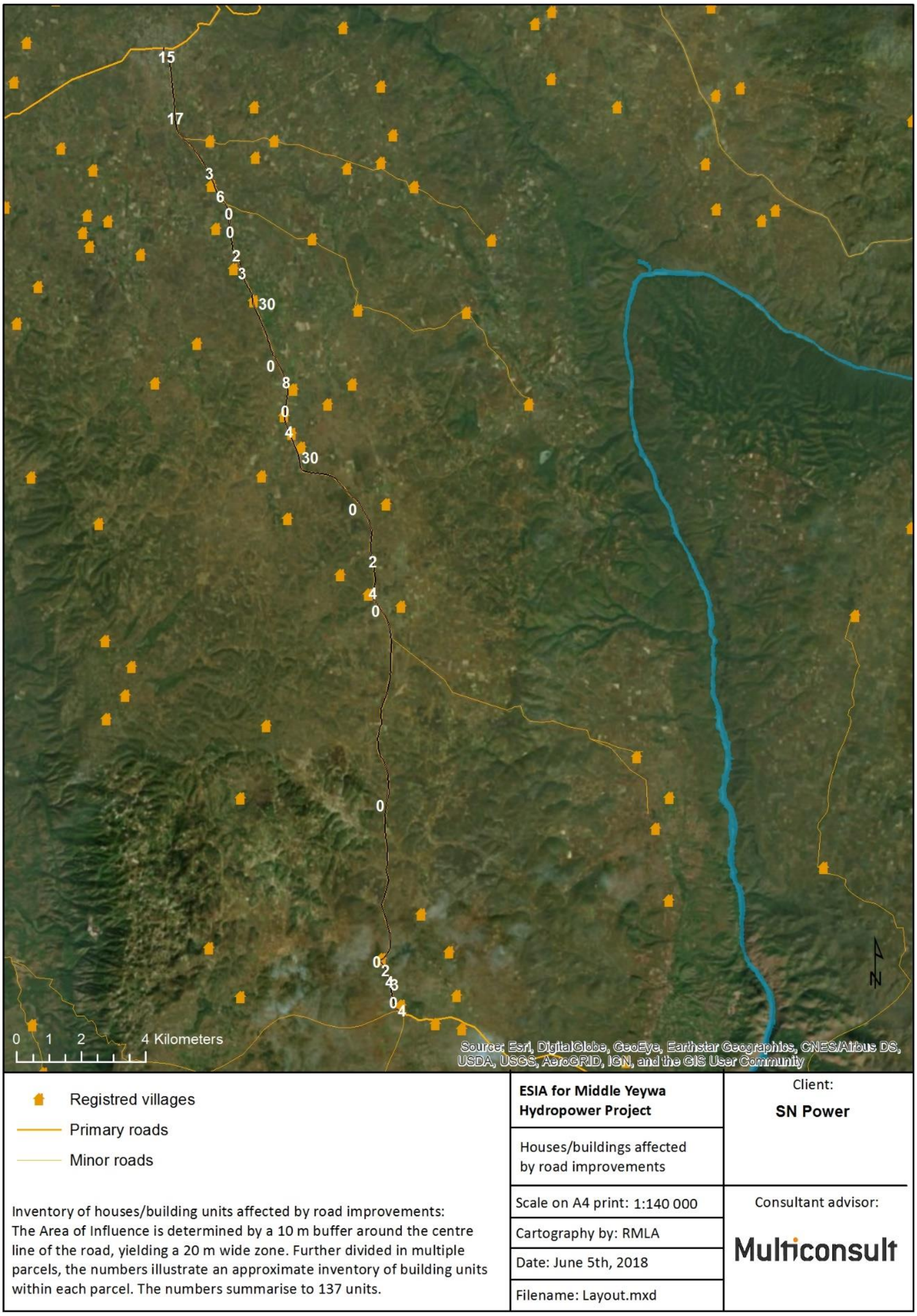


Figure 12-1: Building Structures within a 20 m wide road corridor along access roads from Nawnghkio to Yae Twin Gyi.

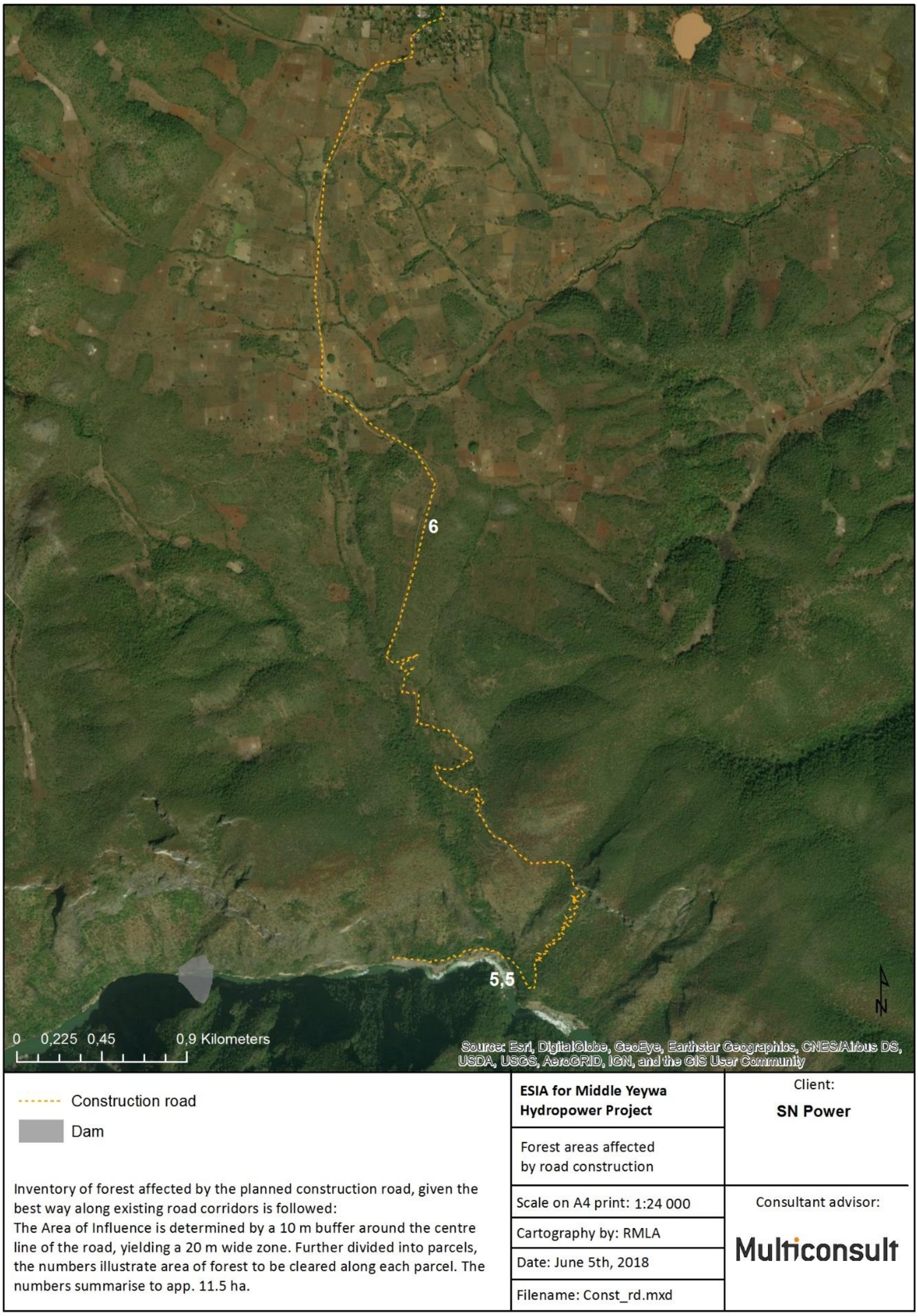


Figure 12-2: Assumed alignment of access road from Yae Twin Gyi to dam site

Agricultural Land The access road from Yae Twin Gyi to the dam site will most likely first follow the existing track across the agricultural fields on the plateau and Google Earth analysis indicate that the track is largely wide enough to accommodate a 20 m wide road corridor (see ***Figure 12-2***). However, the some agricultural land may have to be taken for the road construction. Assuming that the access road corridor will affect a total distance of 500 m of cultivated fields the total loss of agricultural land will be 1.0 ha. Regarding land requirements for camps and other project facilities there should be ample possibilities for locating these on marginal and non-agricultural land and on the plateau around Yae Twin Gyi. However, some loss of agricultural land due to camp and project facilities cannot be ruled out and it is assumed that this could amount to another 1.0 to 2.0 ha of agricultural land. For good measure, it is stipulated that the loss of agricultural land will be 3.0 ha in total. The compensation cost for one ha of paddy land in connection with other projects in Kyaukme District (Gote Twin bridge) has been around 26 000 for developed paddy land and around 17 500 USD for upland agricultural fields. A compensation amount of 20 000 USD per ha has been assumed for agricultural land in the Yae Twin Gyi area and the total compensation for agricultural land is therefore estimated to be 60 000 USD.

Compensation Payment Modalities

On the basis of signed inventory forms and approved compensation rates, valuation forms showing the awarded compensation for the individual property owner/household will be prepared. If accepted and countersigned by the property owner, the compensation can be transferred. To make the compensation payment process transparent and safe, the compensation will only be transferred to the property owner's bank account. The Project will open bank accounts for those property owners that do not already have a bank account.

Compensation Options - Replacement in Kind or Cash Payment

The non-vulnerable project affected persons/households will be offered the choice between replacement of lost assets in kind or cash compensation payments. In the case of in-kind replacement, the Project will take the full responsibility to procure all construction materials and to engage builders to constructs replacement commercial or residential buildings.

12.3.5 Grievance Mechanism

In line with IFC's requirements and to ensure that the basic rights and interests of the project affected persons/households are protected, that concerns are adequately addressed and entitlements delivered, a grievance procedure will be set-up. All affected persons/households will be informed about the existence of a defined process for expressing dissatisfaction and to seek redress. Information regarding the existence of this procedure will be made public during the consultations as well as during the asset survey and compensation process.

Grievances and disputes related to resettlement and compensation may arise for different reasons including:

- Mistakes related to the identification of affected property;
- Disagreements related to the ownership of property;
- Disagreements regarding land and asset valuation;
- Disagreements regarding other compensation allowances.

Proposed Grievance Procedure / Structure

The most important element of the grievance resolution is conflict avoidance. The consultative and participatory approach that will be employed for the compensation process is intended to minimise the occurrence of disagreements and conflicts regarding entitlements. In instances where disagreements do occur, it will be important that they are resolved quickly before positions harden and disagreements escalate.

If a project affected person/household or person is not satisfied with the awarded compensation or if, for any reason, the compensation is not provided in accordance with the Project's entitlement policy, the affected person/household shall have the right to lodge a complaint/grievance.

Village Grievance Committee

The Village Grievance Committee (VGC) will function as the lowest grievance level. When affected households/persons are dissatisfied with their awarded compensation, they will first address their grievance to the VGC. The VGC will try to resolve the issue and bring the complaint to the ESU and the Grievance and the Compensation Team for reconsideration of the survey result and the valuation of the land or asset. If it is found that the compensation has been awarded on faulty survey data or an erroneous valuation computation, a new compensation award will be offered by the Project.

If the VGC cannot resolve the grievance or if the claimant is not satisfied with the offer of settlement from the Project, the VGC or the claimant can refer the grievance to the next grievance level.

Township Grievance Committee

As the second grievance level, it is suggested that a Township Grievance Committee (TGC) be established. The TGC will be composed of a representative from SN Power management, a representative from the General Administration Department and the Township Planning Office.

The TGC will consider grievances that are referred to it and try to reach an agreement with the affected households/persons by offering additional compensation or support if the grievances are found to be justified.

The TGC will be required to respond to any claim or grievance within one month and the ruling of the TGC will be binding on SN Power. The TGC cannot, however, award compensation that goes beyond established precedents.

Both the VGC and the TGC will maintain written records of the grievances they address and their decisions.

Referral to the Courts

If the claimants do not accept the decision of the Township Grievance Committee, they can, as a last resort, refer their grievance to the courts, as is their right under the Land Acquisition Act through an application to the Collector.

The grievance procedure is illustrated in **Error! Reference source not found.*Figure 12-3*** overleaf.

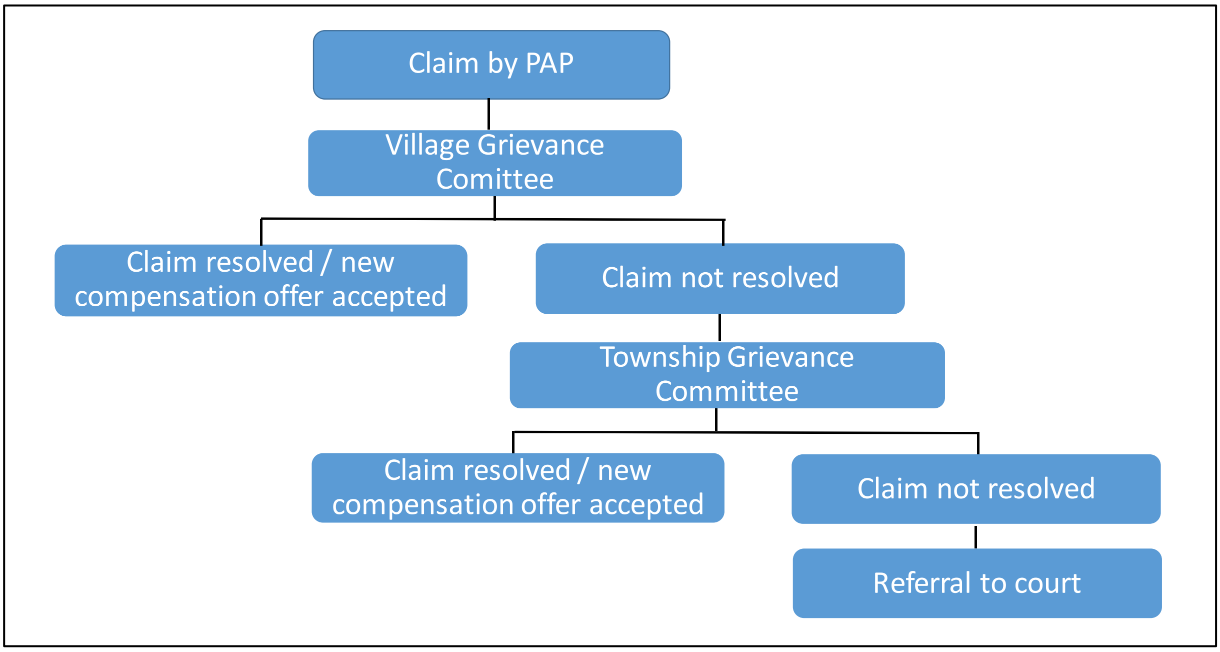


Figure 12-3: Proposed Grievance Mechanism for the Middle Yeywa Hydropower Project

12.3.6 Budget and Schedule

The compensation payments for fixed assets will have to be completed before building structures residential land and other fixed assets are affected by construction activities. It is therefore assumed that all compensation costs are paid in the pre-construction phase and in the two first years of the construction phase. The costs for building structures and properties plus agricultural land add up to 142 000 USD for the pre-construction year, 147 000 for the first year of the construction phase and 137,000 for the second year. The total compensation costs thus amount to 426 000 USD.

12.4 Social Management for Construction Areas

12.4.1 Overall Goals and Objectives

The construction of the Middle Yeywa HPP will involve the employment of approximately 700 workers at the peak of the construction phase. The establishment of camps for workers and contactors is expected to attract a certain number of in-migrants that will impact on and interact with villages located near the project camps. Given experience with other in the region the number of in-migrants will probably not exceed the number of workers and could be less than this. However, a Social Management Plan will be required to limit and mitigate the impacts of the population influx especially with regard to health issues and preventing traffic accidents

The Social Management Plan aims to comply with the requirements of IFC's Performance Standards, most notably Performance Standard 2 – Labour and Working Conditions and Performance Standard 4 – Community Health, Safety and Security.

The objectives of the Social Management Plan for the construction areas of Middle Yeywa HPP are to:

- Minimize and limit negative impacts associated with the influx of camp followers and people seeking to benefit from the market and business possibilities of all kinds created by the Project activities;
- Address the concerns of the residents in or close to impacted areas with regard to security and health concerns;

- Make sure that in-migrants and host village populations have access to basic sanitation facilities and safe drinking water to safeguard their health condition and prevent disease outbreaks;
- Prevent and reduce incidents of Sexually Transmitted Diseases.

12.4.2 Roles and Responsibilities

SN Power will have the overall responsibility for implementing the activities aimed at preventing and reducing potential negative social impacts in the construction areas. However, it is expected that the local authorities will be an important partner in the implementation and monitoring of planned activities and that some of the implementation responsibilities can be delegated to township and village level authorities.

12.4.3 Staffing and Organisational Aspects

The Social Management and Consultation Team of the Environmental and Social Unit (ESU) consisting will be responsible for detailed planning and implementation of the social mitigation and management activities. The team will cooperate closely with Nawnghkio Township government authorities and village authorities when it comes to planning and implementation of specific activities.

12.4.4 Specific Activities

Management of Camp Followers

It is assumed that in-migrants and people who are seeking some kind of business opportunity in connection with the Project will seek accommodation in villages in the project area rather than settling in unmanaged camps close to the workers' camps. The villages that receive the camp followers may have limited capacity to absorb the in-migrants and therefore some kind of preparedness for managing the potential population influx has to be put in place. The Environmental and Social Unit through its Social Management and Consultation Team will therefore prepare a plan for management of in-migrants that will address the following main issues:

- Improvement of water supply and sanitation infrastructure in receiving villages;
- Health status and services for the in-migrants and local population ;
- Security and population management issues.

Depending on the actual influx of people there may be a need to improve water supply and sanitary conditions in the villages that receive in-migrants. In addition, there will be a need to organise an effective waste collection and disposal system.

In addition to safe water supply, sanitation and waste collection and disposal, there are a number of other outstanding health issues. Cooperation with local health authorities will be established to carry out monitoring of the general health situation among the in.migrants. This may include monitoring of births, mortality, causes of mortality and illness. Regarding monitoring of Sexually Transmitted Infections engaging an NGO to assist in carrying out this task will be considered if the responsible government agencies at township/district or state level does not have the sufficient capacity.

For internal security reasons and potential negative impacts on nearby communities (crime or negative social influences), a proper management of the in-migrants will be necessary. This will have to be done in close collaboration with the local authorities and village authorities. Possible population management issues will include:

- Proper registration of new individuals and families settling in the vicinity of the workers camps and local communities;
- Development of a system for the registration and tracking of temporary residents;
- Monitoring of informal entertainment venues and "truck stops".

Traffic Safety Measures

As a result of project activities and the upgrading and construction of access roads in the project area, more accidents and incidents are likely if proper measures are not introduced. Project related traffic can be expected to increase considerably along the new main access from Nawnghkio to Yae Twin Gyi village which is the village located closest to the dam and powerhouse site. Measures to reduce traffic related accidents may include the following:

- Adherence to standard safety procedures and regulations regarding noise and dust pollution, such as regulating working hours for heavy machinery, signposting and watering of roads in inhabited areas;
- Construction of speed bumps at strategic locations on the roads;
- Development of traffic regulations and monitoring for implementation in project construction areas;
- Implementation of a road safety programme for schools along the upgraded or new access roads.

Sexually Transmitted Disease Control Measures

According to the Global AIDS Response Progress Report for Myanmar (Ministry of Health, 2015), the HIV infection rate for female commercial sex workers was estimated to be around 6% in 2014. Given the fact that the Project will be employing a considerable number of workers and also attract in-migrants, there is a risk that the Project may lead to an increase in the number of commercial sex activities in the wider project area, for instance in connection with informal "truck stops" along local roads. Local authorities can be expected to control these kind of activities efficiently but there will be a need for support from the Project in terms of funds for HIV/AIDS prevention campaigning. The ESU will therefore engage an NGO that has the necessary experience and capacity to develop and implement an Information, Education and Communication (IEC) campaign for workers, commercial sex workers and surrounding communities, ensuring that both women and men have access to the information. This will be done in close cooperation with the local health authorities

Conflict Resolution Measures (Villages vs. Workers/Camp Followers)

With the establishment of project camps, conflicts between villagers and construction workers or camp followers may arise due to improper behaviour and disputes about money and payments. The best mitigation measure regarding these potential conflicts is conflict avoidance, hence channels for consultation and conflict prevention must be put in place. In the cases that conflicts do occur, all efforts should be made to resolve them quickly before they escalate and become intractable. For this reason, different approaches may be required according to the seriousness of the conflicts, including:

- Conflict avoidance through participatory planning and decision making;
- Simple disagreements resolution through informal negotiation, discussion and mediation;
- Solution of established conflict situations by use of the Project's Grievance Mechanism;
- Intractable conflicts may be referred to the local court system.

12.4.5 Budget and Schedule

In-migrants

For the management of in-migrants and construction of water supply and sanitary facilities in receiving villages, a lump sum of 30,000 USD to be expended early in the construction phase has been stipulated. For health checks and other health related activities in the six year construction phase, a total sum of 5,000 USD per year is assumed. The total budget for in-migrants amounts to 55,000 USD.

Traffic Safety

Traffic safety campaigning and implementation of traffic safety measures will start before the construction and continue through the first three years of the construction phase. A lump sum of 10,000 USD is assumed for the pre-construction phase while 5,000 USD is stipulated for the first three years of the construction phase. This amounts to a total traffic safety budget of 25,000 USD.

Sexually Transmitted Diseases (STD)

The IEC activities for the local population will start in the pre-construction phase and continue with the inclusion of workers and camp followers into the construction phase. Although it is anticipated that most of the IEC activities will be implemented during the early construction phase it will need to be followed up by monitoring as long as there are construction workers and in-migrants in the area. A lump sum of 5,000 USD has been assumed for the pre-construction period while 10,000 USD annually is stipulated for the first three years of the construction phase. For the last three years, an annual budget of 5,000 USD is assumed. The total budget for the STD control measures will thus amount to 50,000 USD.

Total Social Management Budget

Regarding the costs for resolving conflicts between workers, in-migrants and the local population, it is assumed that they will be covered by the consultation budget. The three other components under the Social Management for Construction Areas programme will totally amount to 130,000 USD.

12.5 Community Development Initiatives (CDI)

12.5.1 Overall Goals and Objectives

Establishing good relations with impacted communities and local government is necessary for the long-term operations of the Project. Benefit-sharing in the form of supporting local development and through sustainable initiatives should lead to cooperation and stable conditions during construction and operation, as well as benefits to communities in the project affected area.

As part of the preparation for this document, consultations were held with all local communities directly affected by the project or in the vicinity of the project and with local and regional governments. Views and concerns were solicited from these stakeholders and options were investigated in terms of feasibility and practical arrangements within the scope of the project. The following areas were repeatedly mentioned by many stakeholders:

1. Rural road construction or upgrading existing tracks;
2. Rural electrification;
3. Water supply.

After these initial consultations were held, meetings were conducted between the Developer and various government agencies in order to acquire information about ongoing government infrastructure projects and regional and local plans. It was important to identify synergies between potential project assistance and existing government plans so that any contribution the Project made would be compliant with and complement government priorities and initiatives.

Part of the discussions with local and regional organizations also related to obtaining an understanding of routines, procurement and procedures, as well as capacity of various agencies that would be involved in joint implementation arrangements.

12.5.2 Roles and Responsibilities

The implementation of the CDI will require a close cooperation between the Project and the government. It is proposed that a committee be formed that consists of relevant government implementation agencies and representatives from the Developer in order to coordinate detailed planning and design, procurement and supervision of contractors.

Using existing government procedures and routines will guide the implementation process, and the Developer will have the role of technical advisor and supervision/quality control of the work.

12.5.3 Staffing and Organisational Aspects

In terms of staffing, the Developer will have one engineer to oversee the planning, procurement and quality control of the activities. In addition, there will be 2-3 field supervisors to jointly supervise the work in accordance to specifications and health and safety standards.

On the government's side, existing staff in relevant agencies and support organizations will provide expertise in detailed planning, drawing up tender specifications, contract selection and supervision/quality control. Monitoring of compliance with contracts and health and safety should be carried out jointly. Regular reports on progress shall be submitted to the committee.

It is assumed that the government contribution to the planning and supervision in terms of manpower resources will be provided without cost to the Project and that the project staff work closely with them. The costs of materials and other expenses necessary for construction will form part of the project budget.

12.5.4 Specific Actions

Rural Roads

Compared to many areas in rural Myanmar, the project area has a relatively good rural road system. However, conditions of rural roads (unsealed) differ greatly within the project area. Roads on the right bank (Zone 4a) and lower left bank (Zone 4c) are in considerably better condition than those on the upper left bank (Zone 4b) due to terrain. The former areas are relatively flat and some of the roads are elevated with drainage whereas the hilly terrain on the left bank can severely limit access in the rainy season.

In terms of the level of upgrade, an assessment of construction cost versus maintenance costs has been undertaken with government authorities. The following choices were presented:

- Upgrade to gravel road (12 feet wide and 1 foot in depth) is approximately 100,000 USD per mile
- Upgrade to sealed asphalt road (12 feet wide and 1 foot in depth) is approximately 125,000 USD per mile;
- Upgrade to concrete road (12 feet wide and 1 foot in depth) is approximately 170,000 USD per mile.

The gravel road is the cheapest type but will require more maintenance. Thus the sealed asphalt road is the preferred option as the cost is 20% higher but the maintenance is considerably less. The option of concrete roads is considered too high for rural roads that are not heavily trafficked.

Main Project Access Road – Right Bank (Zone 1c)

The main road traversing the project area, National Road (NR) 41, joining the State Capital, Taunggyi, to Nawnghkio via Lawksawk is presently being upgraded by the government and due to be completed by 2020. This will result in a sealed, two-lane road (3.6m in width). The project will need to upgrade a section of this road from Nawnghkio to the project construction site to a width of 5.5m and capable of handling 60-tonne loads.

The costs for this road upgrade are covered in the technical contractor documents. However, there may be compensation payments despite the fact that the Right-of-Way is defined and ample enough for the expansion of the road (see 12.3.4).

The existing rural road from National Road 41 in the direction of Yae Twi Gyi will need to be upgraded to a project access road in sections and a new road will need to be constructed that bypasses the village and continues onto the dam site. Estimates of the compensation costs for infrastructure and land are provided in Section 12.3.4.

There may also be minor compensation costs related to the construction of the new bridge and possible new roads linking that to NR 41. It will only be possible to estimate this after a detailed design is completed. The section of the road from the upgrade stress of NR 41 to the bridge will remain in accordance with the planned government upgrade as this route will not be essential for the project except limited vehicular traffic.

Rural Roads Development – Right Bank (Zone 4a)

NR 41 runs parallel to the river on the right bank in Zone 4a. This is a paved road and facilities good market access for these villages along the road and in villages on each side. Rural roads to the villages are not paved but in reasonable condition with some simple structures and drainage due to the fact that most are raised above the surrounding fields. In the wet season, some of these roads become muddy but villagers are still able to use the roads throughout the year.

The government presently has no immediate plans for upgrading village rural roads on the right bank. The Department of Border Affairs and National Races in Taunggyi indicated that this was not a prioritized area but was aware that the present conditions were not satisfactory as the roads were often damaged during the wet season and by heavy loads

The upgrade of these rural roads are not connected to the project schedule but linked indirectly to the upgrade of National Road 41 to which these roads would be linked. However, as a benefit sharing measure it is proposed that the following roads are assessed and upgraded:

- NR 41 to the village of Naungcho Gyi (approximately 12 km or 7.5 miles) via several other village sites;
- NR 41 to Naung Lin, Yae Maung Tan, Meh Poke and Naung Cho Kone (approximately 15 km or 9.5 miles).

The estimated costs for sealed surface (asphalt) amounts to 125 000 USD x 17 miles = 2.125 million USD. Additional costs of culverts and other features will likely bring the cost to 2.5 million USD.

In terms of schedule, it is proposed that these roads be considered first as they will be to villages closest to project activities in terms of traffic and reservoir impacts. It may be possible to start the work on one part of the road in the preconstruction phase in order to indicate to stakeholders, both local government and villagers, the intensions of the project.

Rural Roads Development – Upper Left Bank (Zone 4b)

The rural road leading from NR 41 to the villages of Thar Si and Pin Ping is in very poor condition as the road passes through steep terrain with gullies and streams. Sections of the road are virtually impassable during the wet season and have deep ruts due to heavy traffic. The first 5km would require considerable repair and possible realignment. These roads are presently not part of any government plans and no survey has been undertaken for these sections.

The upgrade of these rural roads are not connected to the project schedule but linked indirectly to the upgrade of National Road 41 to which these roads would be linked. The National Road 41 upgrade probably needs to be finished before rural roads can be upgraded.

This bank of the river is presently under the nominal control of the Shan State Army South and any work along this route would have to follow an agreement between the SSAS and the government in terms of security.

The road areas that are proposed for assessment and upgrade include:

- NR 41 to the village of Thar Si (approximately 10 km or 6 miles) but the first 5 km will require considerable work with culverts and drainage due to the steep terrain and present very poor condition of the route.
- From Thar Si to Pin Ping (approximately 10 km or 6 miles) – the terrain is flatter here with little need of culverts

The estimated costs for sealed surface (asphalt) amounts to 125,000 USD x 12 miles = 1.5 million USD, while additional costs of culverts and other features will likely bring the cost to 1.8 million USD.

In terms of schedule, it is proposed that these roads be considered second as they will provide access to villages near to project activities on the left bank but not affected by traffic or construction activities.

Rural Roads Development – Lower Left Bank (Zone 4c)

National Road 41 is presently being upgraded from Nawnghkio to Lawksawk and the existing state of this route is fair to good. One rural road leads from Kyauk Ku town to the villages of Tawng Hkan and Hpet Yin Kone, which are closest to the project area south of the dam site. The road is not paved but in reasonable condition with some simple structures and drainage. Although the road is not connected to the project schedule, it is proposed to upgrade them as a benefit sharing measure. The section that is proposed for upgrade and improvement starts at Kyauk Ku on Road NR 41 and runs to the village of Hpet Yin Kone via Tawng Hkan (approximately 12 km or 7.5 miles). There are many other villages in the area which will be able to benefit from this upgraded section of the road.

The estimated costs for sealed surface (asphalt) amounts to 125,000 USD x 7.5 miles = 940 000 USD. Additional costs of culverts and other features will likely bring the cost to 1 million USD.

In terms of schedule, it is proposed that these roads be considered third as they will provide access to villages on the left bank that are not directly affected by traffic or construction activities.

Contracting Arrangements

Most government departments have staff that not only work on design and supervision but also full-time work crews for construction, repair and maintenance. These are local mobile work teams who draw a salary from the government departments to which they are attached. Hence, work forces are already available and the Project will need to coordinate with government as to availability in relation to ongoing programs and activities. This will determine the schedule unless companies are hired in addition to these work forces.

A government tendering process is used for acquiring construction materials. There are lists of qualified companies and a selection process. This process will need to be vetted so that it is completely transparent and compliant with SN Power and IFC standards for selecting contractors.

The government has qualified design teams and can provide detailed technical documents after surveying the different routes. The Company will need qualified engineers, either staff or consultants, to check the designs, bills of qualities and selection of suppliers.

Right-of-Way and Compensation

There are different Right-of-Way (RoW) measurements for different road standards. Although these standards are defined there is evidence, especially in villages and built up areas, of encroachment into the RoW since in rural areas this is not always enforced systematically. Much will depend on the road alignment and avoiding structures but it is likely that some structures will need to be removed and relocated or new structures built so that there is no loss of physical structures.

A detailed assessment will be required after the draft road alignment is studied and options are presented. Only detailed planning will reveal whether there are compensation issues to be address in the road upgrades. Any expenses in this regard should be covered by contingency funds for CDI activities.

Rural Electrification

All villagers in the project direct and indirect impact areas mentioned rural electrification during consultations. There were strong opinions in terms of expectations since it was understood that a hydropower investment would increase electricity production for the country and be located adjacent to areas without electricity at present. Except for a few micro-hydro schemes that run when water is available and a limited number of solar panels, there are presently only small tractor driven generator sets that provides villages in the project area with electricity. People also use car batteries for televisions.

Villages in this area are not a priority and are category ‘C’, as the government is putting its resources into main lines along road corridors and not primarily extensions into rural areas.

The government agencies have provided estimates of the cost of establishing rural lines based on ongoing rates and prices and approximations in USD:

- 11kV transmission line 1 mile = 23.7 million Kyats (17,500 USD);
- 11kV/400V transformer for 100 Household = 11.5 Million Kyats (8,500 USD);
- 400V distribution line 1 mile = 33.1 million Kyats (24,500 USD);
- Connection fee per household of 250 USD.

These costs have been used for estimating budgets for the rural electrification initiatives.

Rural Electrification – Lower Left Bank (Zone 4c)

None of the villages off the main road (NR 41) have access to electricity but there is evidence that the government is planning or has been planning to install electricity as some concrete poles were observed along the road into Hpet Yin Kone. No solar or micro-hydro plants were observed in this area.

The project will consider electrification of two villages with a total estimated population of 1,257 people divided on 277 households. Further extension of the line on this bank would also be possible but this would be for settlements outside the project impacted area and would be covered by the government or part of project assistance during operation. The two villages considered for electrification are

- Tawng Hkan
- Hpet Yin Kone

The transmission line along NR 41 will facilitate this extension of the grid to villages in the lower left bank (Zone 4c). Hence, this work could commence first before other lines are in place that would facilitate extension of the grid to other rural areas.

It is difficult to estimate costs as the extent of project support will be based on the overall scope of rural electrification assistance and support, and approval of government plans and surveys. However, the following costs have been used as a basis for arriving at a tentative total cost for the electrification of these two villages:

- 11kV line for ca. 7.5 miles: 131 000 USD;
- At least 4 substation facilities: 36,000 USD (depends on the village population);
- 400V line in villages (approximately 6 miles): 147,000.

Total cost for Phase 1 would be approximately 314,000 USD

Rural Electrification – Right Bank (Zone 4a)

The urban area of Nawnghkio has a grid connection which provides it with a relatively stable electricity supply. From Nawnghkio there is a line 11 kV line that goes to the military facilities on the Right Bank. There is evidence of some solar panels for domestic use and small units for charging mobile phones and two mini-hydro plants that work intermittently for providing electricity to temples and community buildings. People also use car batteries for televisions.

It will be necessary to see if there are any synergies between the project needs and electricity supply to the site along NR 41 corridor which could reduce the cost of providing costs.

The project will consider electrification of the following villages:

- Ma Gyi Yae and village along the road;
- Nawnghkio Gyi and villages along that route (Hpar Thun, Nyang Taw and Nawng Lin (1));
- Nawng Lin (2), Yae Maung Tan, Meh Poke and Nawnghkio Kone;
- Yae Twi Gyi.

A transmission line (government or project) needs to be in place along the access road south of Nawnghkio in order to facilitate further extension of the grid to villages along the right bank of the project. The timing of when this rural electrification work can commence will depend on the demands for electricity by the project during construction and how these may be accommodated in relation to rural electrification.

It is difficult to estimate costs as the extent of project support will be based on the overall scope of rural electrification assistance and support, and approval of government plans and surveys. It is expected that the electrification of villages will be done in four different phases so that the construction costs will be spread out over time.

Phase 1: Yae Twin Gyi should be electrified first as it is the village closest to the construction area. Other villages (Met Hlut, Loi Pang, Taung Gyi and Ah Nauk Kone) along this route may also be included. The following cost estimates have been applied to arrive at a tentative cost for village electrification in Phase 1:

- Line from NR 41 to Yae Twin Gyi approximately 4 miles: 70,000 USD;
- 10 substations: 85,000 USD;
- 400V line in villages (approximately 6 miles): 147,000.

Based on these figure the total cost for Phase 1 would be approximately 302,000 USD

Phase 2 In this phase villages in the upper parts of Zone 4a will be connected to the grid from the town of Nawnghkio. The following cost estimates have been applied to arrive at a tentative cost for village electrification in Phase 2:

- Line from Nawnghkio to Nawnghkio Gyi and villages along that route (Hpar Thun, Nyang Taw and Nawng Lin (1) – approximately 10 km or 7 miles: 122,500 USD;
- 8 substations: 68,000 USD;
- 400V line in villages (approximately 8 miles): 196,000 USD.

Based on these figures the total cost for Phase 2 would be approximately 386,500 USD.

Phase 3 Electrification in phase 3 will cover villages in the upper parts of Zone 4a, the next group along a rural road leading to the edge of the Plateau. The following cost components have been assumed:

- Line Nawng Lin (2), Yae Maung Tan, Meh Poke and Nawnghkio Kone – approximately 15 km or 9.5 miles: 162 250 USD;
- 8 substations: 68,000 USD;
- 400V line in villages (approximately 8 miles): 196,000 USD.

Total cost for Phase 3 would be approximately 430,250 USD

Phase 4 Phase 4 will consist of one village along the road to the bridge in Zone 4a. The following cost components have been assumed:

- Yae Twi Gyi – approximately 4 miles: 70 000 USD
- 2 substations: 17,000 USD
- 400V line in villages (approximately 2 miles): 49,000 USD

Total cost for Phase 4 would be approximately 136,000 USD

Rural Electrification – Upper Left Bank (Zone 4b)

There are a few houses in this zone that utilize small solar panels and batteries for specific needs, like charging mobile phones or televisions. Electrification of this zone is presently not part of any government plans and no survey has been undertaken for these villages. In addition, this zone is nominally under the control of the Restoration Council for the Shan State (RCSS) which limits government development initiatives in the area.

The Project could consider electrification of Thar Si and Pin Ping which together have a population of around 3000 people. Further extension of the line on this bank would also be possible but this would be for settlements outside the project impacted area and be the responsibility of the government.

Discussions with technical teams from the government proposed that the most cost-effective means of extending the grid to these villages would be to link up with a 11kV line on the right bank rather than construct a new line along the existing track. The following conditions need to be in place before such an extension can be supported by the project:

- Identify the best location for the 11kV line on the right bank near the villages of Nawnghkio Gyi or Nawng Lin for a possible crossing. This will depend on surveys and the best location where a line can be continued over the river to the upper left bank;
- Since this bank of the river is presently under the nominal control of the RCSS, any work would have to follow an agreement between this organization and the government in terms of security;

The estimated costs of constructing an 11kV line to villages in Zone 4b and distribution system within the villages have been calculated as follows:

- 11kV line for ca. 10 km: 175,000 USD;
- Additional high towers for river crossing: 0.5 million USD;
- 4 substation facilities: 50,000 USD;
- 400V line in villages (approximately 3 miles): 61,500 USD.

The total cost for electrification of Thar Si and Pin Ping has been estimated at approximately 786,500 USD

12.5.5 Other Interventions

In the village consultations improved water supply has been suggested as one possible community development intervention in addition to road improvement and electrification. Today the project area villages are in general relying on mainly surface water sources and poorly protected shallow wells for their water supply. This lack of clean water supply is along with poor sanitation facilities part of the reason for a relatively high incidence of that diarrhoea in the villages.

The Project will through further consultations and discussions with local authorities consider funding improvement of water supply in targeted villages with poor water supply facilities in order to improve health conditions and to lessen the work burden, in particular for women and children who normally are those in the household responsible for fetching water.

As improving only the water supply probably will be insufficient for improving health conditions in villages the Project will also consider improvement of sanitation facilities such as latrines to be implemented alongside the water supply.

If improved water supply and sanitation facilities are prioritised as desirable community interventions by local authorities and communities, more detailed plans will be developed and costed before a final decision regarding these possible community interventions are taken. A total amount of 200 000 USD has been stipulated for investments in water supply and for the whole 6 year construction period.

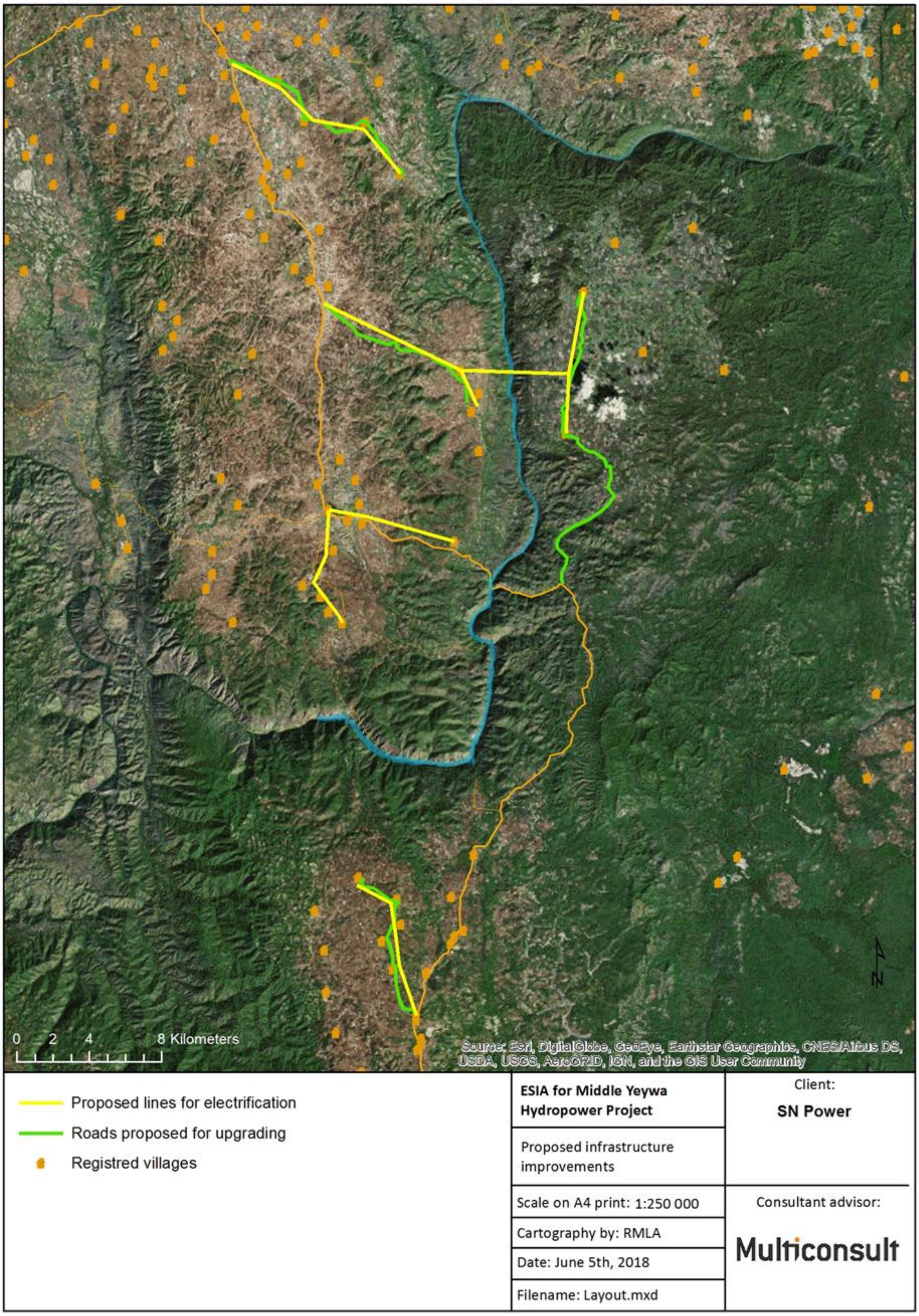


Figure 12-4: Proposed villages road improvement and transmission lines for village electrification

12.5.6 Budget and Schedule

The total Community Development Initiative budget will amount to 8 305 250 USD. The breakdown per year and type of initiative is shown in the table below.

Table 12-1: Community Development Initiative Budget

No	Item	Zone	Pre-constr	Construction Phase						Total
			Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	NR 41 to the village of Naungcho Gyi Road Upgrade	4a	200 000	800 000	200 000					1 200 000
2	NR 41 to Naung Lin, Yae Maung Tan, Meh Poke and Naung Cho Kone Road	4a		300 000	1 000 000					1 300 000
3	NR 41 to the village of Thazi Road	4b			200 000	800 000				1 000 000
4	From Thazi to Bin Bine Road	4b				200 000	600 000			800 000
5	NR 41 at Kyawk Ku to the village of Hpet Yin Kone via Tawng Hkan Road	4c					200 000	800 000		1 000 000
6	Kyawk Ku to the village of Hpet Yin Kone via Tawng Hkan electrification	4c	100 000	214 000						314 000
7	Ma Gyi Yae and villages along the road - electrification	4a		302 000						302 000
8	Nawnghkio Gyi via Hpar Thun, Nyang Taw and Nawng Lin villages electr.	4a			386 500					386 500
9	Nawng Lin (2), Yae Maung Tan, Meh Poke and Nawnghkio Kone electr.	4a			430 250					430 250
10	Yae Twi Gyi village electrification	4a				136 000				136 000
11	Thazi and Bin Bine electrification	4b				786 500				786 500
12	Additional support for electrification of villages near project impact areas						100 000	100 000	100 000	300 000
13	Water Supply and other possible interventions (to be identified)			20 000	40 000	40 000	40 000	40 000	20 000	200 000
14	Assistance for Road Maintenance						50 000	50 000	50 000	150 000
	Total budget for Community Development Initiatives	Na	**300 000**	**1 636 000**	**2 256 750**	**1 962 500**	**990 000**	**990 000**	**170 000**	**8 305 250**

12.6 Workforce Recruitment and Employment

12.6.1 Overall Goals and Objectives

The overall goal of the workforce recruitment strategy is to ensure that the local population benefit from the employment opportunities created by the Middle Yeywa HPP. As is the case with most hydropower in developing economies, populations in project impacted areas indicated a keen interest in obtaining work during the construction phase. There are a number of opportunities and challenges regarding using local labour. The advantages include providing income directly to local communities, improving skills and long-term opportunities for workers through work experience, reducing the size of work camps and impacts on the local communities, possible reduction of costs for the developer and contractors, and obtaining support from local communities during the construction phase.

However, there are some challenges as well. Contractors often prefer to use trusted and tried workers and can be reluctant to use local labour that are often concerned with other tasks, such as labour requirements during harvesting or taking days off for local festivals and events. Contractors are also often unwilling to use resources to train new workers.

In addition, the project area is relatively prosperous in terms of income levels due to investments in cash crops, market access and relatively good infrastructure and services. The expectations for salaries could be higher than what contractors are willing to pay given that there would be workers available from previous projects at potentially lower rates.

12.6.2 Roles and Responsibilities

The contactors will have the direct responsibility for selecting and recruiting workers of the different categories that they will need. However, SNP will retain the overall responsibility for following up on the recruitment process to ensure that the requirements with regard to hiring national and local workers, specified in the tender documents and in the concession agreement between SNP and the Government, are fully complied with.

12.6.3 Staffing and Organisational Aspects

The Environmental and Social Unit will be responsible for following up the workers recruitment process by the contractors and the sub-contractors. The requirement to preferably recruit local workers shall be specified in the tender documents. The Social Management and Consultation Team will cooperate closely with Nawnghkio Township government authorities and village authorities when it comes to planning and implementation of specific activities. The Social Management and Consultation Team will also monitor the number of local workers hired by the contactors and will facilitate the recruitment as needed by acting as a link between the local villages and contractors.

12.6.4 Specific Activities

Tender Documents

Clauses in the contractor Tender Documents will stipulate that contractors should give preference to local labour over labour from outside the region for similar work. It is proposed that the contactor shall be required to recruit at least 30% of the total workforce locally. Measures will be taken to ensure that labour recruitment is carried out in a fair and transparent manner by contractors and the Company. It will necessary for the Project to work closely with local authorities and villages in facilitating local employment using the following methods:

- Compiling lists of skilled and semi-skilled village and local able-bodied workers with local leaders in the direct impacted areas near the construction site, along the reservoir and along the access roads;
- Provide these lists to contractors prior to mobilisation and monitoring the contractors' local recruitment;
- Consider establishing a recruitment centre with local authorities to ensure an orderly recruitment process;
- Keep statistics on the number of local workers and establish a target level with contractors.

Training and Skills Development

Discussions have been held with the Department of Border Affairs and Development of National Races in Taunggyi in order to obtain information on government training programs carried out by the Human Resource Unit of this department. The unit has regular programs covering teacher training, vocational training (carpentry, masonry and rebar work), and these are implemented by mobile training teams in cooperation with technical colleges. The Project will through the ESU engage with this unit to explore possibilities arranging training courses for local people so that they can acquire skills and qualify them for work on the Project. Training that can enable local people to become suppliers of produce and services will also be considered.

The following programs will be considered for local communities in the vicinity of the project:

- English language skills;
- Carpentry;
- Brick laying;
- Rebar work;
- Agricultural production techniques for food product (vegetable cultivation);
- Processing of local agricultural products, (fruit based snacks etc.).

12.6.5 Budget and Schedule

Cost in connection with workforce recruitment and employment will be covered by the contractors under their construction contact budgets. For covering expenses and allowances for local authorities in connection organising and monitoring the recruitment of local labourers, an annual budget of 5 000 USD per year for the pre-construction phase and the first three years of the construction phase has been stipulated.

For training and skills development a lump sum of 10 000 USD for the same period has been stipulated

12.7 Occupational Health and Safety

12.7.1 Overall Goals and Objectives

The overall goal of the occupational health and safety (OHS) measures to be put in place is to safeguard the health of the workers and to prevent accidents leading to injuries. However, if accidents do occur, the objective is to make sure that routines for providing lifesaving first-aid and stabilisation of the injured workers are in place.

12.7.2 Roles and Responsibilities

SNP will have the overall responsibility for providing necessary medical treatment facilities and ambulance services at the construction site. In addition, SNP will be responsible for monitoring the OHS performance of the contactors, making sure that they comply with all OHS requirements in their contracts as well as national legal OHS requirements.

The contactors will have the responsibility for training all workers in work safety routines and provide them with the necessary personal protection equipment (PPE).

12.7.3 Staffing and Organisational Aspects

An OHS Unit will be established within the project organisation and adequately staffed with OHS specialists and inspectors so that regular inspections can be made at all job sites. The OHS Unit will not be a part of the ESU but the two units will cooperate and coordinate as needed, for instance in connection with issues concerning handling of hazardous waste.

12.7.4 Specific Activities

Occupational Health and Safety Planning by Contactors

The contractors will be required to submit an Occupational Health and Safety (OHS) plan which as a minimum has the following content:

- Description of the their overall OHS policy and its goals;
- Description of potential hazards and risks to workers' safety and health arising from each working site environment;
- Identification of sources of injury and harm that can be eliminated by preventive and/or protective measures;
- Identification of risks that cannot be completely eliminated but can be reduced by preventative measures.

Awareness and Training

In order to achieve the objectives defined in the OHS plan, the contractors should ensure that personnel on all levels in the organisation are aware of and participate in OHS activities.

The contractors shall be required to establish and maintain the necessary arrangements to ensure that all persons with OHS responsibilities at all levels are competent to perform their duties and responsibilities. The contractor shall also be required provide initial and refresher OHS training for all workers. The developer will establish a OHS unit to monitor and supervise the contractors in relation to compliance and standards. This unit will be part of the technical team but will be working closely in coordinating site inspection visits with the ESU and representatives of the contractor.

Incidents Reporting and Investigations

The contractor shall be required to identify, investigate, record and report all incidents including accidents, near misses, diseases, and environmental incidents. The findings and conclusions of every investigation shall be reported to the OHS Unit without delay. The contractor shall notify the Project Developer's HSE Unit and the Project Manger immediately when any accident occurs, whether on site or off site. Such initial notification may be verbal and shall be followed by a written comprehensive report within 24 hours of the incident.

Emergency Preparedness and Response

The contractor shall be required to establish and maintain emergency preparedness and response measures, including first-aid stations, fire-fighting equipment, trained personnel and an evacuation plan in case of emergencies and serious accidents.

The emergency preparedness and response plan shall describe how to provide rapid and effective countermeasures to contain and control incidents and to prevent or limit undesired consequences. The emergency preparedness and response plan shall outline the following:

- Notification and warning procedures, including coordination with the OHS Unit;
- Evacuation procedures;
- First-aid facilities and equipment;
- Procedures for rescue of people and treatment of the injured.

Training drills should include rescue, evacuation, first-aid, fire-fighting (use of different extinguishing agents and fire truck), communicating and use of communication equipment.

The contractor shall be required to produce accessible consultation sheets for review in case of emergency situations. These should have phone numbers for police, fire-fighters, hospital, site manager, etc.

Medical Screening

In order to facilitate placement decisions and early detection of occupational diseases, pre-placement and periodic medical screening of all workers is required. The medical check shall be performed by qualified medical personnel. The contractors shall keep health records of all their personnel.

Malaria and Disease Prevention

Special precautions shall be taken by the contractors at their own expense to keep the incidence of malaria and other diseases as low as possible. The contractor shall spray with approved insecticide the interiors of buildings on a regular basis. All pools of water and other likely mosquito breeding places within and adjacent to the works area shall either be eliminated or sprayed in an approved manner. The contractors shall provide mosquito nets to workers and prophylactic treatment for malaria.

Safety Equipment and Regulations

The contractor shall be required to provide proper safety equipment and draw up emergency regulations, including fire and electric shock prevention, stretchers and first-aid boxes, together with rescue facilities, as well as properly trained personnel to administer these.

Lifesaving vests and lifesaving rings shall be available at construction sites bordering the river and reservoir.

The contractor shall provide adequate training regarding justification for and use of safety equipment to all workers. The contractor shall make basic safety equipment available, and enforce use of such equipment during all working operations that may expose workers to occupational health hazards.

Minimum requirement to Personal Protective Equipment (PPE) for all personnel at site are:

- Protective helmet / hardhat;
- Protective footwear/safety boots;
- Appropriate work gloves;
- Working clothing with strong colours and wide reflecting bands;
- Safety goggles or over specs.

Additional PPE such as ear, eye and respiratory protection or fall protection, shall be provided when required to avoid occupational health incidents or illnesses as stipulated in regulatory requirements, and/or material safety data sheet.

The contractor shall provide hearing protection for all workers working around equipment or at locations with a noise level of 80 dB(A) or more (e.g. heavy equipment and drills, blasting activities). An appropriate instrument at site to measure noise levels shall be provided for this.

All workers handling hazardous materials shall be trained and provided with suitable PPE, including footwear, masks, protective clothing and goggles, emergency eyewash, and shower stations.

All restricted plant facilities shall be labelled with caution signs, especially those with potential risk for workers. Moreover, all construction areas shall be marked and fenced to avoid accident caused by unauthorised entry.

12.7.5 Budget and Schedule

The costs for OHS training for workers and provision of PPE will be borne by the contactors. The personnel and operational costs for OHS Unit is not part of the SMP budget but will be covered by other allocations under the budget for the project organisation.

12.8 Summary of SMP Budget

Table 12-2 below summarises the budget for the Social Management Plan for the Middle Yeywa HPP. The Community Development Initiatives is the largest cost item with 8,305,250 USD. The total SMP budget amounts to 8,938,750 USD.

It should be noted that the cost estimates can only be indicative at this stage of project development and may change considerably as the project planning progresses.

Table 12-2: Summary of the SMP Budget

No	Item	Pre-constr	Construction Phase						Total
		Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
1	Stakeholder Management Plan	10 000	5 000	5 000	5 000	2 500	2 500	2 500	32 500
2	Compensation	167 000	167 000	137 000					471 000
3	Social Management for Construction Areas	15 000	45 000	20 000	20 000	10 000	10 000	10 000	130 000
4	Community Development Initiatives	300 000	1 636 000	2 256 750	1 962 500	990 000	990 000	170 000	8 305 250
Total Social Mangement Plan Budget		**492 000**	**1 853 000**	**2 418 750**	**1 987 500**	**1 002 500**	**1 002 500**	**182 500**	**8 938 750**

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Tractebel. 2018. Technical Feasibility – Phase 2: Activity 1.8: Sedimentation Study, Final Report

Tractebel. 2018. Technical Feasibility – Phase 2: Activity 1.10: Tailwater rating curve, Status Report

Tractebel. 2018. Technical Feasibility – Phase 2: Activity 1.11: Re Sim Cascade Model, Status Report

Tractebel. 2018. Technical Feasibility – Phase 2: Activity 1.12: Back water effects study; Final Report

ANNEX 1

SCOPE OF WORK

Scope of Work

ESIA of the dam and associated structures including access

The following shall be undertaken by the Consultant:

Task 1: Initial Site Visit and Coordination of Study

- Consultant is to make arrangements for a visit to Yangon to meet with SN Power representatives and the local consultants, MIID, for an orientation meeting and latest update on the status of the project. This should commence early January 2017.
- Conduct a site visit accompanied by SNP to familiarize the Consultant with the area and project-related issues
- Preliminary discussions of the details of the ESIA work in relation to issues, conditions, methodologies, available reports and data post field visit and agreement on a detailed schedule moving forward
- SNP will make all reports and information available to the Consultant for review at this time for the next task

Task 2: "Gap Report" and Review of existing reports and data:

- Review existing information on project features, design and technical aspects, and identify any issues that require further clarification or more details – note that the technical feasibility studies will be undertaken in parallel and some information may be lacking at this early stage
- Review of sections on legal requirements, policies and procedures, including those in draft format that could affect the completion of the ESIA, and identify any additional actions or missing elements
- Review all available environmental data in the Pre-Feasibility Report and subsequent environmental reports on water quality, hydrology and ecology, and identify all gaps in data and quality issues with existing information
- Review all available social baseline data and information in the Pre-Feasibility Report and subsequent field reports on livelihood, local economic conditions, education, health, history, relations between groups, government capacity at all levels and the consultation process, and identify all gaps in data and quality issues with existing information and any further results – if required additional consultations will be carried out by the nominated subcontractor under the Consultant supervision
- Assess the security situation by reviewing all information in the reports, in discussions with MIID and other sources, and identify all issues to be addressed in the ESIA and any further information requirements
- Approval form SN Power will be sought by the Consultant for any additional ground survey or data collection required to complete the ESIA

Task 3: Analysis of Policy and Legal Requirements

- Update the sections in the Pre-Feasibility Study on legal requirements and update on any new laws, policies and procedures, including those in draft format that could affect the project implementation
- Compare existing legislature and requirements in relation to IFC Performance Standard

requirements, identifying any gaps and alternatives for addressing these gaps within the context of the ESIA

- Create a table listing all the key elements of the IFC PS requirements and how these are addressed in the ESIA so that donors can have easy reference
- Review and comment on project policy, proposed project impact zone classification and entitlement matrixes that will be provided by SN Power for inclusion in the ESIA based on the information provided in the technical studies
- Draft sections on overarching issues in relation to policy and requirements: these should include gender, vulnerable groups and ethnic minorities
- Evaluate the status of the Danu and other smaller groups in the project area in relation to the IFC PS7 on Indigenous People
- Include findings and recommendation from the planned Human Rights report that will be carried out by SNP during the contract period

Task 4: Write-up and analysis of Environmental Baseline

- Complete description of the terrestrial vegetation, both natural and man-made environments – evaluate the flora of the project area and identify any important or listed species based on samplings and analysis
- Complete description of the fauna (mammals, herpetofauna and birds)– evaluate species in the project area and identify any important or listed species based on samplings and analysis
- Description of the aquatic ecosystem, including fish fauna – evaluate species of the project area and identify any important or listed species based on samplings and analysis
- Participate and/or oversee additional survey work with MIID and other local consultants, as required in the field and discuss findings and data, paying special attention to species listed as endangered or critically endangered by IUCN
- Analyse any additional information and field surveys as required for any species on the IUCN Red Lists to ensure that these species are common to the area and located in other parts of the catchment or in the region – to be discussed with SNP after the "Gap Report"

Task 5: Write-up and analysis of Social Baseline

- Complete sections on regional characteristics and descriptions based on the information in the Pre-Feasibility Report and other sources
- Oversee MIID's detailed socio-economic and health survey of left-bank villages and villages located at the tail-end of the reservoir using the methodology and formats that have been used for right-bank villages and based on the information provided in the Pre-feasibility study and reconnaissance
- Complete the description of cultural practices and beliefs of the Danu ethnic group and cultural heritage issues (physical cultural resources) in the project area, including the location of holy sites, graveyards and shrines in the proposed reservoir, project construction lands or along transmission line and road corridors in coordination with MIID.
- Description of cultural practices and beliefs of the local Shan ethnic group (end of the

reservoir and adjacent areas) and cultural heritage issues (physical cultural resources) in the project area, including the location of holy sites, graveyards and shrines in the proposed reservoir, project construction lands or along transmission line and road corridors.

- Provide any additional information on regional history and inter-ethnic relations and conflict
- Complete description of uses of the project impacted areas or adjacent areas of the reservoir, construction lands, camp and work areas, transmission line corridors and road corridors
- Complete description of regional development trends, infrastructure and services in the project area and other social challenges that could be of concern for the development of this Project – identify any developmental NGO activities that could complement project activities
- Oversee additional survey work with MIID and other local sub-consultants, as required in the field and discuss findings and data
- Oversee ongoing consultations led by MIID in impacted communities during the contract period, as required, in order to quality control the ongoing work
- Analyse any additional information and field surveys as required for completion of the socio-economic analysis of the project zones – to be discussed with SNP after the “Gap Report”

Task 6: Analysis of Stakeholder Management and Consultation Process:

- Complete stakeholder mapping and analysis of stakeholder relations in terms of decision-making and influence, including the identification of any vulnerable groups
- Compile a list of meetings and consultations for the report based on material and information provided by SNP and MIID, and ongoing consultations
- Summarize the main topics, comments and outcomes of the various consultation meetings held in the project area
- Complete an assessment of local government understanding of national legislation and international standards, and their capacity to carry out tasks related to project mitigation

Task 7: Impact Assessment

- Revise and improve the chapter (6) on alternatives in the Pre-Feasibility Report taking into consideration different layouts, ranking and criteria, including energy demand and supply alternatives, siting alternatives, production regimes and project design
- Provide a simple and concise methodology for assessing impact in terms of extent, magnitude and duration – the methodology should be used for all E&S components so that there can be comparison of the different themes and topics and prioritization
- List all impacts on the environment:
    - Impacts on physical and chemical environment
    - Impacts on biological environment
- List all impacts on the communities and social aspects:
    - Impacts due to loss of land and production
    - Impacts on natural resources (forests/river)

  - Health and safety aspects
- Identity cumulative impacts
  - From the four projects on the river (Upper, Middle, Lower Yeywa and Deedoke schemes and the basin as a whole) in terms of hydrology and water management
  - The IFC approach to cumulative impacts as Valued Environmental and Social Components (VECs) is to be used in relation to defining scope and impacts
  - Issues related to fisheries and aquatic biodiversity
  - Issues related to impacts on communities – loss of land, fisheries, livelihoods, natural resource access, etc.

Task 8: Executive Summary

- The Executive Summary should be no more than five pages in length and shall build on the Executive Summary in the Pre-Feasibility Report
- It should contain a summary of each of the main chapters and sections in the report, including main findings and analysis
- It should reiterate the main points of policy and approach to E&S for the project
- Include a project site map and relevant tables

Task 9: Submission of the Draft ESIA

- Follow the outline in the Pre-Feasibility and in the annex to this ToR and modify as required in order to cover all topics and issues
- Provide maps, photos and other materials (using existing or improved ones) for the report
- Submit the Draft ESIA for review by SNP

Task 10: Submission of Final Draft ESIA

- Comments on the Draft ESIA will be provided by SNP
- Revise, in consultation with SNP, the report and finalize it for submission

ESMP

The following shall be undertaken by the Consultant:

Task 1: Analysis of the Scope and Extent of the ESMP

- Consultant is to review the draft Table of Contents and finalize this in discussion with the consultant, including agreement of tasks to be carried out by the two parties
- Submit a detailed plan and schedule as to how the write-up and analysis will be carried out
- Identify any further needs for surveys, information or data
- Agree on staff arrangement
- Coordination with ongoing consultations and other activities
- Identify any further technical information required to complete the report sections

Task 2: Draft of EMP Sections

- Draft sections as outlined in the ToR Annex and agreed to as of Task 1 above
- Construction management plan in cooperation SNP and with information provided by the ongoing technical studies
- Water quality and fisheries monitoring plans
- Conservation, forestry and biodiversity offset management and monitoring plans
- Transmission Line
- Reservoir clearance, filling and safety issues
- Operational environmental framework

Task 3: Draft of SMP Sections

- Draft sections as outlined in the ToR Annex and agreed to as of Task 1 above
- Stakeholder Management and communication strategy together with SNP
- Compensation, restoration and replacement of loss for all project areas, including the TL Corridor
- Development initiatives and implementation arrangements
- Social management of construction areas for population influx and camp followers
- Operational social program framework

Task 8: Executive Summary

- The Executive Summary should be no more than five pages in length
- It should contain a summary of each of the main chapters and sections in the report, including main mitigation measures and strategies
- Include a summary table of all measures and objectives

Task 9: Submission of the Draft ESMP

- Follow the outline in ToR and modify as required in order to cover all topics and issues
- Provide maps, photos and other materials (using existing or improved ones) for the report
- Submit the Draft ESMP for review by SNP

Task 10: Submission of Final Draft ESMP

- Comments on the Draft ESMP will be provided by SNP
- Revise, in consultation with SNP, the report and finalize it for submission

The Client will at its sole discretion decide whether to proceed or not with some of these services at the relevant time of the assignment. These optional services, if requested by the Client will be treated as additional services with reference to the Contractual conditions.

Deliverables

Language
All deliverables shall be in the English language.

Approval of deliverables
As a minimum and unless stated otherwise in the relevant sections the Consultant will seek the approval without comments from the Client of any deliverables and as part of the Services. To this extent, the Consultant will submit as much revisions that are required to obtain this approval.

Each deliverable will be submitted to the Client in draft version for approval without comments. SNP will provide its comments, requests for clarification/amendment/completion within 28 calendar days, except if stated otherwise in this section, from the reception of a workable electronic format of the report, including all the appendices.

Supervision of Client's nominated sub-contractor

The Client has nominated Myanmar Institute for Integrated Development as a sub-contractor (Contractor) to the Consultant. The Consultant will be in charge of and responsible for the supervising and overseeing of the Contractor's works. The Consultant shall take all the necessary actions towards the Contractor to correct any deviations from the technical requirements and specifications of the works and thereafter ensuring that the Contractor complies. In particular the Consultant shall ensure that the Contractor rectifies any procedure(s) that may prevent the Consultant from being provided with a complete and full set of accurate baseline data which the Consultant requires to assess the environmental and social impacts of the Project.

The Client shall receive a copy of all instructions and notifications issued by the Consultant. The Consultant will monitor and inform the Client about the implementation of the corrective measures by the Contractor.

For the sake of clarity, the Client remains liable of selecting the Contractor; therefore, the Consultant shall bear no liability regarding the final quality or final quantity of the results provided by the Contractor in the event that the Contractor has failed to abide timely instructions given by the Consultant.

ANNEX 2

BIODIVERSITY REPORTS

ANNEX 2A

Pre-feasibility for the Middle Yeywa Hydropower Project:

Annex 4 - Biodiversity Survey of the Nam Tu River upstream of the Middle Yeywa Hydropower Project

ANNEX 4: BIODIVERSITY SURVEY OF THE NAM TU RIVER UPSTREAM OF THE MIDDLE YEYWA HYDROPOWER PROJECT

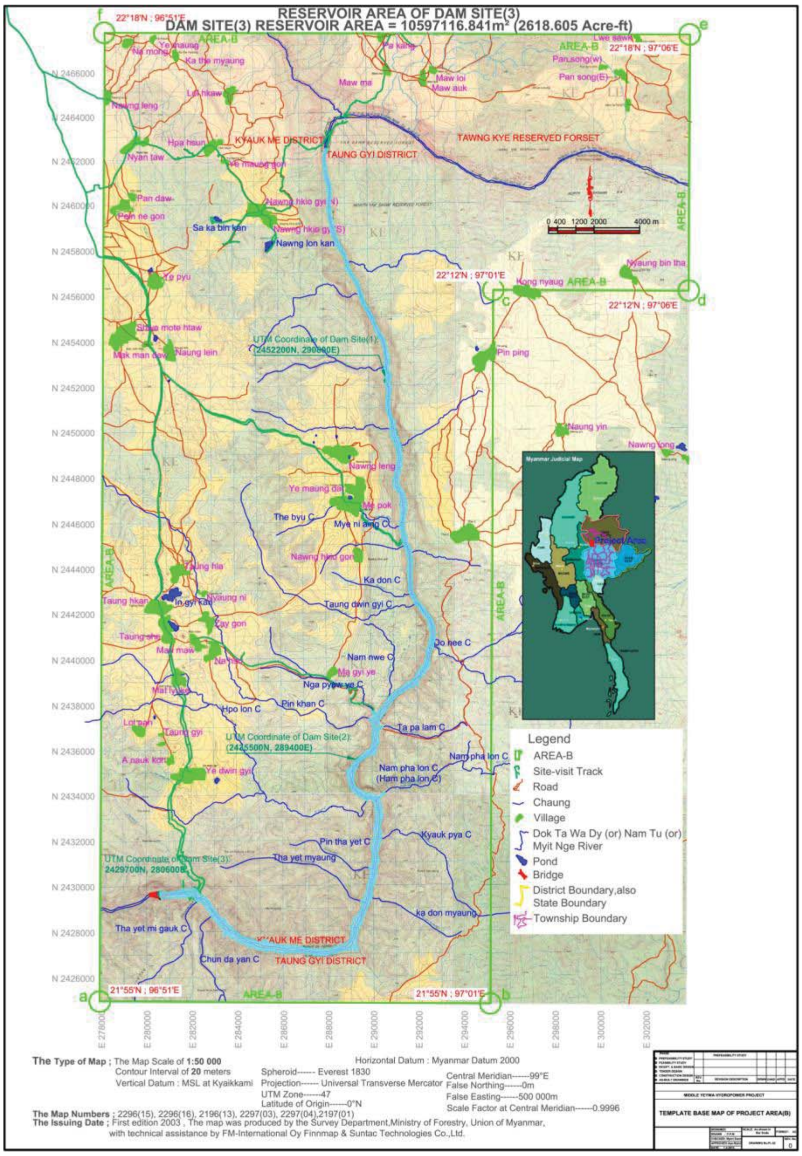
I. INTRODUCTION

The environmental Impact assessment, especially on the biodiversity of intended inundated area of Middle YeYwar hydropower dam on Dodtawaddy River in Naung-cho Township, Shan State, which will be constructed near future, has been carried out in March, April and May 2015.

1.1 Location

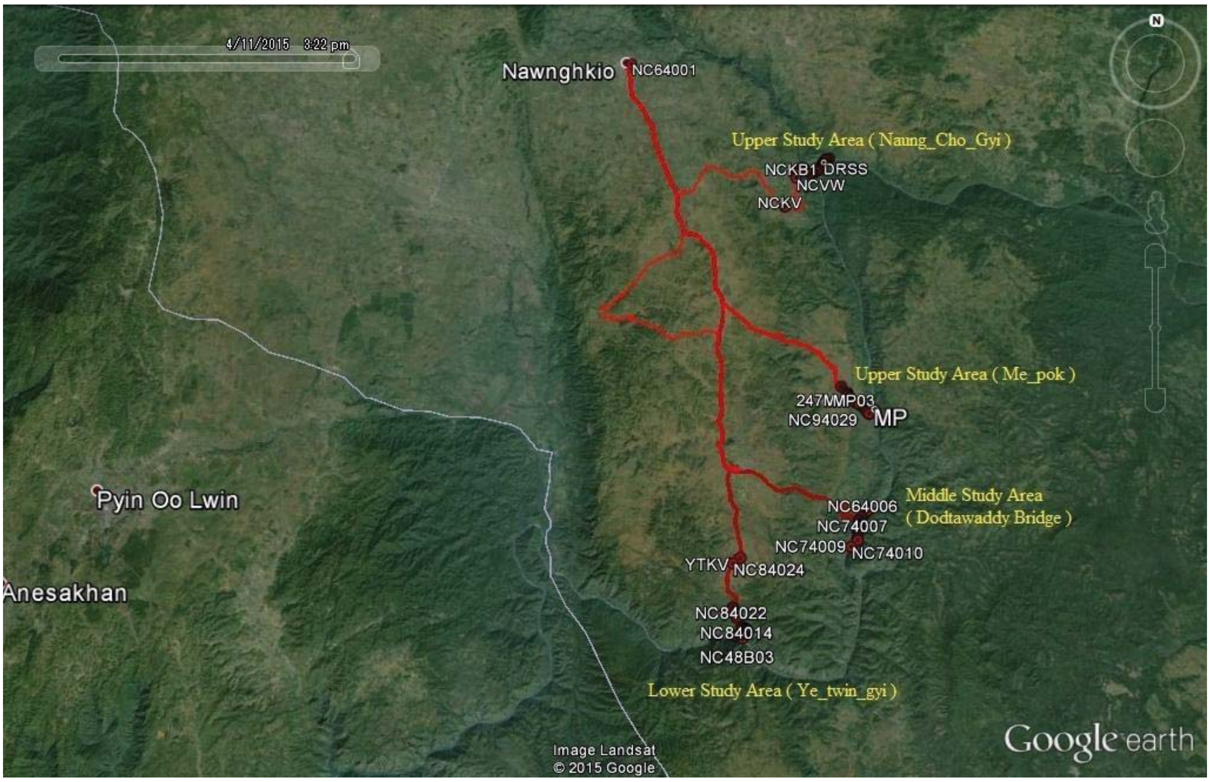
The Middle YeYwar Hydropower Dam project is located between 21° 55'N, 96° 51' E and 21° 55' N, 97° 01' E near Ye-twin-gyi Village in Naung-cho Township, on down stream become confluence with Tha-yet-migauk Stream and Dodtawaddy River.(Map.I)

Map. I



A river with three names, Nantu River, Dodtawaddy River and Myintnge River, which originate from the northern Shan State mountain ranges, flow from east to west in Kyaukme Township, named as Nantu River and continues to flow from north to south and then turns to flow from east to west in Naung-cho Township, named as Dodtawaddy River and then it continues to flow from north east to south west in the low land area of Mandalay Division, named as Myintnge River. Zawgi River and Panlaung River drain into the Myintnge River before it drains into the Ayarwaddy River. Myintnge River flows into the Ayarwaddy River in Tada-u Township and Amayapura Township. The river is 154.4 kilometer long as Nantu, 159 kilometer long as Dodtawaddy and 98.8 kilometer long as Myintnge. (Photo Map I).

Photo Map I. All Study Sites

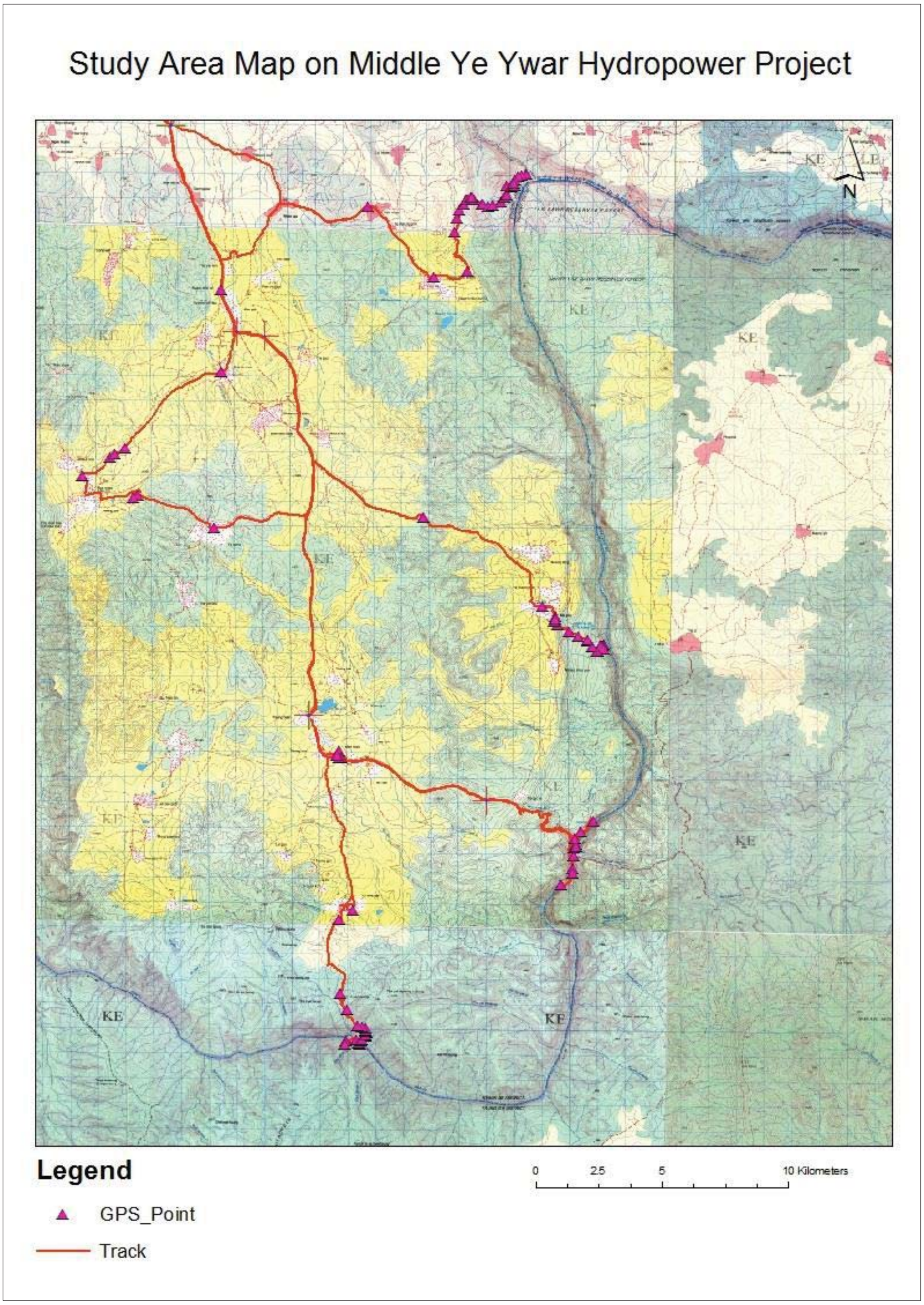


There will be three hydropower dams on Dodtawaddy, the upper YeYwar, Middle YeYwar and Lower YeYwar. The distance between Upper YeYwar dam and Lower YeYwar is 130 kilometer. Upper YeYwar dam and Lower YeYwar dams had been already constructed. The intended Middle YeYwar hydropower dam will be 80.4 kilometer away from lower YeYwar and 49.6 kilometer away from Upper YeYwar. The dam site lies between high mountains and gorges. The elevation of the mountain ranges along the Dodtawaddy River which comprise in the catchment area is 1000 meter**.** The river flows in the narrow V-shaped valley and has steep bank slope. So the flooded area is narrow and long, along the river. Total flooded area along the sloping banks at elevation 320 m is estimated to be about 100 hectare.

1.2 Topography

The Middle YeYwar Dam project site falls 22° 18' N to 21° 55' N Latitude and 96° 51' E to 96° 51' E longitude. The catchment area is 10597.12 km^2 and total flooded area is about 1100 hectare (Map II). The normal pool level will be 320 m. The lowest elevation in the area is 281 m and highest at upstream is 1000 m.

Map II.



1.3 Climate

Generally the climate of Middle YeYwar Hydropower Dam site is monsoon climate with distinct seasons; cool and dry season, hot dry season and warm and wet rainy season. The wet raining season is from May to October. The average annual rain fall is 1312 mm. (According to Naung Cho Twonship data)

1.4 Forest in the context of Ecoregion

The Middle YeYwar Dam area lies in WWF eco-region of Northern Indochina Subtropical forest. The vegetation of this eco-region includes both lowland and mountain forest. The devided habitat within this eco-region from deciduous forest dominated by *Shorea* species and mixed deciduous forest with evergreen tree species like *Quercus* and *Castanopsis* species.

1.5 Local people and their livelihood

The people dwelling this area include Da-nu, Shan and Bamar. Most of them are farmer cultivating rice, vegetables, green tea (*Camellia*), Maize and Sugar cane. A few are traders.

II. AIMS AND OBJECTIVES

1. To collect, indentify the plants and animal species in the area
2. To record the dominant tree species and evaluate the forest types
3. To assess the potential impacts and to suggest the mitigation measure

III. MATERIALS AND METHODS

3.1 Participants

Flora

(1) U Nyo Maung (Retired Professor), Taxonomist

(2) Dr.Win Myint (Associated Professor, ex.), Ecologist

(3) Dr. Ei Ei Phyoe, Taxonomist

(4) U Tun Thura, Botanist & GIS/RS

Fauna

(1) Dr.Yin Win Tun, Lecturer, Zoology Department, Myeik University (Fish specialist)

(2) U Aung Pe Lwin, Assistant Lecturer, Zoology Department, Dagon University; (Herpet specialist)

(3) U Yan Naing Hein, Field Specialist; (Bird specialist)

(4) U Nay Myo Aung, Field specialist; (Insect and Mammal specialist)

3.2 Methodology (Flora)

3.2.1 Method

The floristic data and ecological data collection were conducted by the following methods in the study Area.

3.2.1.1 Sample Plotting

The Global Positioning System was used to navigate and mark the coordinates of the sample plots. In order to obtain essential data for predicting of tree species composition in the forest and vegetation types, 20x20 and 30x30 meter quadrants, were set up and tree species in the plot were collected and population of each species were also counted. For the Bamboo survey, 30x30 meter quadrants were set up and bamboo species were collected and number of clump of each species were also counted. The species identification was carried out by using key to families of flowering plants and appropriate literature and confirmed by matching with herbarium specimens of Department of Botany, University of Yangon.

3.2.1.2 Random Transecting

To get representative checklists of the tree species and bamboo species, plant collection was also carried out by random transect lines along the banks of the river and between one plot and another wherever possible. Specimen collection was made within 10 meter on either sides of the transect line and start from on river bank until the edge of the water in the river to cover the whole riverine forest.

3.2.1.3 Mapping

Location maps are set by the method based on the UTM maps and UTM zone 47 N, WGS 84, coordinate system to determine the forests of the proposed areas.

3.2.2 Materials

Materials used for recording are strings for sample plotting and transecting, digital camera for recording, GPS, maps, heavy duty plastic bags, old newspapers, corrugated paper, alcohol, spray jug (for fixing specimens), 10x lens, permanent marker, field note books, field press, drying press and dryers.

3.2.3 Data Analysis

After field survey, data entry was carried out in excel work sheet. Analysis of population per hectare percentage was conducted using excel work 2007. For identification of threaten species, it is conducted matching with IUCN red data list version 2014.3.

3.2.3.1 Population of Individual Species (per hectare)

The population of species will show not only the composition of species but also the richness of the species in the study area. According to R.He'dl, M Sva'tek, M. Dancak, Rodzay A.W., M. Salleh A.B., Kamariah A.S.(2009), population of individual species (per hectare) is determined by following formula.

$$\text{Population of Individual Species} = \frac{\text{Total Individual species}}{\text{Total Plots Area } (m^2)} \times 10000m^2(1ha)$$

3.2.3.2 Relative Density of Tree species

The density of a species refers to the numerical representation of its individual and the availability of space in a unit area. The density index shows not only the richness of the texa but also the relative distribution of the individuals. According to Curtis (1959), the density index is determined by the following formula.

$$\text{Relative Density of Tree species} = \frac{\text{No. of Individual species}}{\text{Total no. of all individual Species}} \times 100$$

3.3 Methodology (Fauna)

Five kinds (Birds, fishes, mammals, herpets and insects) animals were surveyed for the diversity assessment.

3.3.1 Bird survey

Birds were studied using the watching methods with help of the binoculars. Species identification was examined using the field guide books. Counting of bird number and habitat utilization were observed. Species richness and observed frequency were assessed for species diversity.

3.3.2 Fish survey

Fishes were surveyed by two ways, by direct catching method with the help of local fishermen (local fishing gear with two inches mesh which were used in the fast running water) and market survey methods. The local fishes in the markets were categorized.

3.3.3 Mammal survey

Direct count method (especially for squirrels), remains of animal’s body parts (skin, spines, antlers, ect.) footprints and interviewed methods were used for mammal survey.

3.3.4 Herpet survey

Snakes, lizards and frogs were caught and taken as voucher species and were identified. Snakes were caught by snake stick, lizards were shot by rubber bands, and frogs were collected in their roosting habitats. Some snakes (king cbra, pythons) were surveyed as interviewed methods.

3.3.5 Insect survey

Insects (butterflies, dragonflies, beetles, and other insects and invertebrates) were caught and taken as voucher specimens. Flying insects as butterflies and dragonflies were caught by insect net (made of nylon sheet and stick); beetles were collected by digging the grounds, peering the tree barks with the knife. Some beetles in the trees were shaken out and fall down on the grounds; these insects were collected by hands and a pairs of forceps.

3.3.6 Diversity of Fauna species

A total of 142 species representing 68 birds, 17 fishes, 14 mammals, 16 herpets and 27 insects were recorded as fauna diversity of the project area for the Middle Ye Ywar Hydropower project in Nyaungcho Township, Shan state **in dry season**.

A total of 131 species representing 43 birds, 27 fishes, 16 mammals, 18 herpets and 27 insects were recorded as fauna diversity of the project area **in wet season.**

IV. OBSERVATION

4.1 FLORA

4.1.1 Studied Site

The area is divided into three parts to cover up the whole flooded area. The first part includes the downstream portion closed to the dam near Ye-twin-gyi on Dodtawaddy River at the lowest elevation level of 218 m.

The second part includes the upstream portion closed to the Dodtawaddy Bridge and its surroundings. The elevation level of this area is 270m above the sea level.

The third part includes the upstream portion near Mepok and Naung-cho-gyi villages. The lowest elevation level in this area is 323 meter above the sea level.

4.1.2 The first part around Ye-twin-gyi Village

Photo Vegetation Profile of Ye-twin-gyi

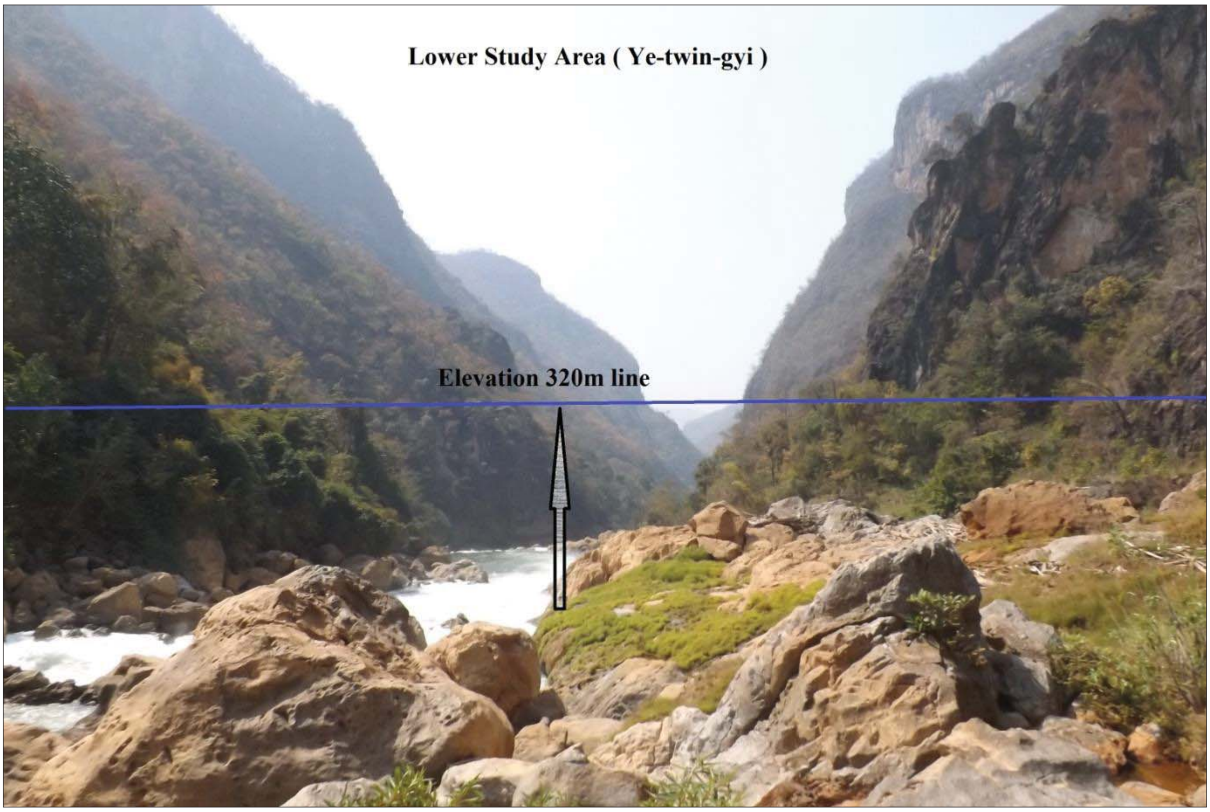


Photo Map II. Study points

Ye-twin-gyi village (Indaing Forest)

Indaing Forest

4.1.2.1 Species composition

The total number of species collected in this part is 101 species belonging to 86 genera and 52 families.

List of Species in the Study Area

No.	Scientific Name	Common Name	Family Name
1	*Acmella calva* (DC.) R.K. Jansen	Pe-le-nyin	Asteraceae
2	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae
3	*Albizia chinensis* (Osbeck)Merr.	Bom-me-za	Mimosaceae
4	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae
5	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae
6	*Amaranthus gracilis* Desf.	Hin-nu-nwe-yaing	Amaranthaceae
7	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae
8	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae
9	*Argyreia nervosa* (Burm.f.)Bojer	Kazun-gyi	Convolvulaceae
10	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae
11	*Bambusa bambos*(L.)Voss.	Kya-khat-wa	Poaceae
12	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae
13	*Bauhinia* sp.	Swe-daw	Caesalpiniaceae
14	*Bidens pilosa*	Hmwe-sok	Asteraceae
15	*Bischofia javanica*	Not known	Euphorbiaceae

No.	Scientific Name	Common Name	Family Name
16	*Blumea balsamifera*	Not known	Asteraceae
17	*Boerhavia diffusa* L.	Pa-yan-na-wa	Nyctaginaceae
18	*Bombax ceiba* L.	Let-pan	Bombacaceae
19	*Bombax insigne* Wall.	De-du	Bombacaceae
20	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae
21	*Buddleja asiatica* Lour	Not known	Buddlejaceae
22	*Calycopteris floribunda* Lam.	Kyun-khaung-nwee	Combretaceae
23	*Canscora diffusa* (Vahl) R.Br.	Kyauk-pan	Gentianaceae
24	*Careya arborea* Roxb.	Ban-bwe	Lecythidaceae
25	*Cassia fistula* L.	Ngu	Caesalpiniaceae
26	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae
27	*Cibotium barometz* (Linn.) J. Sm.	Da-yin-kauk	Dicksoniaceae
28	*Combretum alfredii* Hance	Not known	Combretaceae
29	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae
30	*Curcuma* sp.	Mar-la	Zingiberaceae
31	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae
32	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae
33	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae
34	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae
35	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae
36	*Dendrophthoe pentandra* (L.) Miq.	Kyi-paung	Loranthaceae
37	*Desmodium pulchellum* Benth.	Taung-damin	Fabaceae
38	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae
39	*Dioscorea cylindrica* Burm.	KYwary-thon-ywet	Dioscoreaceae
40	*Dioscorea pentaphylla* L.	KYwary-ngar-ywet	Dioscoreaceae
41	*Diospyros kaki* L.f.	Tae	Ebenaceae
42	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae
43	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae
44	*Ehretia acuminata* R.Br	Taung-poe-lu-lin	Boraginaceae
45	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae
46	*Emblica officinalis* Gaertn.	Sha-phyu	Euphorbiaceae
47	*Erythrina stricta* Roxb.	Ka-thit	Fabaceae
48	*Eugenia densiflora* DC.	Kyauk-tha-bye	Myrtaceae
49	*Ficus bengalensis* L.	Pyin-nyaung	Moraceae
50	*Ficus hispida* L.	Kha-aung	Moraceae
51	*Ficus pumila* L.	Creeping fig.	Moraceae
52	*Gagea reticulata* (Pall.) Schult.	Not known	Liliaceae
53	*Gardenia coronaria* Buch-Ham.	Yin-khat-gyi	Rubiaceae
54	*Getonia floribunda* Roxb.	Kywet-nwee	Combretaceae
55	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae
56	*Gochnatia decora*	Not known	Asteraceae

No.	Scientific Name	Common Name	Family Name
57	*Grewia eriocarpa*Juss.	Pin-ta-yaw	Tiliaceae
58	*Hiptage benghalensis* (L.) Kurz	Sar-say/Bein-nwee	Malpighiaceae
59	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae
60	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae
61	*Lannea coromandelica* (Houtt.) Merr.	Na-be	Anacardiaceae
62	*Ludwigia hyssopifolia*	Lay-nyin-thay	Onagraceae
63	*Ludwigia octovalvis*	Lay-nyin-gyi	Onagraceae
64	*Melanorrhoea usitata* Wall.	Thit-si	Anacardiaceae
65	*Millettia ovalifolia* Kurz	Thin-win	Fabaceae
66	*Mimosa pudica* L.	Hti-ka-yon	Mimosaceae
67	*Ochna integerrima*	Indaing-seni	Ochnaceae
68	*Oxalis corniculata* L.	Hmo-chin	Oxalidaceae
69	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae
70	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae
71	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae
72	*Physalis minima* L.	Bauk-thi	Solanaceae
73	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae
74	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae
75	*Pterospermum diversifolium*	Not known	Sterculiaceae
76	*Randia uliginosa* DC.	Hman-ni	Rubiaceae
77	*Rumex crispus* L.	Not known	Polygonaceae
78	*Rumex trisetifer*	Not known	Polygonaceae
79	*Saccharum spontaneum* L.	Kaing	Poaceae
80	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae
81	*Schima wallichii* (DC.) Korth.	Lauk-ya	Theaceae
82	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae
83	*Schrebera swietenioides* Roxb.	Thit-swe-le	Oleaceae
84	*Scoparia dulcis* L.	Dana-thu-kha	Scrophulariaceae
85	*Scurrula parasitica* L.	Kyi-paung	Loranthaceae
86	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae
87	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae
88	*Spirogyra* sp.	Algae	Zygnemataceae
89	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae
90	*Sterculia foetida* L.	Shaw-phyu	Sterculiaceae
91	*Sterculia villosa*	Shaw	Sterculiaceae
92	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae
93	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae
94	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae
95	*Utricularia caerulea*	Ye-bu-baung	Lentibulariaceae
96	*Uvaria cordata* Schum. & Thonn.	Tha-but-gyi	Annonaceae
97	*Vanda coerulescens* Griff.	Mo-lon-hmying-apyar-	Orchidaceae

No.	Scientific Name	Common Name	Family Name
		lay	
98	*Vangueria spinosa* Roxb.	Ma-gyi-pauk	Rubiaceae
99	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae
100	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae
101	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae

4.1.2.2 Vegetation type in the study area

No.	Sample Quadrant	Vegetation type	Latitude/ Longitude	Altitude	Dominant species
1	Q XV	Indaing Forest	N21 57 56.0 E96 53 25.1	2123 ft	*Shorea siamensis*(Kurz)Miq., *Sterculia foetida* L., *Terminalia alata* (Heyne) Roth, *Erythrina stricta* Roxb. *Schrebera swietenioides* Roxb., *Hiptage benghalensis* (L.) Kurz *Buchanania latifolia* Roxb., *Calycopteris floribunda* Lam.
2	Q XVI	Indaing Forest	N21 57 57.4 E96 53 21.2	2209 ft	
3	Q XVII	Indaing Forest	N21 57 58.9 E96 53 15.0	2301 ft	
4	Q XVIII	Indaing Forest	N21 58 20.0 E96 53 01.8	2716 ft	
5	Q XIX	Indaing Forest	N21 58 40.9 E96 52 52.9	3046 ft	
6	Q XX	Indaing Forest	N22 00 15.3 E96 52 51.0	3289 ft	

The determination of vegetation type (forest type) was carried out in accordance with their species composition and population density. The dominant tree species and rare tree species are determined according to their species composition in sample plots.

4.1.2.3 Floristic composition

The total number of tree species collected in 12 representative sample plots in this area is 30 species belonging to 27 genera. The dominant tree species in this area are *Shorea siamensis* (Kurz) Miq. (In-gyin) followed by *Sterculia foetida* L. (Shaw-phyu) and *Terminalia alata* (Heyne) Roth (Htauk-kyant), *Erythrina stricta* Roxb. (Ka-thit).

4.1.2.4 Tree Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha (%)
1	*Albizia lebbekoides* (DC.) Benth.	1	0.93	0.15
2	*Bombax ceiba* L.	3	2.78	0.45
3	*Buchanania latifolia* Roxb.	23	21.30	3.47
4	*Calycopteris floribunda* Lam.	15	13.89	2.27
5	*Chukrasia velutina* Roem.	1	0.93	0.15
6	*Croton oblongifolius* Roxb.	2	1.85	0.30
7	*Dalbergia cultrata* Grah.	2	1.85	0.30
8	*Dalbergia oliveri* Gamble	9	8.33	1.36
9	*Diospyros kaki* L.f.	3	2.78	0.45
10	*Duabanga grandiflora*	6	5.56	0.91
11	*Ehretia acuminata* R.Br	1	0.93	0.15

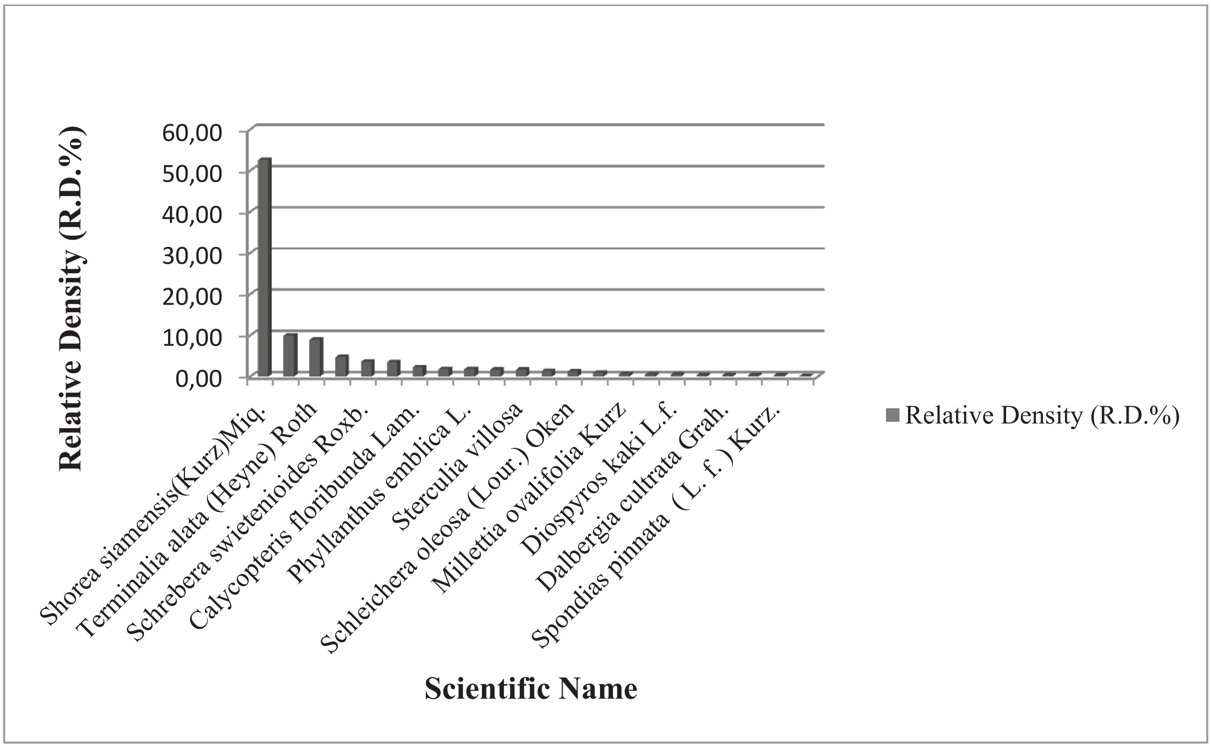
No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha (%)
12	*Erythrina stricta* Roxb.	31	28.70	4.68
13	*Grewia eriocarpaJuss*	1	0.93	0.15
14	*Hiptage benghalensis* (L.) Kurz	12	11.11	1.81
15	*Holarrhena pubescens* Wall. ex G. Don	1	0.93	0.15
16	*Lannea coromandelica* (Houtt.) Merrr.	1	0.93	0.15
17	*Millettia ovalifolia* Kurz	4	3.70	0.60
18	*Phyllanthus emblica* L.	12	11.11	1.81
19	*Pterocarpus indicus*Willd.	11	10.19	1.66
20	*Pterospermum diversifolium*	1	0.93	0.15
21	*Samadera indica* Gaertn.	2	1.85	0.30
22	*Schleichera oleosa* (Lour.) Oken	8	7.41	1.21
23	*Schrebera swietenioides* Roxb.	24	22.22	3.63
24	*Shorea obtusa* Wall.	1	0.93	0.15
25	*Shorea siamensis*(Kurz)Miq.	348	322.22	52.57
26	*Spondias pinnata* (L. f.) Kurz.	2	1.85	0.30
27	*Sterculia foetida* L.	66	61.11	9.97
28	*Sterculia villosa*	11	10.19	1.66
29	*Tectona grandis* L. f.	1	0.93	0.15
30	*Terminalia alata* (Heyne) Roth	59	54.63	8.91
	Total	**662**	**612.96**	**100**

4.1.2.5 Relative density

Among the sample plots species density per hectare varied and the highest density was observed *Shorea siamensis* (Kurz) Miq., *Sterculia foetida* L., *Terminalia alata* (Heyne) Roth followed by *Erythrina stricta* Roxb., *Schrebera swietenioides* Roxb., and *Buchanania latifolia* Roxb.,. This shows that these six species are abundant in this area.

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Shorea siamensis* (Kurz)Miq.	29.00	52.57
2	*Sterculia foetida* L.	5.50	9.97
3	*Terminalia alata* (Heyne) Roth	4.92	8.91
4	*Erythrina stricta* Roxb.	2.58	4.68
5	*Schrebera swietenioides* Roxb.	2.00	3.63
6	*Buchanania latifolia* Roxb.	1.92	3.47
7	*Calycopteris floribunda* Lam.	1.25	2.27
8	*Hiptage benghalensis* (L.) Kurz	1.00	1.81
9	*Phyllanthus emblica* L.	1.00	1.81
10	*Pterocarpus indicus*Willd.	0.92	1.66
11	*Sterculia villosa*	0.92	1.66
12	*Dalbergia oliveri* Gamble	0.75	1.36

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
13	*Schleichera oleosa* (Lour.) Oken	0.67	1.21
14	*Duabanga grandiflora*	0.50	0.91
15	*Millettia ovalifolia* Kurz	0.33	0.60
16	*Bombax ceiba* L.	0.25	0.45
17	*Diospyros kaki* L.f.	0.25	0.45
18	*Croton oblongifolius* Roxb.	0.17	0.30
19	*Dalbergia cultrata* Grah.	0.17	0.30
20	*Samadera indica* Gaertn.	0.17	0.30
21	*Spondias pinnata* (L. f.) Kurz.	0.17	0.30
22	*Albizia lebbekoides* (DC.) Benth.	0.08	0.15
23	*Chukrasia velutina* Roem.	0.08	0.15
24	*Ehretia acuminata* R.Br	0.08	0.15
25	*Grewia eriocarpaJuss*	0.08	0.15
26	*Holarrhena pubescens* Wall. ex G. Don	0.08	0.15
27	*Lannea coromandelica* (Houtt.) Merrr.	0.08	0.15
28	*Pterospermum diversifolium*	0.08	0.15
29	*Shorea obtusa* Wall.	0.08	0.15
30	*Tectona grandis* L. f.	0.08	0.15



4.1.2.6 Threaten Species List

No.	Scientific Name	Common Name	Family Name	IUCN criteria
1	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	LC
2	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	NT
3	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae	EN A 1cd
4	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	LC
5	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae	LC
6	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	LC
7	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	LC
8	*Ludwigia hyssopifolia*	Lay-nyin-thay	Onagraceae	LC
9	*Ludwigia octovalvis*	Lay-nyin-gyi	Onagraceae	LC
10	*Mimosa pudica* L.	Hti-ka-yon	Mimosaceae	LC
11	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	LC
12	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	VU
13	*Saccharum spontaneum* L.	Kaing	Poaceae	LC
14	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	LR/LC
15	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/LC
16	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	LC

EN=Endangered, LC=Least Concern, LR/LC=Lower Risk/Least Concern, NT=Near Threatened, VU=Vulnerable

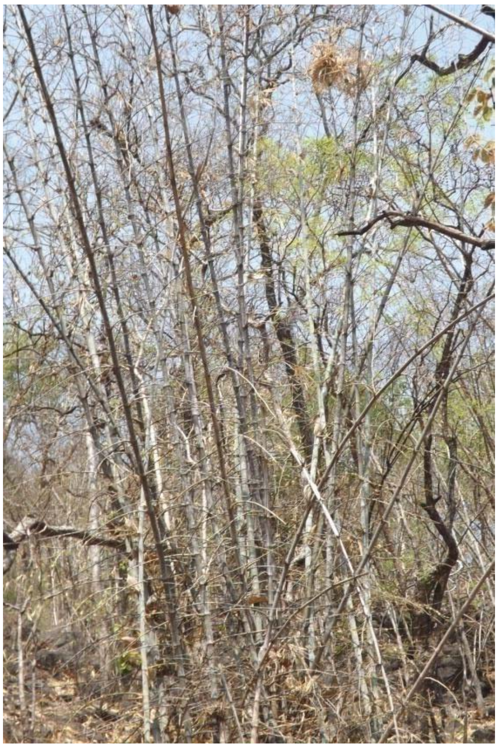
Shorea obtusa Wall.

Shorea siamensis (Kurz) Miq.

*Pterocarpus indicus*Willd.

Ludwigia hyssopifolia

4.1.2.7 Bamboo Forest



Bamboo Forest

4.1.2.8 Bamboo Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Dendrocalamus membranaceus* Munro	**3850**	6111.111111	100

4.1.2.9 Relative density

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Dendrocalamus membranaceus* Munro	550	100

4.1.3 The second part around Dodtawaddy Bridge

Photo Vegetation Profile of Dokhtawaddy Bridge

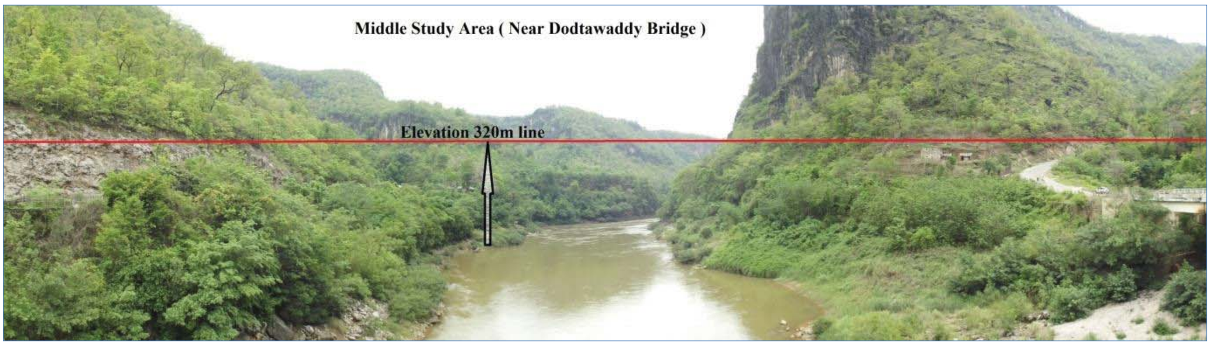
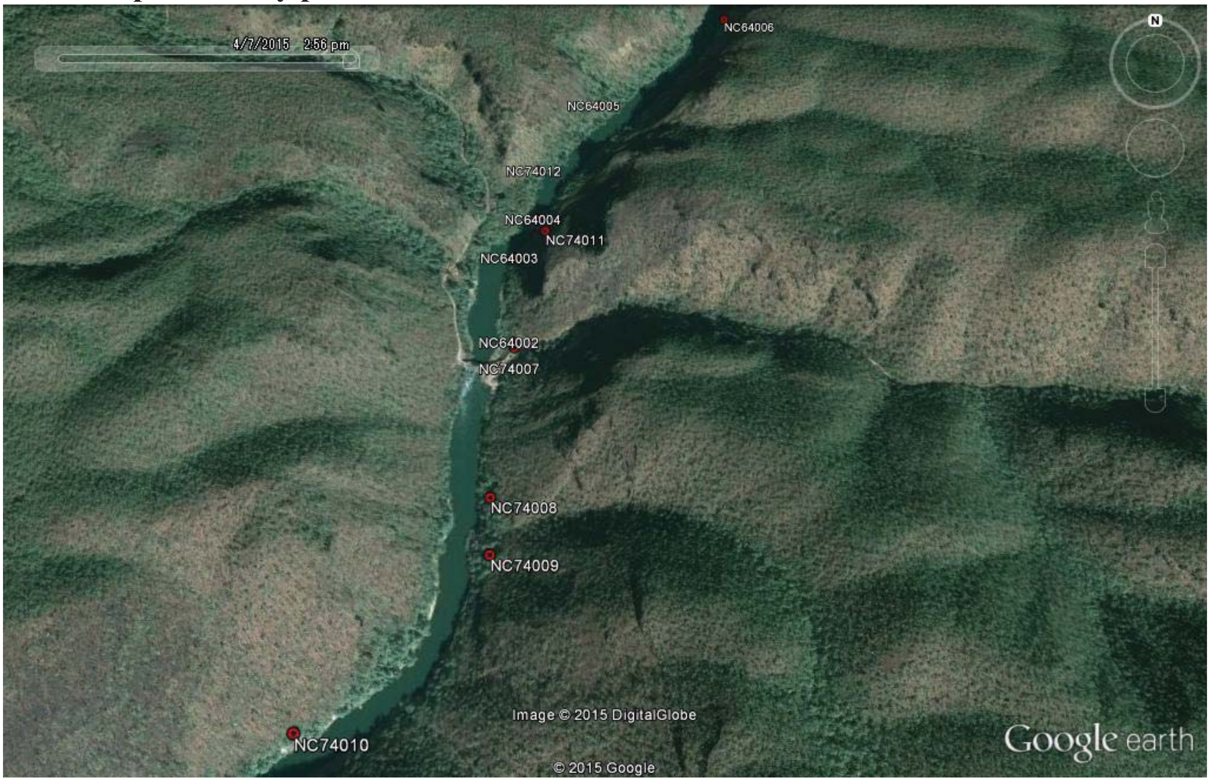


Photo Map III. Study points



Dodtawaddy Bridge (Riverine Forest)

Riverine Forest

4.1.3.1 Species Composition

The total number of species collected in this part is 131 species belonging to 21 genera and 59 families.

List of Species in the study area

No	Scientific Name	Common Name	Family Name
1	*Acacia concinna* (Willd.) DC.	Ka-mon-chin	Mimosaceae
2	*Acacia intsia* Willd.	Su-bok	Mimosaceae
3	*Acer laurinum* Hassk.	Not known	Aceraceae
4	*Acer negunda*	Not known	Aceraceae
5	*Acmella calva* (DC.) R.K. Jansen	Pe-le-nyin	Asteraceae
6	*Adenostemma viscosum*	Not known	Asteraceae
7	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae
8	*Albizia chinensis* (Osbeck)Merr.	Bom-me-za	Mimosaceae
9	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae
10	*Alstonia scholaris*(L.) R. Br.	Taung-ma-yoe	Apocynaceae
11	*Alternanthera nodiflora* R.Br.	Ka-na-phaw-yaing	Amaranthaceae
12	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae
13	*Amaranthus gracilis* Desf.	Hin-nu-nwe-yaing	Amaranthaceae
14	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae
15	*Anogeissus acuminata* Wall.	Yon	Combretaceae
16	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae
17	*Argyreia nervosa* (Burm.f.)Bojer	Kazun-gyi	Convolvulaceae
18	*Artemisia* sp.	Not known	Asteraceae

No	Scientific Name	Common Name	Family Name
19	*Asparagus filicinus* Buch.-Ham. ex D. Don	Ka-nyut	Asparagaceae
20	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae
21	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae
22	*Bauhinia* sp.	Swe-daw	Caesalpiniaceae
23	*Bidens pilosa*	Hmwe-sok	Asteraceae
24	*Blumea balsamifera*	Not known	Asteraceae
25	*Bombax ceiba* L.	Let-pan	Bombacaceae
26	*Bombax insigne* Wall.	De-du	Bombacaceae
27	*Buddleja asiatica* Lour	Not known	Buddlejaceae
28	*Calycopteris floribunda* Lam.	Kyun-khaung-nwee	Combretaceae
29	*Cananga latifolia*	Not known	Annonaceae
30	*Careya arborea* Roxb.	Ban-bwe	Lecythidaceae
31	*Carissa spinarum* A. DC.	Taw-khan-pin	Apocynaceae
32	*Cassia fistula* L.	Ngu	Caesalpiniaceae
33	*Celosia argentea* L.	Taw-kyet-mauk	Amaranthaceae
34	*Chenopodium acuminatum* subsp. virgatum	Not known	Chenopodiaceae
35	*Chromolaena odorata* (L.) R.M. King & H Robinson	Bi-zet	Asteraceae
36	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae
37	*Cibotium barometz* (Linn.) J. Sm.	Da-yin-kauk	Dicksoniaceae
38	*Clerodendrum villosum* Blume	Phet-kha	Verbenaceae
39	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae
40	*Crateva magna* (Lour.) DC.	Ka-det	Capparaceae
41	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae
42	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae
43	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae
44	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae
45	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae
46	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae
47	*Dichanthium caricosum* (L.)A.Camus	Pa-daw-myet	Poaceae
48	*Dichrocephala integrifolia (*L.f.)Kuntze	Not known	Asteraceae
49	*Dicliptera neesii* Trimen.	Not known	Acanthaceae
50	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae
51	*Dioscorea cylindrica* Burm.	KYwary-thon-ywet	Dioscoreaceae
52	*Dioscorea pentaphylla* L.	KYwary-ngar-ywet	Dioscoreaceae
53	*Diospyros kaki* L.f.	Tae	Ebenaceae
54	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae
55	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae
56	*Elaeocarpus hainanensis* Oliv.	Kywe-pan-pin	Elaeocarpaceae
57	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae
58	*Entada scandens* Benth.	Doe-nwee	Mimosaceae
59	*Equisetum hyemale*	Not known	Equisetaceae
60	*Erythrina stricta* Roxb.	Ka-thit	Fabaceae
61	*Eugenia densiflora* DC.	Kyauk-tha-bye	Myrtaceae
62	*Euphorbia antiquorum* L.	Tazaung-gyi	Euphorbiaceae
63	*Euphorbia hypericifolia* L.	Kywe-kyaung-hmin-se	Euphorbiaceae
64	*Ficus pumila* L.	Creeping fig.	Moraceae
65	*Ficus racemosa*	Tha-phan	Moraceae
66	*Ficus variegata*	Kon-tha-phan	Moraceae
67	*Flueggea leucopyrus* Willd	Ye-chin-ya	Euphorbiaceae
68	*Getonia floribunda* Roxb.	Kywet-nwee	Combretaceae
69	*Harrisonia perforata*	Su-gyit	Simaroubaceae

No	Scientific Name	Common Name	Family Name
70	*Heliotropium indicum* L.	Sin-hna-maung	Boraginaceae
71	*Hibiscus ficulneus* L.	Taw-yon-pade	Malvaceae
72	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae
73	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae
74	*Hydrocotyle sibthorpioides* Thunb	Myin-khwa	Apiaceae
75	*Hypericum japonicum* Thunb. ex Murray	Not known	Hypericaceae
76	*Lagerstroemia speciosa* (L.) Pers.	Pyin-ma	Lythraceae
77	*Lannea coromandelica* (Houtt.) Merrr.	Na-be	Anacardiaceae
78	*Leea hirta* Banks	Naga-mauk-aphu	Leeaceae
79	*Leucaena leucocephala* (Lam.) De.Wit	Baw-za-gaing	Mimosaceae
80	*Lithocarpus craibianus* Barnett	Thit-ae	Fagaceae
81	*Ludwigia hyssopifolia*	Lay-nyin-thay	Onagraceae
82	*Ludwigia octovalvis*	Lay-nyin-gyi	Onagraceae
83	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae
84	*Merremia vitifolia* (Burm.f.) Hallier. f.	Kyet-hinga-lae-new	Convolvulaceae
85	*Mesua ferrea* L.	Taw-gan-gaw	Hypericaceae
86	*Mikania micrantha* H.B.K.	Bi-zet-new	Asteraceae
87	*Millettia extensa* Benth.	Win-u	Fabaceae
88	*Millettia ovalifolia* Kurz	Thin-win	Fabaceae
89	*Mimosa pudica* L.	Hti-ka-yon	Mimosaceae
90	*Morus indica* L.	Po-sa	Moraceae
91	*Myriopteron paniculatum* Griff	Ti-lay-nantha	Asclepiadaceae
92	*Oxalis corniculata* L.	Hmo-chin	Oxalidaceae
93	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae
94	*Pandanus odoratissimus* L.f.	Sat-tha-phu	Pandanaceae
95	*Passiflora foetida* L.	Taw-su-ka	Passifloraceae
96	*Pennisetum purpureum*	Yon-sa-myet	Poaceae
97	*Persicaria odorata*	Kywe-hna-khaung-gate	Polygonaceae
98	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae
99	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae
100	*Physalis minima* L.	Bauk-thi	Solanaceae
101	*Ploiarium alternifolium*	Not known	Theaceae
102	*Polygonum plebeium*	Not known	Polygonaceae
103	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae
104	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae
105	*Pterospermum diversifolium*	Not known	Sterculiaceae
106	*Rumex crispus* L.	Not known	Polygonaceae
107	*Rumex trisetifer*	Not known	Polygonaceae
108	*Saccharum spontaneum* L.	Kaing	Poaceae
109	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae
110	*Schima wallichii* (DC.) Korth.	Lauk-ya	Theaceae
111	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae
112	*Scoparia dulcis* L.	Dana-thu-kha	Scrophulariaceae
113	*Scurrula parasitica* L.	Kyi-paung	Loranthaceae
114	*Senna hirsuta* (L.) Irwin & Barneby	Ka-thaw-hmwe-htu	Caesalpiniaceae
115	*Senna tora* (L.) Roxb	Dan-gwe	Caesalpiniaceae
116	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae
117	*Solanum aculeatissimum* Jacq.	Not known	Solanaceae
118	*Solanum indicum* L.	Ka-zaw-kha	Solanaceae
119	*Solanum torvum* Swartz	Kha-yan-ka-zawt	Solanaceae
120	*Spirogyra* sp.	Algae	Zygnemataceae

No	Scientific Name	Common Name	Family Name
121	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae
122	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae
123	*Tanacetum tibeticum* Hook.f. & Thomson	Not known	Asteraceae
124	*Taraxacum officinale*	Not known	Asteraceae
125	*Tectona grandis* L. f.	Kyun	Verbenaceae
126	*Terminalia oliveri* Brandis	Than	Combretaceae
127	*Tetrameles nudiflora* R.Br.	Thit-pok	Datiscaceae
128	*Trametes versicolor*	Hmo	Polyporaceae
129	*Tylophora indica*	Not known	Apocynaceae
130	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae
131	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae

4.1.3.2. Vegetation type in the study area

No.	Sample Quadrant	Vegetation type	Latitude/ Longitude	Altitude	Dominant species
1	Q I	Riverine Forest	N22 01 47.1 E96 57 51.8	940 ft	*Eugenia densiflora* DC., *Schleichera oleosa* (Lour.) Oken, *Homonoia riparia*, *Crateva magna* (Lour.) DC., Albizia lebbekoides (DC.) Benth., *Cananga latifolia, Calycopteris floribunda Lam.*
2	Q II	Riverine Forest	N22 02 08.5 E96 58 00.9	1026 ft	
3	Q III	Riverine Forest	N22 02 21.6 E96 58 16.7	1119 ft	
4	Q IV	Riverine Forest	N22 01 20.7 E96 57 50.7	1017 ft	
5	Q V	Riverine Forest	N22 01 15.4 E96 57 51.0	1005 ft	
6	Q VI	Riverine Forest	N22 01 00.6 E96 57 35.3	973 ft	
7	Q VII	Riverine Forest	N22 01 48.6 E96 57 55.2	926 ft	
8	Q VIII	Riverine Forest	N22 01 59.1 E96 57 53.9	969 ft	

The vegetation type is determined by tree species composition, population density and dominant species.

4.1.3.3. Floristic composition

The total number of tree species collected in 8 representative sample plots in this area is 31 species belonging to 29 genera. The dominant tree species in this area are *Eugenia densiflora* DC. (Kyauk-tha-bye) followed by *Schleichera oleosa* (Lour.) Oken (Gyo) and *Homonoia riparia* (Ye-mo-ma-kha), *Crateva magna* (Lour.) DC. (Ka-det).

4.1.3.4. Tree Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Acer laurinum* Hassk.	4	5.56	2.35
2	*Albizia lebbekoides* (DC.) Benth.	9	12.50	5.29
3	*Anogeissus acuminata* Wall.	2	2.78	1.18
4	*Bombax ceiba* L.	1	1.39	0.59
5	*Bombax insigne* Wall.	5	6.94	2.94
6	*Calycopteris floribunda* Lam.	6	8.33	3.53
7	*Cananga latifolia*	7	9.72	4.12
8	*Cassia fistula* L.	1	1.39	0.59

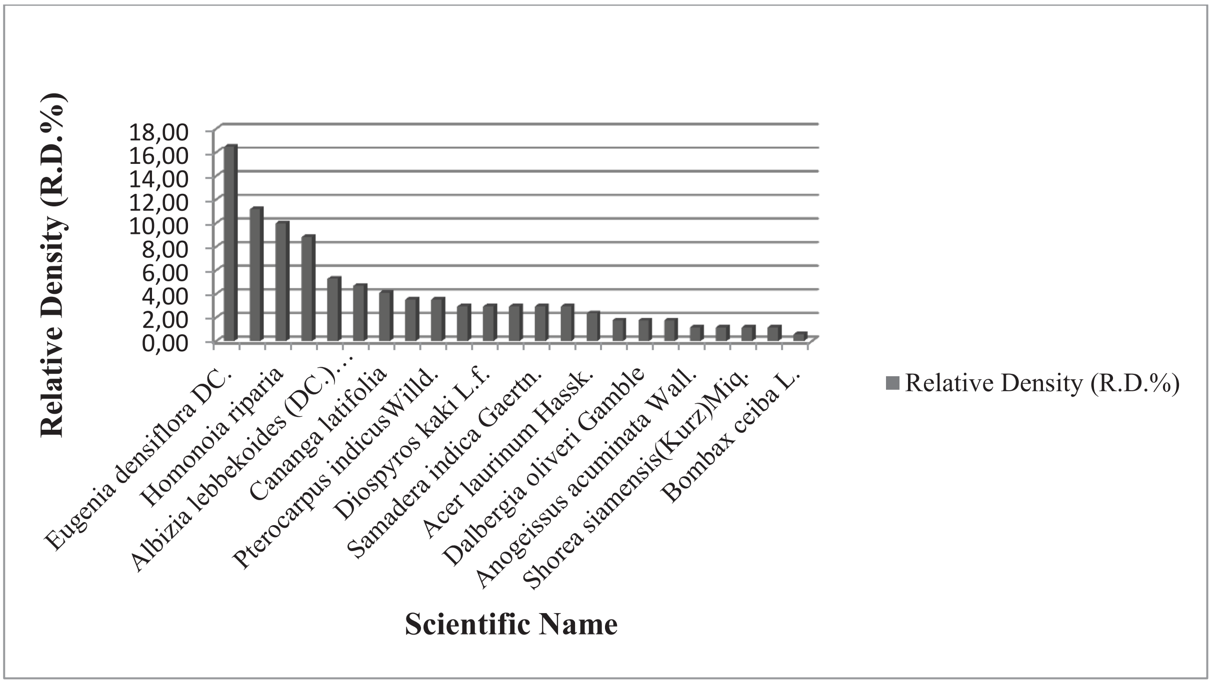
9	*Crateva magna* (Lour.) DC.	15	20.83	8.82
10	*Croton oblongifolius* Roxb.	2	2.78	1.18
11	*Dalbergia fusca* Pierre	3	4.17	1.76
12	*Dalbergia oliveri* Gamble	3	4.17	1.76
13	*Diospyros kaki* L.f.	5	6.94	2.94
14	*Duabanga grandiflora*	1	1.39	0.59
15	*Elaeocarpus hainanensis* Oliv.	1	1.39	0.59
16	*Erythrina stricta* Roxb.	1	1.39	0.59
17	*Eugenia densiflora* DC.	28	38.89	16.47
18	*Ficus variegata*	8	11.11	4.71
19	*Homonoia riparia*	17	23.61	10.00
20	*Lannea coromandelica* (Houtt.) Merrr.	3	4.17	1.76
21	*Mangifera sylvatica* Roxb.	5	6.94	2.94
22	*Millettia ovalifolia* Kurz	1	1.39	0.59
23	*Pterocarpus indicus*Willd.	6	8.33	3.53
24	*Pterospermum diversifolium*	1	1.39	0.59
25	*Samadera indica* Gaertn.	5	6.94	2.94
26	*Schleichera oleosa* (Lour.) Oken	19	26.39	11.18
27	*Schrebera swietenioides* Roxb.	1	1.39	0.59
28	*Shorea siamensis*(Kurz)Miq.	2	2.78	1.18
29	*Stereospermum suaveolens* (Roxb.) DC.	2	2.78	1.18
30	*Terminalia oliveri* Brandis	1	1.39	0.59
31	*Tetrameles nudiflora* R.Br.	5	6.94	2.94
	Total	**170**	**236.11**	**100**

4.1.3.5 Relative density

Among the sample plots species density per hectare varied and the highest density was observed *Eugenia densiflora* DC., *Schleichera oleosa* (Lour.) Oken, *Homonoia riparia* followed by *Crateva magna* (Lour.) DC., *Albizia lebbekoides* (DC.) Benth., and *Ficus variegata*. This shows that these six species are abundant in this area.

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Eugenia densiflora* DC.	3.50	16.47
2	*Schleichera oleosa* (Lour.) Oken	2.38	11.18
3	*Homonoia riparia*	2.13	10.00
4	*Crateva magna* (Lour.) DC.	1.88	8.82
5	*Albizia lebbekoides* (DC.) Benth.	1.13	5.29
6	*Ficus variegata*	1.00	4.71
7	*Cananga latifolia*	0.88	4.12
8	*Calycopteris floribunda* Lam.	0.75	3.53
9	*Pterocarpus indicus*Willd.	0.75	3.53

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
10	*Bombax insigne* Wall.	0.63	2.94
11	*Diospyros kaki* L.f.	0.63	2.94
12	*Mangifera sylvatica* Roxb.	0.63	2.94
13	*Samadera indica* Gaertn.	0.63	2.94
14	*Tetrameles nudiflora* R.Br.	0.63	2.94
15	*Acer laurinum* Hassk.	0.50	2.35
16	*Dalbergia fusca* Pierre	0.38	1.76
17	*Dalbergia oliveri* Gamble	0.38	1.76
18	*Lannea coromandelica* (Houtt.) Merrr.	0.38	1.76
19	*Anogeissus acuminata* Wall.	0.25	1.18
20	*Croton oblongifolius* Roxb.	0.25	1.18
21	*Shorea siamensis*(Kurz)Miq.	0.25	1.18
22	*Stereospermum suaveolens* (Roxb.) DC.	0.25	1.18
23	*Bombax ceiba* L.	0.13	0.59
24	*Cassia fistula* L.	0.13	0.59
25	*Duabanga grandiflora*	0.13	0.59
26	*Elaeocarpus hainanensis* Oliv.	0.13	0.59
27	*Erythrina stricta* Roxb.	0.13	0.59
28	*Millettia ovalifolia* Kurz	0.13	0.59
29	*Pterospermum diversifolium*	0.13	0.59
30	*Schrebera swietenioides* Roxb.	0.13	0.59
31	*Terminalia oliveri* Brandis	0.13	0.59



4.1.3.6 Threaten Species List

No	Scientific Name	Common Name	Family Name	IUCN criteria
1	*Alstonia scholaris*(L.) R. Br.	Taung-ma-yoe	Apocynaceae	LR/LC
2	*Alternanthera nodiflora* R.Br.	Ka-na-phaw-yaing	Amaranthaceae	LC
3	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	LC
4	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	NT
5	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae	EN A 1cd
6	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	LC
7	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae	LC
8	*Equisetum hyemale*	Not known	Equisetaceae	LC
9	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	LC
10	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	LC
11	*Hydrocotyle sibthorpioides* Thunb	Myin-khwa	Apiaceae	LC
12	*Ludwigia hyssopifolia*	Lay-nyin-thay	Onagraceae	LC
13	*Ludwigia octovalvis*	Lay-nyin-gyi	Onagraceae	LC
14	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae	LR/LC
15	*Mimosa pudica* L.	Hti-ka-yon	Mimosaceae	LC
16	*Polygonum plebeium*	Not known	Polygonaceae	LC
17	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	VU
18	*Saccharum spontaneum* L.	Kaing	Poaceae	LC
19	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/LC
20	*Tetrameles nudiflora* R.Br.	Thit-pok	Datiscaceae	LR/LC
21	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	LC

EN=Endangered, LC=Least Concern, LR/LC=Lower Risk/Least Concern, NT=Near Threatened, VU=Vulnerable

Dalbergia fusca Pierre

Equisetum hyemale

Polygonum plebeium

Ludwigia octovalvis

4.1.4 The third part around Me-pok and Naung-cho-gyi

4.1.4.1 Me-pok Village Area

Photo Vegetation Profile of Me-pok area

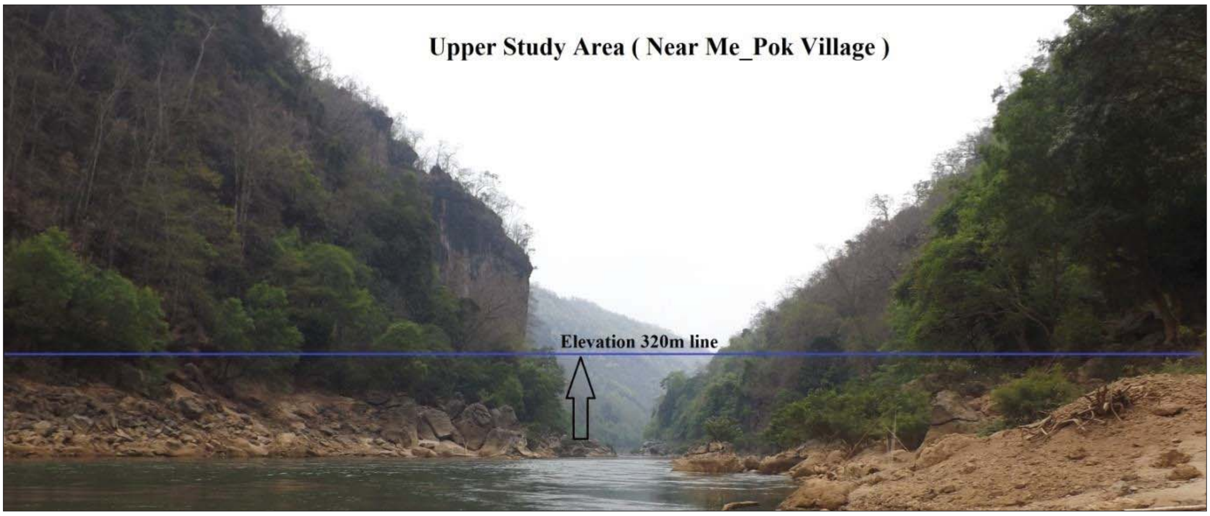
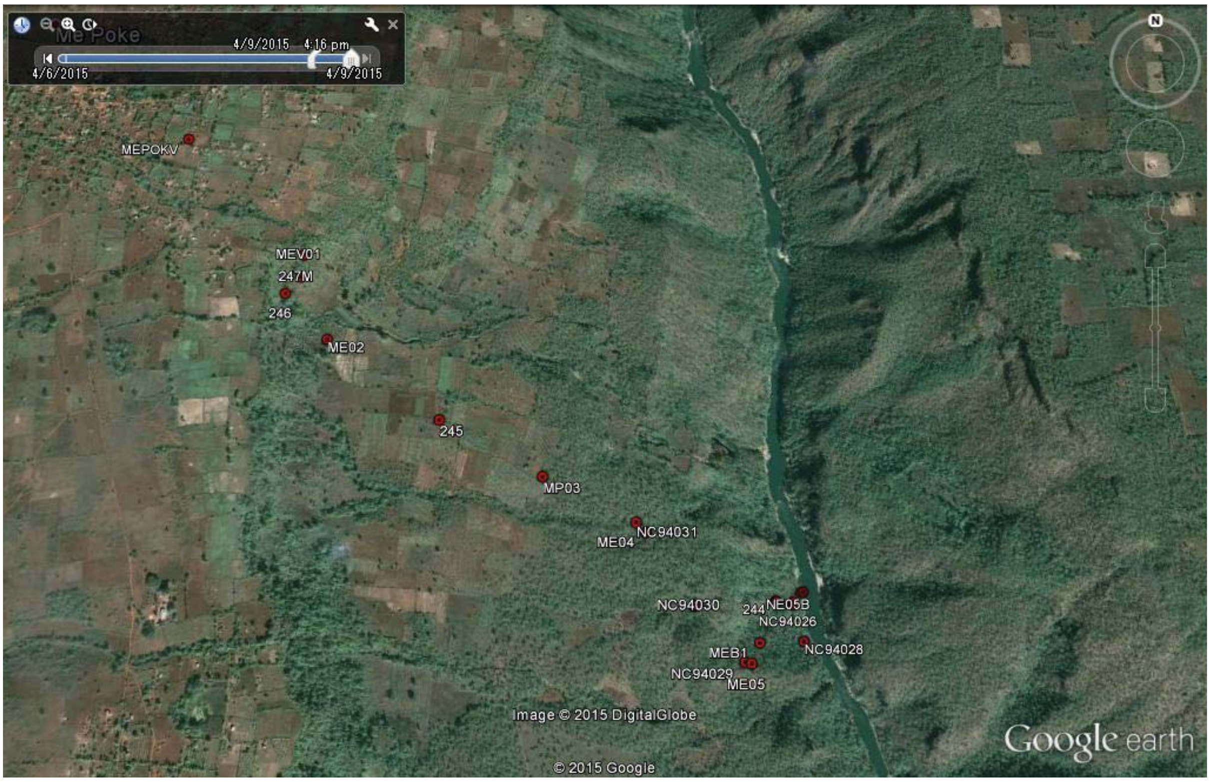


Photo. Map IV. Study points



Me-pok Village (Indaing Forest)

Indaing Forest

4.1.4.1.1 Species Composition

The total number of species collected in this part is 70 species belonging to 12 genera and 37 families.

List of species in the study area

No.	Scientific Name	Common Name	Family Name
1	*Acmella calva* (DC.) R.K. Jansen	Pe-le-nyin	Asteraceae
2	*Adenostemma viscosum*	Not known	Asteraceae
3	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae
4	*Albizia chinensis* (Osbeck)Merr.	Bom-me-za	Mimosaceae
5	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae
6	*Alternanthera nodiflora* R.Br.	Ka-na-phaw-yaing	Amaranthaceae
7	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae
8	*Amaranthus gracilis* Desf.	Hin-nu-nwe-yaing	Amaranthaceae
9	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae
10	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae
11	*Argyreia nervosa* (Burm.f.)Bojer	Kazun-gyi	Convolvulaceae
12	*Artemisia* sp.	Not known	Asteraceae
13	*Asparagus filicinus* Buch.-Ham. ex D. Don	Ka-nyut	Asparagaceae
14	*Bambusa bambos*(L.)Voss.	Kya-khat-wa	Poaceae
15	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae
16	*Bauhinia* sp.	Swe-daw	Caesalpiniaceae

No.	Scientific Name	Common Name	Family Name
17	*Bidens pilosa*	Hmwe-sok	Asteraceae
18	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae
19	*Buddleja asiatica* Lour	Not known	Buddlejaceae
20	*Calycopteris floribunda* Lam.	Kyun-khaung-nwee	Combretaceae
21	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae
22	*Curcuma* sp.	Mar-la	Zingiberaceae
23	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae
24	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae
25	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae
26	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae
27	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae
28	*Dioscorea cylindrica* Burm.	KYwary-thon-ywet	Dioscoreaceae
29	*Dioscorea pentaphylla* L.	KYwary-ngar-ywet	Dioscoreaceae
30	*Diospyros kaki* L.f.	Tae	Ebenaceae
31	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae
32	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae
33	*Gochnatia decora*	Not known	Asteraceae
34	*Grewia eriocarpa*Juss.	Pin-ta-yaw	Tiliaceae
35	*Grewia laevigata* Vahl	Ta-yaw	Tiliaceae
36	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae
37	*Hiptage benghalensis* (L.) Kurz	Sar-say/Bein-nwee	Malpighiaceae
38	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae
39	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae
40	*Melanorrhoea usitata* Wall.	Thit-si	Anacardiaceae
41	*Millettia ovalifolia* Kurz	Thin-win	Fabaceae
42	*Ochna integerrima*	Indaing-seni	Ochnaceae
43	*Oxalis corniculata* L.	Hmo-chin	Oxalidaceae
44	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae
45	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae
46	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae
47	*Pseuderanthemum polyanthum*	Not known	Acanthaceae
48	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae
49	*Pterospermum diversifolium*	Not known	Sterculiaceae
50	*Rumex crispus* L.	Not known	Polygonaceae
51	*Rumex trisetifer*	Not known	Polygonaceae
52	*Saccharum spontaneum* L.	Kaing	Poaceae
53	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae
54	*Schima wallichii* (DC.) Korth.	Lauk-ya	Theaceae
55	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae
56	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae
57	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae

No.	Scientific Name	Common Name	Family Name
58	*Spirogyra* sp.	Algae	Zygnemataceae
59	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae
60	*Sterculia foetida* L.	Shaw-phyu	Sterculiaceae
61	*Sterculia villosa*	Shaw	Sterculiaceae
62	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae
63	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae
64	*Syzygium grande* (Wight) Walp	Tha-bye	Myrtaceae
65	*Tanacetum tibeticum* Hook.f. & Thomson	Not known	Asteraceae
66	*Taraxacum officinale*	Not known	Asteraceae
67	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae
68	*Vanda coerulescens* Griff.	Mo-lon-hmying-apyar-lay	Orchidaceae
69	*Vangueria spinosa* Roxb.	Ma-gyi-pauk	Rubiaceae
70	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae

4.1.4.1.2. Vegetation type in the study area

No.	Sample Quadrant	Vegetation type	Latitude/Longitude	Altitude	Dominant species
1	Q XXI	Indaing Forest	N22 06 07.8 E96 58 29.0	976 ft	*Shorea siamensis*(Kurz)Miq., *Terminalia alata* (Heyne) Roth, *Schleichera oleosa* (Lour.) Oken, *Dalbergia oliveri* Gamble, *Shorea obtusa* Wall., *Phyllanthus emblica* L., *Buchanania latifolia* Roxb.,*Grewia laevigata* Vahl
2	Q XXII	Indaing Forest	N22 06 07.7 E96 58 26.6	1125 ft	
3	Q XXIII	Indaing Forest	N22 06 03.3 E96 58 30.0	1287 ft	
4	Q XXIV	Indaing Forest	N22 06 00.2 E96 58 22.0	1618 ft	
5	Q XXV	Indaing Forest	N22 06 05.7 E96 58 16.0	1824 ft	
6	Q XXVI	Indaing Forest	N22 06 14.6 E96 58 09.2	1940 ft	

The vegetation type is determined by tree species composition, population density and dominant species.

4.1.4.1.3. Floristic composition

The total number of tree species collected in 6 representative sample plots in this area is 13 species belonging to 12 genera. The dominant tree species in this area are *Shorea siamensis* (Kurz) Miq. (In-gyin) followed by *Terminalia alata* (Heyne) Roth (Htauk-kyant), *Schleichera oleosa* (Lour.) Oken (Gyo), and *Shorea obtusa* Wall. (Thit-ya).

4.1.4.1.4. Tree Species Population

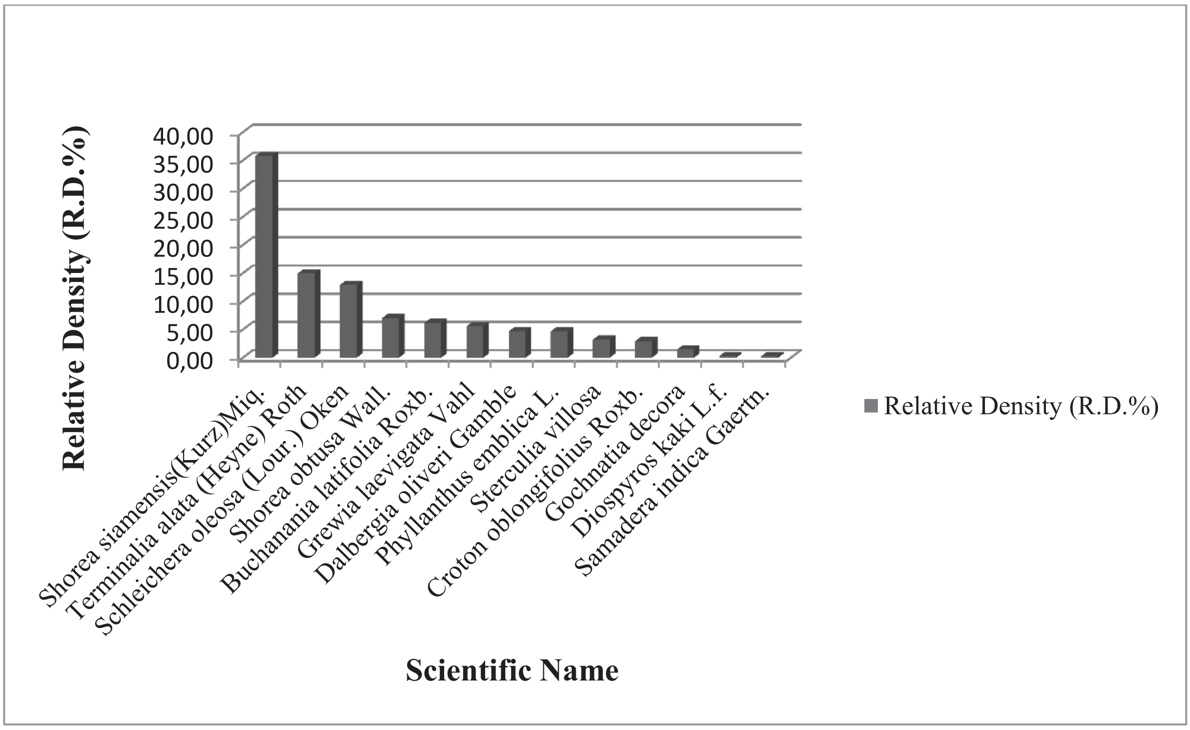
No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Buchanania latifolia* Roxb.	21	38.89	6.16
2	*Croton oblongifolius* Roxb.	10	18.52	2.93
3	*Dalbergia oliveri* Gamble	16	29.63	4.69
4	*Diospyros kaki* L.f.	1	1.85	0.29
5	*Gochnatia decora*	5	9.26	1.47
6	*Grewia laevigata* Vahl	19	35.19	5.57

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
7	*Phyllanthus emblica* L.	16	29.63	4.69
8	*Samadera indica* Gaertn.	1	1.85	0.29
9	*Schleichera oleosa* (Lour.) Oken	44	81.48	12.90
10	*Shorea obtusa* Wall.	24	44.44	7.04
11	*Shorea siamensis*(Kurz)Miq.	122	225.93	35.78
12	*Sterculia villosa*	11	20.37	3.23
13	*Terminalia alata* (Heyne) Roth	51	94.44	14.96
	Total	**341**	**631.48**	**100**

4.1.4.1.5. Relative density

Among the sample plots, species density per hectare varied and the highest density was observed *Shorea siamensis*, *Terminalia alata*, *Schleichera oleosa* followed by *Shorea obtusa*, *Buchanania latifolia* and *Grewia laevigata*. This shows that these six species are abundant in this area.

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Shorea siamensis*(Kurz)Miq.	20.33	35.78
2	*Terminalia alata* (Heyne) Roth	8.50	14.96
3	*Schleichera oleosa* (Lour.) Oken	7.33	12.90
4	*Shorea obtusa* Wall.	4.00	7.04
5	*Buchanania latifolia* Roxb.	3.50	6.16
6	*Grewia laevigata* Vahl	3.17	5.57
7	*Dalbergia oliveri* Gamble	2.67	4.69
8	*Phyllanthus emblica* L.	2.67	4.69
9	*Sterculia villosa*	1.83	3.23
10	*Croton oblongifolius* Roxb.	1.67	2.93
11	*Gochnatia decora*	0.83	1.47
12	*Diospyros kaki* L.f.	0.17	0.29
13	*Samadera indica* Gaertn.	0.17	0.29

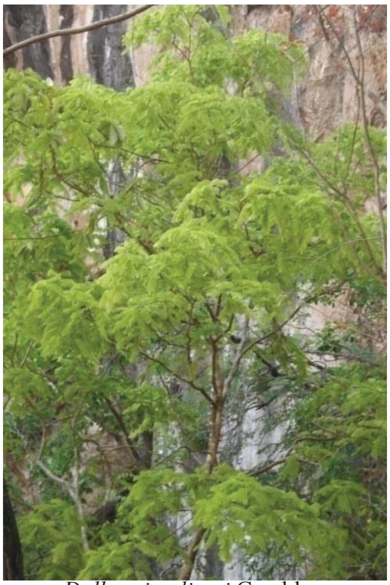


4.1.4.1.6 Threaten Species List

No.	Scientific Name	Common Name	Family Name	IUCN criteria
1	*Alternanthera nodiflora* R.Br.	Ka-na-phaw-yaing	Amaranthaceae	LC
2	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	LC
3	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	NT
4	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	EN A 1cd
5	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	LC
6	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	LC
7	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	LC
8	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	VU
9	*Saccharum spontaneum* L.	Kaing	Poaceae	LC
10	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	LR/LC
11	*Shorea siamensis* (Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/LC

EN=Endangered, LC=Least Concern, LR/LC=Lower Risk/Least Concern, NT=Near Threatened, VU=Vulnerable

Dendrocalamus membranaceus Munro



Dalbergia oliveri Gamble

Dalbergia cultrata Grah.

Holarrhena pubescens Wall. ex G. Don

4.1.4.2 Naung-cho-gyi Area

Photo Vegetation Profile of Naung-cho-gyi Area

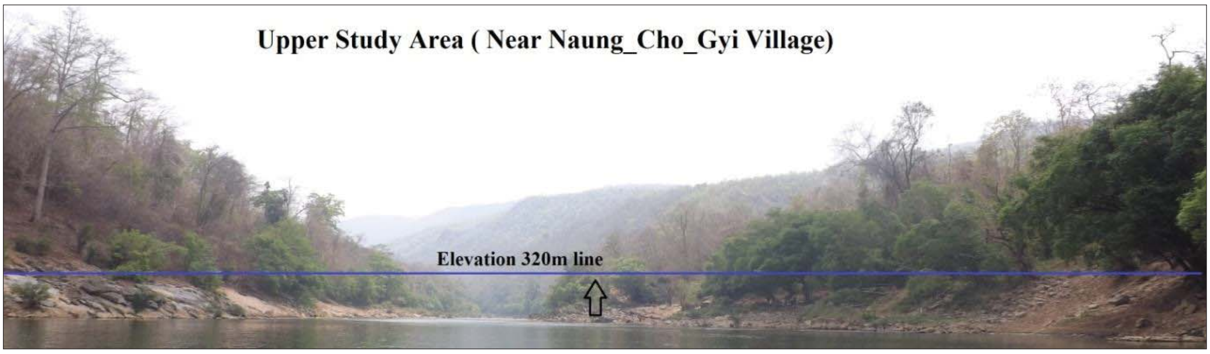


Photo. Map.V Study points

Naung-cho-gyi Village (Indaing Forest)

Indaing Forest

4.1.4.2.1 Species Composition

The total number of species collected in this part is 88 species belonging to 15 genera and 46 families.

List of species in the study area

No.	Scientific Name	Common Name	Family Name
1	*Adenanthera pavonina* L.	Ywe-gyi	Mimosaceae
2	*Adenostemma viscosum*	Not known	Asteraceae
3	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae
4	*Albizia chinensis* (Osbeck)Merr.	Bom-me-za	Mimosaceae
5	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae
6	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae
7	*Amaranthus gracilis* Desf.	Hin-nu-nwe-yaing	Amaranthaceae
8	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae
9	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae
10	*Argyreia nervosa* (Burm.f.)Bojer	Kazun-gyi	Convolvulaceae
11	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae
12	*Bambusa bambos*(L.)Voss.	Kya-khat-wa	Poaceae

No.	Scientific Name	Common Name	Family Name
13	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae
14	*Bauhinia* sp.	Swe-daw	Caesalpiniaceae
15	*Bidens pilosa*	Hmwe-sok	Asteraceae
16	*Bischofia javanica*	Not known	Euphorbiaceae
17	*Blumea balsamifera*	Not known	Asteraceae
18	*Boerhavia diffusa* L.	Pa-yan-na-wa	Nyctaginaceae
19	*Bombax ceiba* L.	Let-pan	Bombacaceae
20	*Bombax insigne* Wall.	De-du	Bombacaceae
21	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae
22	*Calycopteris floribunda* Lam.	Kyun-khaung-nwee	Combretaceae
23	*Canscora diffusa* (Vahl) R.Br.	Kyauk-pan	Gentianaceae
24	*Careya arborea* Roxb.	Ban-bwe	Lecythidaceae
25	*Cassia fistula* L.	Ngu	Caesalpiniaceae
26	*Curcuma* sp.	Mar-la	Zingiberaceae
27	*Cymbidium aloifolium* (L.)Sw.	Thit-tet-lin-nae	Orchidaceae
28	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae
29	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae
30	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae
31	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae
32	*Dendrophthoe pentandra* (L.) Miq.	Kyi-paung	Loranthaceae
33	*Desmodium pulchellum* Benth.	Taung-damin	Fabaceae
34	*Dichanthium caricosum* (L.)A.Camus	Pa-daw-myet	Poaceae
35	*Dillenia parviflora* Griff.	Zin-byun	Dilleniaceae
36	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae
37	*Dioscorea cylindrica* Burm.	KYwary-thon-ywet	Dioscoreaceae
38	*Dioscorea pentaphylla* L.	KYwary-ngar-ywet	Dioscoreaceae
39	*Diospyros kaki* L.f.	Tae	Ebenaceae
40	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae
41	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae
42	*Ehretia acuminata* R.Br	Taung-poe-lu-lin	Boraginaceae
43	*Elaeocarpus hainanensis* Oliv.	Kywe-pan-pin	Elaeocarpaceae
44	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae
45	*Emblica officinalis* Gaertn.	Sha-phyu	Euphorbiaceae
46	*Engelhardtia spicata*	Pan-swe-le	Juglandaceae
47	*Erythrina stricta* Roxb.	Ka-thit	Fabaceae
48	*Eugenia densiflora* DC.	Kyauk-tha-bye	Myrtaceae
49	*Euphorbia antiquorum* L.	Tazaung-gyi	Euphorbiaceae
50	*Ficus bengalensis* L.	Pyin-nyaung	Moraceae
51	*Ficus hispida* L.	Kha-aung	Moraceae
52	*Ficus pumila* L.	Creeping fig.	Moraceae
53	*Ficus racemosa*	Tha-phan	Moraceae

No.	Scientific Name	Common Name	Family Name
54	*Ficus variegata*	Kon-tha-phan	Moraceae
55	*Flueggea leucopyrus* Willd	Ye-chin-ya	Euphorbiaceae
56	*Gagea reticulata* (Pall.) Schult.	Not known	Liliaceae
57	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae
58	*Grewia laevigata* Vahl	Ta-yaw	Tiliaceae
59	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae
60	*Hiptage benghalensis* (L.) Kurz	Sar-say/Bein-nwee	Malpighiaceae
61	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae
62	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae
63	*Lannea coromandelica* (Houtt.) Merrr.	Na-be	Anacardiaceae
64	*Melanorrhoea usitata* Wall.	Thit-si	Anacardiaceae
65	*Micromelum minutum* (G. Forst.) Wight & Arn.	Pa-le-pan/Pauk-chaung	Rutaceae
66	*Mikania micrantha* H.B.K.	Bi-zet-new	Asteraceae
67	*Millettia ovalifolia* Kurz	Thin-win	Fabaceae
68	*Ochna integerrima*	Indaing-seni	Ochnaceae
69	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae
70	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae
71	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae
72	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae
73	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae
74	*Schima wallichii* (DC.) Korth.	Lauk-ya	Theaceae
75	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae
76	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae
77	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae
78	*Spirogyra* sp.	Algae	Zygnemataceae
79	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae
80	*Sterculia foetida* L.	Shaw-phyu	Sterculiaceae
81	*Sterculia villosa*	Shaw	Sterculiaceae
82	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae
83	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae
84	*Syzygium grande* (Wight) Walp	Tha-bye	Myrtaceae
85	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae
86	*Vanda coerulescens* Griff.	Mo-lon-hmying-apyar-lay	Orchidaceae
87	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae
88	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae

4.1.4.2.2. Vegetation type in the study area

No.	Sample Quadrant	Vegetation type	Latitude/Longitude	Altitude	Dominant species
1	Q XXXV	Indaing Forest	N22 15 39.3 E96 55 44.8	2130 ft	*Shorea obtusa* Wall., *Syzygium grande* (Wight) Walp, *Buchanania latifolia* Roxb., *Dalbergia oliveri* Gamble, *Shorea siamensis*(Kurz)Miq.s *Phyllanthus emblica* L., *Schleichera oleosa* (Lour.) Oken, *Terminalia alata* (Heyne) Roth, *Dillenia parviflora* Griff.
2	Q XXXVI	Indaing Forest	N22 15 33.0 E96 55 54.4	2012 ft	
3	Q XXXVII	Indaing Forest	N22 15 29.7 E96 56 01.9	1881 ft	
4	Q XXXVIII	Indaing Forest	N22 15 36.8 E96 56 18.3	1585 ft	
5	Q XXXIX	Indaing Forest	N22 15 42.0 E96 56 23.6	1383 ft	
6	Q XXXX	Indaing Forest	N22 15 45.8 E96 56 25.7	1204 ft	

The vegetation type is determined by tree species composition, population density and dominant species.

4.1.4.2.3. Floristic composition

The total number of tree species collected in 6 representative sample plots in this area is 9 species belonging to 8 genera. The dominant tree species in this area are *Shorea obtusa* Wall. (Thit-ya) followed by *Syzygium grande* (Wight) Walp (Tha-bye), *Buchanania latifolia* Roxb. (Lun-pho), and *Dalbergia oliveri* Gamble (Ta-ma-lan).

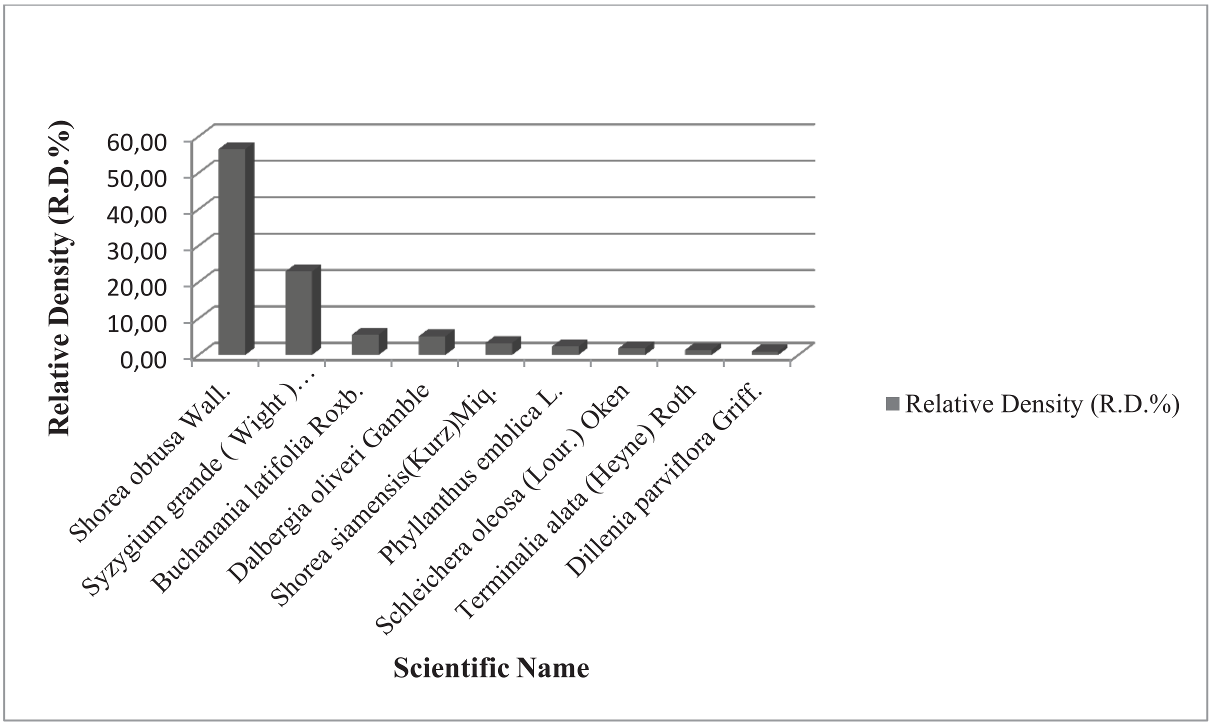
4.1.4.2.4. Tree Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Buchanania latifolia* Roxb.	12	16.67	5.61
2	*Dalbergia oliveri* Gamble	11	15.28	5.14
3	*Dillenia parviflora* Griff.	2	2.78	0.93
4	*Phyllanthus emblica* L.	5	6.94	2.34
5	*Schleichera oleosa* (Lour.) Oken	4	5.56	1.87
6	*Shorea obtusa* Wall.	121	168.06	56.54
7	*Shorea siamensis*(Kurz)Miq.	7	9.72	3.27
8	*Syzygium grande* (Wight) Walp	49	68.06	22.90
9	*Terminalia alata* (Heyne) Roth	3	4.17	1.40
	Total	**214**	**297.22**	**100.00**

4.1.4.2.5. Relative density

Among the sample plots, species density per hectare varied and the highest density was observed *Shorea obtusa* Wall., *Alnus nepalensis* D. Do *Syzygium grande* (Wight) Walp, *Buchanania latifolia* Roxb., followed by *Dalbergia oliveri* Gamble, *Shorea siamensis*(Kurz)Miq., and *Phyllanthus emblica* L. This shows that these six species are abundant in this area.

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Shorea obtusa* Wall.	20.17	56.54
2	*Syzygium grande* (Wight) Walp	8.17	22.90
3	*Buchanania latifolia* Roxb.	2.00	5.61
4	*Dalbergia oliveri* Gamble	1.83	5.14
5	*Shorea siamensis*(Kurz)Miq.	1.17	3.27
6	*Phyllanthus emblica* L.	0.83	2.34
7	*Schleichera oleosa* (Lour.) Oken	0.67	1.87
8	*Terminalia alata* (Heyne) Roth	0.50	1.40
9	*Dillenia parviflora* Griff.	0.33	0.93



4.1.4.2.6. Threaten Species List

No.	Scientific Name	Common Name	Family Name	IUCN criteria
1	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	LC
2	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	NT
3	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	EN A 1cd
4	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	LC
5	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae	LC
6	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	LC
7	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	LC
8	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	LC
9	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	VU
10	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	LR/LC
11	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/LC

12	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	LC

EN=Endangered, LC=Least Concern, LR/LC=Lower Risk/Least Concern, NT=Near Threatened, VU=Vulnerable

Homonoia riparia

Alternanthera sessilis (L.) R.Br.

Eleusine indica Gaertn.

Ziziphus jujuba Lam.

4.2 Fauna (Dry season)

Table 2. List of fauna recorded from Middle Ye Ywar Hydropwer Project site

Fauna	No. of orders	No. of families	No. of species
Birds	13	37	68
Fish	1	2	17
Mammals	7	11	14
Herpets	4	11	16
Insects	7	14	27
Total	32	75	142

Table 3. List of fish fauna recorded from Middle Ye Ywar Hydropower Project, Naung- cho Township

Order	Family	Species	Common Name	Local Name
Cypriniformes	Cyprinidae	1. *Burbus hexastichus*	Nga Kyaung	Nga kyaung
Cypriniformes	Cyprinidae	2. *Morulius calbasu*	Orangefin labeo	Nga net ma
Cypriniformes	Cyprinidae	3. *Folifer brevifilis*	Burbus Brevifilis	Kyaut Ngalu
Cypriniformes	Cyprinidae	4. *Puntius amphibious*	Pool barb	Nga khone ma
Cypriniformes	Cyprinidae	5.*Puntius oligolipis*	Checker barb	Nga khonema wah
Cypriniformes	Cyprinidae	6. *Puntius sp.*	Barb	Nga khone ma
Cypriniformes	Cyprinidae	7. *Danio kaerri*	Hikari danio	Nga Pyat
Cypriniformes	Cyprinidae	8.*Danio aequipinnutus*	Giant danio	Yay Pawe Nga
Cypriniformes	Cyprinidae	9.*Garra lamta*	Stone sucker	Nga Kyauk Kat
Cypriniformes	Cyprinidae	10.*Crossochelius burmanicus*	Burmese latia	Nga dinlone
Cypriniformes	Cyprinidae	11. *Cabdio moror*	-	Kyaw yoseir
Cypriniformes	Cyprinidae	12.*Barilius sp.*	-	Nga Lettu
Cypriniformes	Cyprinidae	13. *Labeo stoliczkae*	-	Nga lu
Cypriniformes	Cyprinidae	14. *Labeo dyocheilus*	Carp	Nga Me Kyut
Cypriniformes	Cyprinidae	15. *Amblypharyngodon mola*	-	Nga Be

Cypriniformes	Amblycipitidae	*16.Hemibagrus microphthalmus*	Dwarf cat fish	Nga Mote Sai
Cypriniformes	Cyprinidae	*17. Glyptothorax trilineatus*	Yellow cat fish	Nga thinbau

Table 4. Habitat types of fishes, recorded from Middle Ye Ywar Hydropower Project, Naung-cho Township

Species	Number	Data source	Habitat types	Remarks
1. *Burbus hexastichus*	-	IS	Shallow water with dandy bottom	Endemic
2. *Morulius calbasu*	6	VS	Large river but juvenile nurse in flood	
3. Folifer brevifilis	1	VS	Clear water with rocky bottom riparian forest	Uncommon
4. Puntius amphibious	20	VS	Sandy bottom & riparian forest	Common
5.Puntius oligolipis	3	VS	Sandy bottom & riparian water plants	Uncommon
6. Puntius sp.	30	VS	Sandy bottom & riparian water plants	Endemic
7. Danio kaerri	20	VS	Well planted and upper level of stream	Endemic
8.Danio aequipinnutus	15	VS	Sandy and gravel beds in dense ripiarian vegetation	Endemic
9.Garra lamta	6	VS	Torrent rivers and streams with rocky and gravel bottoms	Endemic
10.Crossochelius burmanicus	30	VS	Torrent rivers with rocky bottom	Locally Uncommon
11. Cabdio moror	20	VS	Main stream of large rivers	Occasionalyy
12.Barilius sp.	30	VS	Torrent rivers and streams with rocky bottom	Common
13. Labeo stoliczkae	22	VS	Large rivers and flooded plains	Common
14. Labeo dyocheilus	25	VS	Large rivers with rocky rapids	Uncommon
15. Amblypharyngodon mola	52	VS	Marsh land and flood plain	Common
16.Hemibagrus microphthalmus	6	IS	Rivers and larger streams to suck the rocks	Seasonal common
17. Glyptothorax trilineatus	3	VS	Torrent streams with rocky rapids	Rare

IS = interview survey, VS = voucher specimen collected

Table 5. Numbers of fishes recorded from survey sites of Middle Ye-Ywar Hydropower Project, Naung-cho Township

Species	site I	site 2	site 3	site 4	site 5	Total
1. *Burbus hexastichus*	-	-	-	-	-	
2. *Morulius calbasu*	1	-	4	-	-	
3. *Folifer brevifilis*	-	-	1	-	-	
4. *Puntius amphibious*	-	2	6	10	2	20
5.*Puntius oligolipis*	-	--	2	-	-	2
6. *Puntius sp.*	-	5	20	5	5	30
7. *Danio kaerri*	4	2	6	3	2	20
8.*Danio aequipinnutus*	3	-	7	3	-	15
9.*Garra lamta*	-	5	6	-	-	6
10.*Crossochelius burmanicus*	3	6	8	9	5	30
11. *Cabdio moror*	5	5	5	3	1	20
12.*Barilius sp.*	16	1	3	4	2	30
13. *Labeo stoliczkae*	2	1	8	5	6	22
14. *Labeo dyocheilus*	0	7	20	4	-	25
15. *Amblypharyngodon mola*	20	-	15	7	3	45
16.*Hemibagrus microphthalmus*	-	-	-	-	-	-
17. *Glyptothorax trilineatus*	-	1	3	-	-	3

Site 1 = Dodtawaddy bridge Downstream
Site 2 = Dodtawaddy bridge Upstream
Site 3 =Ye-twin-gyi
Site 4 = Me-pok
Site 5 = Gote-twin junction river (Naung-cho-gyi)

Table 6. List of Recorded Bird species from Middle Ye Ywar Hydropower Project Area

No.	Order / Family	Scientific Name	Common Name	Remark
I.	**Galliformes**			
1.	Megapodiidae	*Francolinus pintadeanus*	Chinese francolin	T
2.	Megapodiidae	*Cotumix chinensis*	Blue Breasted Quail	T
3.	Phasianidae	*Pavo muticus*	Green Peafowl	T / (QS)
4.	Phasianidae	*Gallus gallus*	Red Jungle fowl	T
II.	**Ciconiiformes**			
5.	Ardeidae	*Egretta casmerodius*	Great Egret	W
6.	Ardeidae	*Bubulcus ibis*	Cattle Egret	W
III.	**Anseriformes**			
7.	Anatidae	*Dendrocygna bicolor*	Fulvous Whistling Duck	W
IV.	**Gruiformes**			
8.	Rallidae	*Gallinula chloropus*	Common Moorhen	W
V.	**Strigiformes**			
9.	Tytonidae	*Tyto alba*	Barn Owl	T
VI.	**Falconiformes**			
10.	Accipitridae	*Milvus migrans*	Black Kite	T
11.	Accipitridae	*Spilornis cheela*	Crested Serpent Eagle	T
12.	Accipitridae	*Accipiter badius*	Shikra	T
13.	Falconidae	*Falco tinnunculus*	Common Kestrel	T
VII.	**Columbiformes**			
14.	Columbidae	*Treron phoenicoptera*	Yellow Footed Green Pigeon	T
15.	Columbidae	*Streptopelia chinensis*	Spotted Dove	T
16.	Columbidae	*Streptopelia orientalis*	Oriental Turtle-Dove	T
VIII.	**Cuculiformes**			
17.	Cuculidae	*Clamator coromandus*	Chestnut Winged Cuckoo	T
18.	Cuculidae	*Eudynamys scolopaceus*	Asian koel	T
19.	Centropodidae	*Centropus sinensis*	Greater Coucal	T
IX.	**Apodiformes**			
20.	Apopidae	*Cypsiurus balasiensis*	Asian Palm Swift	T
21.	Apopidae	*Apus pacificus*	Fork-Tailed Swift	T
22.	Apopidae	*Apus affinis*	House Swift	T
X.	**Coraciiformes**			
23.	Coraciidae	*Coracias benghalensis*	Indian Roller	T
24.	Bucerotidae	*Anthracoceros albirostris*	Oriental Pied Hornbill	T / (QS)
25.	Megalaimidae	*Megalaima haemacephala*	Coppersmith Barbet	T
26.	Megalaimidae	*Megalaima lineate*	Lineated Barbet	T
27.	Alcedinidae	*Halcyon smymensis*	White-Throated Kingfisher	T
28.	Meropidae	*Merops orientalis*	Green Bee-Eater	T

29.	Meropidae	*Merops philippinus*	Blue Tail Bee-Eater	T
30.	Upupidae	*Upupa apops*	Common Hoopoe	T
XI.	**Paciformes**			
31.	Campephagidae	*Pericrocotus flammeus*	Scarlet Minivet	T
32.	Campephagidae	*Pericrocotus solaris*	Grey Chinned Minivet	T
33.	Picidae	*Dinopium javanense*	Common flameback	T
XII.	**Psittaciformes**			
34.	Psittacidae	*Psittacula eupatria*	Alexandrine Parakeet	T
35.	Psittacidae	*Psittacula finschii*	Grey- Headed Parakeet	T
XIII.	**Passeriformes**			
36.	Oriolidae	*Oriolus xanthomus*	Black-Hooded Oriole	T
37.	Dicruridae	*Dicrurus remifer*	Lesser Racket-Tailed Drongo	T
38.	Dicruridae	*Dicrurus macrocercus*	Black Drongo	T
39.	Dicruridae	*Dicrurus Ieucophaeus*	Ashy Drongo	T
40.	Dicruridae	*Dicrurus aeneus*	Bronzed Drongo	T
41.	Corvidae	*Hypothymis azurea*	Black Naped Monarch	T
42.	Corvidae	*Corvus macrorhynchos*	Large-Billed Crow	T
43.	Chloropseidae	*Chloropsis cochinchinensis*	Blue-Winged Leafbird	T
44.	Irenidae	*Irena puella*	Asian Fairy Bluebird	T
45.	Eupylaimidae	*Serilophus lunatus*	Sliver Breasted Broadbill	T
46.	Passeridae	*Motacilla alba*	White Wagtail	T
47.	Passeridae	*Anthus rufulus*	Paddy Field Pipit	T
48.	Passeridae	*Anthus cervinus*	Red throated pipit	T
49.	Muscicapidae	*Copsychus saularis*	Oriental Magpie Robin	T
50.	Muscicapidae	*Copsychus malabaricus*	White Rumped Shama	T
51.	Muscicapidae	*Saxicola caprata*	Pied Bushchat	T
52.	Muscicapidae	*Myophonus caeruleus*	Blue Whistling Thrush	T
53.	Sturnidae	*Acridotheres fuscus*	Jungle Myna	T
54.	Sturnidae	*Sturnus philippensis*	Chestnut Cheeked Starling	T
55.	Pycnonotidae	*Pycnonotus atriceps*	Black Headed Bulbul	T
56.	Pycnonotidae	*Pycnonotus cafer*	Red-Vented Bulbul	T
57.	Pycnonotidae	*Pycnonotus blanfordi*	Streak-Eared Bulbul	T
58.	Pycnonotidae	*Pycnonotus jocosus*	Red-Whiskered Bulbul	T
59.	Pycnonotidae	*Pycnonotus melanicterus*	Black-Crested Bulbul	T
60.	Hirundinidae	*Hirundo rustica*	Barn Swallow	T
61.	Hirundinidae	*Artamus fuscus*	Ashy Wood Swallow	T
62.	Aegithinidae	*Aegithina tiphia*	Common Iora	T
63.	Cisticolidae	*Orthotomus sutorius*	Common Tailorbird	T
64.	Cisticolidae	*Orthotomus cuculatus*	Mountain Tailorbird	T
65.	Nectarinidae	*Nectarinia jugularis*	Olive Backed Sunbird	T
66.	Nectarinidae	*Nectarinia asiatica*	Purple Sunbird	T

67.	Sylviidae	*Acrocephalus aedon*	Thick Billed Warbler	T
68.	Tamaliidae	*Pteruthius flaviscapis*	White-Browed Shrike Babbler	T

Where, T = Terrestrial Bird; W = Water Bird; QS = Questionaries' Survey

Table 7. Estimated number of Bird species from Middle Ye Ywar Hydropower Project Area

No.	Scientific Name	Common Name	Estimated No.	CS	Status
1.	*Francolinus pintadeanus*	Chinese francolin	1	LC	Resident
2.	*Cotumix chinensis*	Blue Breasted Quail	1	LC	Resident
3.	*Pavo muticus*	Green Peafowl	1	EN	Resident
4.	*Gallus gallus*	Red Jungle fowl	1	LC	Resident
5.	*Egretta casmerodius*	Great Egret	4	LC	Resident
6.	*Bubulcus ibis*	Cattle Egret	15	LC	Resident
7.	*Dendrocygna bicolor*	Fulvous Whistling Duck	10	LC	Resident
8.	*Gallinula chloropus*	Common Moorhen	10	LC	Resident
9.	*Tyto alba*	Barn Owl	1	LC	Resident
10.	*Milvus migrans*	Black Kite	2	LC	Resident
11.	*Spilornis cheela*	Crested Serpent Eagle	1	LC	Resident
12.	*Accipiter badius*	Shikra	4	LC	Resident
13.	*Falco tinnunculus*	Common Kestrel	2	LC	Resident
14.	*Treron phoenicoptera*	Yellow Footed Green Pigeon	4	LC	Resident
15.	*Streptopelia chinensis*	Spotted Dove	20	LC	Resident
16.	*Streptopelia orientalis*	Oriental Turtle-Dove	1	LC	Resident
17.	*Clamator coromandus*	Chestnut Winged Cuckoo	1	LC	Resident
18.	*Eudynamys scolopaceus*	Asian koel	4	LC	Resident
19.	*Centropus sinensis*	Greater Coucal	4	LC	Resident
20.	*Cypsiurus balasiensis*	Asian Palm Swift	30	LC	Resident
21.	*Apus pacificus*	Fork-Tailed Swift	6	LC	Resident
22.	*Apus affinis*	House Swift	20	LC	Resident
23.	*Coracias benghalensis*	Indian Roller	2	LC	Resident
24.	*Anthracoceros albirostris*	Oriental Pied Hornbill	1	VU	Resident
25.	*Megalaima haemacephala*	Coppersmith Barbet	3	LC	Resident
26.	*Megalaima lineate*	Lineated Barbet	2	LC	Resident
27.	*Halcyon smymensis*	White-Throated Kingfisher	4	LC	Resident
28.	*Merops orientalis*	Green Bee-Eater	10	LC	Resident
29.	*Merops philippinus*	Blue Tail Bee-Eater	5	LC	Breeding visitor
30.	*Upupa apops*	Common Hoopoe	2	LC	Breeding visitor
31	*Pericrocotus flammeus*	Scarlet Minivet	3	LC	Resident

32.	*Pericrocotus solaris*	Grey Chinned Minivet	2	LC	Resident
33.	*Dinopium javanense*	Common flameback	1	LC	Resident
34.	*Psittacula eupatria*	Alexandrine Parakeet	4	LC	Resident
35.	*Psittacula finschii*	Grey- Headed Parakeet	15	LC	Resident
36.	*Oriolus xanthomus*	Black-Hooded Oriole	2	LC	Resident
37.	*Dicrurus remifer*	Lesser Racket-Tailed Drongo	1	LC	Resident
38.	*Dicrurus macrocercus*	Black Drongo	5	LC	Resident
39.	*Dicrurus Ieucophaeus*	Ashy Drongo	10	LC	Resident
40.	*Dicrurus aeneus*	Bronzed Drongo	3	LC	Resident
41.	*Hypothymis azurea*	Black Naped Monarch	1	LC	Resident
42.	*Corvus macrorhynchos*	Large-Billed Crow	10	LC	Resident
43.	*Chloropsis cochinchinensis*	Blue-Winged Leafbird	2	LC	Resident
44.	*Irena puella*	Asian Fairy Bluebird	1	LC	Resident
45.	*Serilophus lunatus*	Sliver Breasted Broadbill	1	LC	Resident
46.	*Motacilla alba*	White Wagtail	20	LC	Resident
47.	*Anthus rufulus*	Paddy Field Pipit	1	LC	Resident
48.	*Anthus cervinus*	Red throated pipit	1	LC	Resident
49.	*Copsychus saularis*	Oriental Magpie Robin	10	LC	Resident
50.	*Copsychus malabaricus*	White Rumped Shama	1	LC	Resident
51.	*Saxicola caprata*	Pied Bushchat	4	LC	Resident
51.	*Myophonus caeruleus*	Blue Whistling Thrush	1	LC	Winter visitor
53.	*Acridotheres fuscus*	Jungle Myna	12	LC	Resident
54.	*Sturnus philippensis*	Chestnut Cheeked Starling	2	LC	Resident
55.	*Pycnonotus atriceps*	Black Headed Bulbul	1	LC	Resident
56.	*Pycnonotus cafer*	Red-Vented Bulbul	20	LC	Resident
57.	*Pycnonotus blanfordi*	Streak-Eared Bulbul	5	LC	Resident
58.	*Pycnonotus jocosus*	Red-Whiskered Bulbul	10	LC	Resident
59.	*Pycnonotus melanicterus*	Black-Crested Bulbul	4	LC	Resident
60.	*Hirundo rustica*	Barn Swallow	10	LC	Resident
61.	*Artamus fuscus*	Ashy Wood Swallow	2	LC	Resident
62.	*Aegithina tiphia*	Common Iora	4	LC	Resident
63.	*Orthotomus sutorius*	Common Tailorbird	8	LC	Resident
64.	*Orthotomus cuculatus*	Mountain Tailorbird	2	LC	Resident
65.	*Nectarinia jugularis*	Olive Backed Sunbird	2	LC	Resident
66.	*Nectarinia asiatica*	Purple Sunbird	1	LC	Resident
67.	*Acrocephalus aedon*	Thick Billed Warbler	6	LC	Winter visitor
68.	*Pteruthius flaviscapis*	White-Browed Shrike Babbler	1	LC	Resident

Where, CS = Conservation Status; EN = Endangered; VU = Vulnerable; LC = Least Concern

Table 8. Survey site and Habitat type of Recorded Bird species from Middle Ye Ywar Project Area

Sr No.	Species	Number	Habitat	Survey Site
1.	*Francolinus pintadeanus*	1	Shrub and bushes	4
2.	*Cotumix chinensis*	1	Shrub and bushes	3
3.	*Pavo muticus*	1	Near river bank	1
4.	*Gallus gallus*	1	Near river bank	1
5.	*Egretta casmerodius*	4	Near river bank	6
6.	*Bubulcus ibis*	15	Near leach and river	2,5
7.	*Dendrocygna bicolor*	10	Wetland (in leach)	5
8.	*Gallinula chloropus*	10	Wetland (in leach)	5
9.	*Tyto alba*	1	Grass land	2
10.	*Milvus migrans*	2	Top canopy / On sky	3
11.	*Spilornis cheela*	1	On sky	6
12.	*Accipiter badius*	4	Cultivation	4, 5
13.	*Falco tinnunculus*	2	On Sky	6
14.	*Treron phoenicoptera*	4	Top Canopy	5
15.	*Streptopelia chinensis*	20	Cultivation / Tree	1,2,3,4,5,6
16.	*Streptopelia orientalis*	1	Cultivation / Tree	5
17.	*Clamator coromandus*	1	Middle Canopy	5
18.	*Eudynamys scolopaceus*	4	Tree	4,5
19.	*Centropus sinensis*	4	Shrub and bushes	4,5,6
20.	*Cypsiurus balasiensis*	30	Tree / On sky	1,2,4,5,6
21.	*Apus pacificus*	6	Tree / On sky	5,6
22.	*Apus affinis*	20	On Sky	1,4,5,6
23.	*Coracias benghalensis*	2	Tree / Cultivation	4,5
24.	*Anthracoceros albirostris*	1	Tree	3
25.	*Megalaima haemacephala*	3	Middle canopy	3,5,6
26.	*Megalaima lineate*	2	Top canopy	5
27.	*Halcyon smymensis*	4	Tree / Near river bank	1,2
28.	*Merops orientalis*	10	Tree / Cultivation	4,5,6
29.	*Merops philippinus*	5	Tree / Cultivation	2,3,6
30.	*Upupa apops*	2	Cultivation	5,
31.	*Pericrocotus flammeus*	3	Top canopy	3,6
32.	*Pericrocotus solaris*	2	Middle canopy	3
33.	*Dinopium javanense*	1	Tree	1
34.	*Psittacula eupatria*	4	Tree	3
35.	*Psittacula finschii*	15	Tree	3,4,5,6
36.	*Oriolus xanthomus*	2	Middle canopy	1,2
37.	*Dicrurus remifer*	1	Tree	6
38.	*Dicrurus macrocercus*	5	Tree	4
39.	*Dicrurus Ieucophaeus*	10	Tree	5,6
40.	*Dicrurus aeneus*	3	Tree	4
41.	*Hypothymis azurea*	1	Tree	6
42.	*Corvus macrorhynchos*	10	Tree / Cultivation	4,5,6

43.	*Chloropsis cochinchinensis*	2	Middle canopy	2
44.	*Irena puella*	1	Lower canopy	5
45.	*Serilophus lunatus*	1	Tree	6
46.	*Motacilla alba*	20	River bank / Marshes / Cultivation	1,2,3,4,5,6
47.	*Anthus rufulus*	1	Paddy field	4
48.	*Anthus cervinus*	1	Cultivation	5
49.	*Copsychus saularis*	10	Tree / Cultivation	1,4,5,6
50.	*Copsychus malabaricus*	1	Tree	1
51.	*Saxicola caprata*	4	Tree / Cultivation	4,5
52.	*Myophonus caeruleus*	1	River Bank	2
53.	*Acridotheres fuscus*	12	Tree / Cultivation	1,3,4,5,6
54.	*Sturnus philippensis*	2	Tree	6,
55.	*Pycnonotus atriceps*	1	Tree, Canopy	2
56.	*Pycnonotus cafer*	20	Tree/ Cultivation/ River bank	1,2,3,4,5,6
57.	*Pycnonotus blanfordi*	5	Tree / Cultivation	4,5
58.	*Pycnonotus jocosus*	10	Tree / Cultivation	2,4,5
59.	*Pycnonotus melanicterus*	4	Tree, Canopy	2,3
60.	*Hirundo rustica*	10	Tree / Cultivation	4,5,6
61.	*Artamus fuscus*	2	Tree	6
62.	*Aegithina tiphia*	4	Canopy	1,2,5
63.	*Orthotomus sutorius*	8	Tree/ Shrub and Bushes	2,3,4,5,6
64.	*Orthotomus cuculatus*	2	Tree	3
65.	*Nectarinia jugularis*	2	Tree	2
66.	*Nectarinia asiatica*	1	Middle canopy	3
67.	*Acrocephalus aedon*	6	Shrub and Bushes	5
68.	*Pteruthius flaviscapis*	1	Shrub and Bushes	4

Where,Survey Site 1 = Down Stream, at the environ of Dodtawaddy bridge
Survey Site 2 = Up Stream, at the environ of Dodtawaddy bridge
Survey Site 3 = Environ of Dodtawaddy river at Ye-twin-gyi village
Survey Site 4 = Environ of Dodtawaddy river at Me-Pok village
Survey Site 5 = Environ of Mam Maw village, Naung Taw village (1) and (2)
Survey Site 6 = Environ of Dodtawaddy river at Naung-cho-gyi village

Table 9. List of Mammal species recorded from Middle Ye Ywar Hydropower Project, Naung Cho Township

No.	Order	Family/ Sub-family	Scientific name	Common name
I	Insectivora	Erinaceidae	1.*Talpa sp*	Eastern Mole
II	Primate	Lorisidae	2. *Macaca sp.*	Pig Tailed Macaque
			3. *Macaca mulatta*	Rhesus Macaque
III	Pholidota	Manidae	4. *Mnanis pentadactyla*	Chinese Pangolin
			5. Lepus peguensis	Siamese Hare
IV	Rodentia	Sciurinae	6.*Callosciurus erythraeus*	Pallas's Squirrel
			7. Tamiops mcclellandii	Myanmar striped Squirrel
		Histricidae	8. *Hystrix brachyura*	Eastern Asian Porcupine
V	Carnivora	Ursidae	9. *Ursus* sp	Bear
		Herpestidae	10. Herpestes sp	Small AsianMongoose
		Felidae	11. *Felis chaus*	Jungle Cat
VI	Artiodactyla	Suidae	12. *Sus scrofa*	Eurasian wild Pig
		Cervidae	13. *Muntiacus muntjak*	Red Muntjac
VII	Chiroptera	Emballonuridae	14. *Taphozous longimanus*	Tomb Bat

Table 10. Habitat types and conservation status of mammal species in project area

Species	Habitat type	Data source	IUCN Redlist/ CITES
1.*Talpa sp*	Ground hole	QS	-
2. *Macaca sp.*	Tree	VS	VL/Appendix II
3. *Macaca mulatta*	Tree	VS	VL/Appendix II
4. *Mnanis pentadactyla*	Forest	QS	NT/ Appendix I
5. Lepus peguensis	Forest	QS	-
6.*Callosciurus erythraeus*	Teak tree	VS	-
7. Tamiops mcclellandii	Teak tree	VS	-
8. *Hystrix brachyuran*	Forest	Spine	VL/Appendix I
9. *Ursus* sp	Forest	QS	VL/Appendix I
10. Herpestes sp	Forest	QS	-
11. *Felis chaus*	Forest	Footprint	Appendix II
12. *Sus scrofa*	Forest	Qs	-
13. *Muntiacus muntjak*	Forest	Horn	-
14. *Taphozous longimanus*	Limestone Cave	VS	-

QS = Questionaries' survey, VS = voucher specimen collected

Table 11. List of Herpet species collected from Middle Ye Ywar Hydropower Project, Naung Cho Township

Order	Family	Scientific Name	Common Name
I.Anura	Bufonidae	1. *Duttaphrynus melanostictus*	Common Toad
	Ranidae	2. *Fejervarya limnocharis limnocharis*	Paddy Frog/ Swamp Frog
II. Lacertilia	Agamidae	3. *Calotes versicolor*	Garden Fence Lizard
		4. *Calotes mystaceus*	Blue crested lizard
		5. *Pseudoclotes microlepis*	Small-Scaled Forest Lizard
	Gekkonidae	6. *Gekko gecko*	Tockay
		7. *Hemidactylus frenatus*	Common House Gecko
	Scincidae	8. *Sphenomorphus sp*	Spotted Forest Skink
	Varanidae	9.*Varanus sp.*	Monitor
III. Serpentes	Colubridae	10. *Ptyas sp.*	Rat Snake
		11. *Ahaetulla nasuta*	Long-nosed Whip Snake
	Elapidae	12. *Naja sp.*	Cobra
		13. *Ophiophagus Hannah*	King Cobra
	Natricidae	14. *Amphiesma sp*	Keelback
	Pythonidae	15. *Python moluras*	Burmese Python
IV. Testudines	Testudinidae	16. *Indotestudo elongata*	Yellow Tortoise

Table 12. Habitat types and conservation status of mammal species in project area

Species	Habitat type	Data source	IUCN Redlist/ CITES
1. *Duttaphrynus melanostictus*	In grass	VS	-
2. *Fejervarya limnocharis limnocharis*	Riverbank, under rock	VS	-
3. *Calotes versicolor*	Garden fence	VS	-
4. *Calotes mystaceus*	tree	VS	-
5. *Pseudoclotes microlepis*	tree	VS	-
6. *Gekko gecko*	Tree hole	VS	-
7. *Hemidactylus frenatus*	Dwelling house	VS	-
8. *Sphenomorphus sp*	Bush	VS	-
9.*Varanus sp.*	Forest	QS	-
10. *Ptyas sp.*	Forest	QS	-
11. *Ahaetulla nasuta*	Tree	VS	-
12. *Naja sp.*	Forest	Qs	-
13. *Ophiophagus Hannah*	Forest	QS	Endanger
14. *Amphiesma sp*	Grass	VS	-
15. *Python moluras*	Forest	QS	Near Threatened
16. *Indotestudo elongata*	Forest	VS	Endanger/Appendix II

VS= voucher speciemen collected, QS = Questionaries' survey

Table 13. List of Insect species collected from Middle Ye Ywar Hydropower Project, Naung-cho Township

Order	Family	Species	Common Name
I.Lepidoptera	1. Papilionidae	1. *Papilio polite romulus*	Butterfly
		2. *Papilio memnon agenor*	Butterfly
		3. Graphium nomius	Butterfly
	2. Danaidae	4. *Danaus limniace limniace*	Butterfly
	3. Nymphalidae	5. *Junoniaiphita ocyale*	Butterfly
		6. Phalanta Phalanta	Butterfly
		7. *Neptis hylas kamarupa*	Butterfly
		8. Junonia almana almana	Butterfly
		9. Lassipa viraja viraja	Butterfly
	4. Pieridae	10. *Eurema hecabe contubernalis*	Butterfly
		11. Artogenia naganum naganum	Butterfly
		12. Delias descombi descombi	Butterfly
	5. Danaidae	13. *Danaus chrysippus*	Butterfly
		14. *Danaus melanippus*	Butterfly
	6. Satyridae	*15. Melanitis zitenius auletes*	Butterfly
II. Odonata	7.Coenagrionidae	*16. Coeliccia sp*	Damselflies
III. Orthoptera	8. Phasmidae	17. *Anisomorpha sp*.	Walking Stick
		18. *Gryllus sp*	Cricket
		19. *Dissosteira longipenis*	Grasshopper
IV.Hymenoptera	9. Xylocopidae	20. *Apis mellifera*	Honey bee
	10. Formicidae	21. *Camponotus sp*	Carpenter ant
V. Hemiptera	11. Nepidae	22. *Ranatra sp*	Water scorpion
	12. Psyllidae	23. Paratriozn	Psyllid
	13. Coreidae	24. Anasa sp	Squash bug
VI. Pterygota	-	25. Vespa orientalis	Wasp
VII. Araneida	-	26. Aranea sp	Spider
	14. Mantidae	27. Paratenedera	Praying mantis

4.3 Fauna (Wet season)

Table 2. List of fauna recorded from Middle Ye Ywar Hydropwer Project site

Fauna	No. of orders	No. of families	No. of species
Birds	10	26	43
Fish & invertebrates	6	7	27
Mammals	6	11	16
Herpets	4	11	18
Insects	7	14	27
Total	33	69	131

Table 3. List of fish fauna recorded from Middle Ye-Ywar Hydropower Project, Naung-cho Township

Order	Family	Species	Common Name	Local Name
Cypriniformes	Cyprinidae	1. *Burbus hexastichus*	Nga Kyaung	Nga kyaung
Cypriniformes	Cyprinidae	2. *Morulius calbasu*	Orangefin labeo	Nga net ma
Cypriniformes	Cyprinidae	*3. Folifer brevifilis*	Burbus Brevifilis	Kyaut Ngalu
Cypriniformes	Cyprinidae	*4. Puntius amphibious*	Pool barb	Nga khone ma
Cypriniformes	Cyprinidae	*5.Puntius oligolipis*	Checker barb	Nga khonema wah
Cypriniformes	Cyprinidae	*6. Puntius sp.*	Barb	Nga khone ma
Cypriniformes	Cyprinidae	*7. Danio kaerri*	Hikari danio	Nga Pyat
Cypriniformes	Cyprinidae	*8.Danio aequipinnutus*	Giant danio	Yay Pawe Nga
Cypriniformes	Cyprinidae	*9.Garra lamta*	Stone sucker	Nga Kyauk Kat
Cypriniformes	Cyprinidae	*10.Crossochelius burmanicus*	Burmese latia	Nga dinlone
Cypriniformes	Cyprinidae	*11. Cabdio moror*	-	Kyaw yoseir
Cypriniformes	Cyprinidae	*12.Barilius sp.*	-	Nga Lettu
Cypriniformes	Cyprinidae	*13. Labeo stoliczkae*	-	Nga lu
Cypriniformes	Cyprinidae	*14. Labeo dyocheilus*	Carp	Nga Me Kyut
Cypriniformes	Cyprinidae	*15. Amblypharyngodon mola*	-	Nga Be
Cypriniformes	Cyprinidae	*16.Hemibagrus microphthalmus*	Dwarf cat fish	Nga Mote Sai

Cypriniformes	Cyprinidae	*17. Glyptothorax trilineatus*	Yellow cat fish	Nga thinbau
Perciformes	Cobitidae	*18. Botia rostrata*	Golden loach	Nga Sin pyawt
Perciformes	Cobitidae	*19. Botia berdmorei*	Loach	Nga Sinpyawt kyar
Perciformes	Cobitidae	*20. Lepidocephalichthys Berdmori*	Loach	Nga thale htoe
Perciformes	Cobitidae	*21. Neonoemacheilus Labeosus*	Loach	Ngatha le htoe
Perciformes	Channidae	*22. Channa aurolineata*	Channa	Nga yant
Siluriformes	Claridae	*23. Clarias batrachus*	Walking catfish	Nga khue
Anguilliformes	Anguilldae	*24.Anguilla bicolor*	Level finned fish	Nga Myae
Decapoda	Palaemonidae	*25. Cryphiops sp.*	Palaemon	Puzon
Decapoda	Portunidae	*26. Charybdis sp.*	Crab	Ganan Lone
Gastropoda	-	*27. Bufonaria sp.*	Frog shell	Khayu phin chon

Table 4. Habitat types fishes recorded from Middle Ye-Ywar Hydropower Project, Naung Cho Township

Species	Number	Data source	Habitat types	Season	Remarks
1. *Burbus hexastichus*	-	IS	Shallow water with dandy bottom	DS	Endemic
2. *Morulius calbasu*	6	VS	Large river but juvenile nurse in flood	DS	
3. Folifer brevifilis	1	VS	Clear water with rocky bottom riparian forest	DS	Uncommon
4. Puntius amphibious	20	VS	Sandy bottom & riparian forest	DS	Common
5.Puntius oligolipis	3	VS	Sandy bottom & riparian water plants	DS	Uncommon
6. Puntius sp.	30	VS	Sandy bottom & riparian water plants	DS	Endemic
7. Danio kaerri	20	VS	Well planted and upper level of stream	WS	Endemic
8.Danio aequipinnutus	15	VS	Sandy and gravel beds in dense ripiarian vegetation	WS	Endemic
9.Garra lamta	6	VS	Torrent rivers and streams with rocky and gravel bottoms	WS	Endemic
10.Crossochelius burmanicus	30	VS	Torrent rivers with rocky bottom	HS	Locally Uncommon

11. Cabdio moror	20	VS	Main stream of large rivers	WS	Occasionalyy
12.Barilius sp.	30	VS	Torrent rivers and streams with rocky bottom	WS	Common
13. Labeo stoliczkae	22	VS	Large rivers and flooded plains	WS	Common
14. Labeo dyocheilus	25	VS	Large rivers with rocky rapids	WS	Uncommon
15. Amblypharyngodon mola	52	VS	Marsh land and flood plain	WS	Common
16.Hemibagrus microphthalmus	6	IS	Rivers and larger streams to suck the rocks	WS	Seasonal common
17. Glyptothorax trilineatus	3	VS	Torrent streams with rocky rapids	WS	Rare
18. Botia rostrata	4	VS	Main stream with rocky rapids	DS	Occasionally
19. Botia berdmorei	3	VS	Rapids and hill stream	DS	Occasionally
20. Lepidocephalichthys Berdmori	3	VS	Stream with hill to low land	DS	Seasonal
21. Neonoemacheilus Labeosus	2	VS	Rocky rapid and hill stream	DS	Uncommon
22. Channa aurolineata	1	VS	Rivers and streams with riparian forests	DS	Uncommon
23. Clarias batrachus	7	VS	Rivers and marshland	DS	Common
24.Anguilla bicolor	-	IS	Adult inhabit upper rich & main stream	DS	Seasonal common
25. Cryphiops sp.	50	VS	Clean water with sandy and rocky bottom	DS	Common
26. Charybdis sp.	10	VS	Sandy and rocky bottom	DS	Common
27. Bufonaria sp.	70	VS	Main rivers with sandy and rocky bottom	DS	Common

DS = Dry Season; WS = Wet Season

Table 5. Numbers of fishes recorded from survey sites of Middle Ye Ywar Hydropower Project, Naung-cho Township

Species	site I	site 2	site 3	site 4	site 5	Total
1. *Burbus hexastichus*	-	-	-	-	-	
2. *Morulius calbasu*	1	-	4	-	-	
3. *Folifer brevifilis*	-	-	1	-	-	
4. *Puntius amphibious*	-	2	6	10	2	20
5.*Puntius oligolipis*	-	--	2	-	-	2
6. *Puntius sp.*	-	5	20	5	5	30

7. Danio kaerri	4	2	6	3	2	20
8.Danio aequipinnutus	3	-	7	3	-	15
9.Garra lamta	-	5	6	-	-	6
10.Crossochelius burmanicus	3	6	8	9	5	30
11. Cabdio moror	5	5	5	3	1	20
12.Barilius sp.	16	1	3	4	2	30
13. Labeo stoliczkae	2	1	8	5	6	22
14. Labeo dyocheilus	0	7	20	4	-	25
15. Amblypharyngodon mola	20	-	15	7	3	45
16.Hemibagrus microphthalmus	-	-	-	-	-	-
17. Glyptothorax trilineatus	-	1	3	-	-	3
18. Botia rostrata	-	-	2	1	-	4
19. Botia berdmorei	-	-	2	1	-	3
20. Lepidocephalichthys berdmori	-	-	1	1	-	2
21. Neonoemacheilus labeosus	-	-	2	-	-	2
22. Channa aurolineata	-	-	-	2	-	2
23. Clarias batrachus	1	1	1	2	2	7
24.Anguilla bicolor	-	-	-	-	-	-
25. Cryphiops sp.	5	2	10	15	18	50
26. Charybdis sp.	-	1	5	2	2	10
27. Bufonaria sp.	10	25	5	10	10	60

Site 1 = Dodtawaddy bridge downstream
Site 2 = Dodtawaddy bridge Upstream
Site 3 = Me-pok village &Dodtawaddy
Site 4 = Ye-twin-gyi village & Dodtawaddy
Site 5 = Gote twin junction river (Naung-cho-gyi)

Table 6. List of Recorded Bird species from Middle Ye Ywar Hydropower Project Area

No.	Order / Family	Scientific Name	Common Name	Wet season	Remark
I.	**Galliformes**				
1.	Megapodiidae	*Francolinus pintadeanus*	Chinese francolin		T
2.	Megapodiidae	*Cotumix chinensis*	Blue Breasted Quail		T
3.	Phasianidae	*Pavo muticus*	Green Peafowl		T / (QS)
4.	Phasianidae	*Gallus gallus*	Red Jungle fowl		T

II.	**Ciconiiformes**				
5.	Ardeidae	*Egretta casmerodius*	Great Egret		W
6.	Ardeidae	*Bubulcus ibis*	Cattle Egret		W
III.	**Falconiformes**				
7.	Accipitridae	*Milvus migrans*	Black Kite		T
8.	Accipitridae	*Accipiter badius*	Shikra		T
IV.	**Columbiformes**				
9.	Columbidae	*Streptopelia chinensis*	Spotted Dove		T
10.	**Columbidae**	***Treron curvirostra***	**Thick billed green pigeon**	**Wet only**	**T**
V.	**Cuculiformes**				
11.	Cuculidae	*Clamator coromandus*	Chestnut Winged Cuckoo		T
12.	Cuculidae	*Eudynamys scolopaceus*	Asian koel		T
13.	Centropodidae	*Centropus sinensis*	Greater Coucal		T
VI.	**Apodiformes**				
14.	Apopidae	*Cypsiurus balasiensis*	Asian Palm Swift		T
15.	Apopidae	*Apus pacificus*	Fork-Tailed Swift		T
16.	Apopidae	*Apus affinis*	House Swift		T
VII.	**Coraciiformes**				
17.	Coraciidae	*Coracias benghalensis*	Indian Roller		T
18.	Bucerotidae	*Anthracoceros albirostris*	Oriental Pied Hornbill		T / (QS)
19.	Megalaimidae	*Megalaima haemacephala*	Coppersmith Barbet		T
20.	**Megalaimidae**	***Megalaima asiatica***	**Blue throat Barbet**	**Wet only**	**T**
21.	Alcedinidae	*Halcyon smymensis*	White-Throated Kingfisher		T
22.	Meropidae	*Merops orientalis*	Green Bee-Eater		T
23.	Meropidae	*Merops philippinus*	Blue Tail Bee-Eater		T
VIII.	**Paciformes**				
24.	Picidae	*Dinopium javanense*	Common flameback		T
IX.	**Psittaciformes**				
25.	Psittacidae	*Psittacula eupatria*	Alexandrine Parakeet		T
26.	Psittacidae	*Psittacula finschii*	Grey- Headed Parakeet		T
X.	**Passeriformes**				
27.	Oriolidae	*Oriolus xanthomus*	Black-Hooded Oriole		T
28.	Dicruridae	*Dicrurus macrocercus*	Black Drongo		T
29.	Dicruridae	*Dicrurus Ieucophaeus*	Ashy Drongo		T
30.	Corvidae	*Corvus macrorhynchos*	Large-Billed Crow		T
31.	Passeridae	*Motacilla alba*	White Wagtail		T
32.	Muscicapidae	*Copsychus saularis*	Oriental Magpie Robin		T
33.	Muscicapidae	*Saxicola caprata*	Pied Bushchat		T
34.	Sturnidae	*Acridotheres fuscus*	Jungle Myna		T
35.	Pycnonotidae	*Pycnonotus atriceps*	Black Headed Bulbul		T
36.	Pycnonotidae	*Pycnonotus cafer*	Red-Vented Bulbul		T
37.	Pycnonotidae	*Pycnonotus blanfordi*	Streak-Eared Bulbul		T
38.	Pycnonotidae	*Pycnonotus jocosus*	Red-Whiskered Bulbul		T

39.	Pycnonotidae	*Pycnonotus melanicterus*	Black-Crested Bulbul		T
40.	Hirundinidae	*Hirundo rustica*	Barn Swallow		T
41.	**Charadriidae**	***Vamellus indicus***	**Red wattled lapwing**	**Wet only**	**T**
42.	**Nectariniidae**	***Aethopyga siparaja***	**Cromson sun bird**	**Wet only**	**T**
43.	**Cisticolidae**	***Prinia hodgsonii***	**Grey breasted prinia**	**Wet only**	**T**

Where, T = Terrestrial Bird; W = Water Bird; QS = Questionaries' Survey

Table 9. List of Mammal species recorded from Middle Ye Ywar Hydropower Project, Naung-cho Township

No.	Order	Family/ Sub-family	Scientific name	Common name	
I	Insectivora	Erinaceidae	1.*Talpa sp*	Eastern Mole	
			2. *Macaca sp.*	Pig Tailed Macaque	
			3. *Macaca mulatta*	Rhesus Macaque	
II	Pholidota	Manidae	4. *Mnanis pentadactyla*	Chinese Pangolin	
			5. *Lepus peguensis*	Siamese Hare	
III	Rodentia	Sciurinae	6.*Callosciurus erythraeus*	Pallas's Squirrel	
			7. *Tamiops mcclellandii*	Myanmar striped Squirrel	
			8. *Petaurista elegans*	**Lesser Giant flying Squirrel**	**Wet season**
		Histricidae	9. *Hystrix brachyura*	Eastern Asian Porcupine	
IV	Carnivora	Ursidae	10. *Ursus* sp	Bear	
		Herpestidae	11. *Herpestes* sp	Small AsianMongoose	
		Felidae	12. *Felis chaus*	Jungle Cat	
V	Artiodactyla	Suidae	13. *Sus scrofa*	Eurasian wild Pig	
		Cervidae	14. *Muntiacus muntjak*	Red Muntjac	
		Bovidae	**15. *Naemorhedus baileyi***	**Red goral**	**Wet season**
VI	Chiroptera	Emballonuridae	16. *Taphozous longimanus*	Tomb Bat	

Table 10. Habitat types and conservation status of mammal species in project area

Species	Habitat type	Data source	IUCN Redlist/ CITES
1.*Talpa sp*	Ground hole	QS	-
2. *Macaca sp.*	Tree	VS	VL/Appendix II
3. *Macaca mulatta*	Tree	VS	VL/Appendix II
4. *Mnanis pentadactyla*	Forest	QS	NT/ Appendix I
5. Lepus peguensis	Forest	QS	-
6.*Callosciurus erythraeus*	Teak tree	VS	-
7. Tamiops mcclellandii	Teak tree	VS	-
8. *Petaurista elegans*	Tree	QS	-
9. *Hystrix brachyuran*	Forest	Spine	VL/Appendix I
10. *Ursus* sp	Forest	QS	VL/Appendix I
11. Herpestes sp	Forest	QS	-
12. *Felis chaus*	Forest	Footprint	Appendix II
13. *Sus scrofa*	Forest	Qs	-
14. *Muntiacus muntjak*	Forest	Horn	-
15. *Naemorhedus baileyi*	**Red goral**	**QS**	VL/Appendix I
16. *Taphozous longimanus*	Limestone Cave	VS	-

QS = Questionaries' survey VS= voucher specimen collected

Table 11. List of Herpet species collected from Middle Ye Ywar Hydropower Project, Naung-cho Township

Order	Family	Scientific Name	Common Name
Anura	Bufonidae	1. *Duttaphrynus melanostictus*	Common Toad
	Ranidae	2. *Fejervarya limnocharis limnocharis*	Paddy Frog/ Swamp Frog
Lacertilia	Agamidae	3. *Calotes versicolor*	Garden Fence Lizard

		4. *Calotes mystaceus*	Blue crested lizard
		5. *Pseudoclotes microlepis*	Small-Scaled Forest Lizard
	Gekkonidae	6. *Gekko gecko*	Tockay
		7. *Hemidactylus frenatus*	Common House Gecko
	Scincidae	8. *Sphenomorphus sp*	Spotted Forest Skink
	Varanidae	9.*Varanus sp.*	Sight
Serpentes	Colubridae	10. *Ptyas sp.*	Rat Snake
		11. *Ahaetulla nasuta*	Long-nosed Whip Snake
		12. *Chrysopelia ornate*	**Golden tree Snake**
		13. *Dendrelaphis caudolineatus*	**Striped-bronze Back Snake**
	Elapidae	14. *Naja sp.*	Cobra
		15. *Ophiophagus Hannah*	King Cobra
	Natricidae	16. *Amphiesma sp*	Keelback
	Pythonidae	17. *Python moluras*	Burmese Python
Testudines	Testudinidae	18. *Indotestudo elongata*	Yellow Tortoise

Table 12. Habitat types and conservation status of mammal species in project area

Species	Habitat type	Data source	IUCN Redlist/ CITES
1. *Duttaphrynus melanostictus*	In grass	VS	-
2. *Fejervarya limnocharis limnocharis*	Riverbank, under rock	VS	-
3. *Calotes versicolor*	Garden fence	VS	-
4. *Calotes mystaceus*	Tree	VS	-
5. *Pseudoclotes microlepis*	Tree	VS	-
6. *Gekko gecko*	Tree hole	VS	-
7. *Hemidactylus frenatus*	Dwelling house	VS	-
8. *Sphenomorphus sp*	Bush	VS	-
9.*Varanus sp.*	Forest	QS	-
10. *Ptyas sp.*	Forest	QS	-

Species	Habitat type	Data source	IUCN Redlist/ CITES
11. *Ahaetulla nasuta*	Tree	VS	-
12. *Chrysopelia ornata*	Road in the forest	VS	-
13. *Dendrelaphis caudolineatus*	Under log	VS	-
14. *Naja sp.*	Forest	Qs	-
15. *Ophiophagus Hannah*	Forest	QS	Endangered
16. *Amphiesma sp*	Grass	VS	-
17. *Python moluras*	Forest	QS	Near Threatened
18. *Indotestudo elongata*	Forest	VS	Endangered/Appendix II

VS = voucher specimen collected, QS = Questionaries' survey

Table 13 . List of Insect species collected from Middle Ye Ywar Hydropower Project, Naung-cho Township

Order	Family	Species	Common Name
I.Lepidoptera	1. Papilionidae	1. *Papilio polite romulus*	Butterfly
		2. *Papilio memnon agenor*	Butterfly
		3. Graphium nomius	Butterfly
	2. Danaidae	4. *Danaus limniace limniace*	Butterfly
	3. Nymphalidae	5. *Junoniaiphita ocyale*	Butterfly
		6. Phalanta Phalanta	Butterfly
		7. *Neptis hylas kamarupa*	Butterfly
		8. Junonia almana almana	Butterfly
		9. Lassipa viraja viraja	Butterfly
	4. Pieridae	10. *Eurema hecabe contubernalis*	Butterfly
		11. Artogenia naganum naganum	Butterfly
		12. Delias descombi descombi	Butterfly
	5. Danaidae	13. *Danaus chrysippus*	Butterfly
		14. *Danaus melanippus*	Butterfly
	6. Satyridae	*15. Melanitis zitenius auletes*	Butterfly
II. Odonata	7.Coenagrionidae	*16. Coeliccia sp*	Damselflies

Order	Family	Species	Common Name
III. Orthoptera	8. Phasmidae	17. *Anisomorpha sp.*	Walking Stick
		18. *Gryllus sp*	Cricket
		19. *Dissosteira longipenis*	Grasshopper
IV.Hymenoptera	9. Xylocopidae	20. *Apis mellifera*	Honey bee
	10. Formicidae	21. *Camponotus sp*	Carpenter ant
V. Hemiptera	11. Nepidae	22. *Ranatra sp*	Water scorpion
	12. Psyllidae	23. Paratriozn	Psyllid
	13. Coreidae	24. Anasa sp	Squash bug
VI. Pterygota	-	25. Vespa orientalis	Wasp
VII. Araneida	-	26. Aranea sp	Spider
	14. Mantidae	27. Paratenedera	Praying mantis

Morulius calbasu

Crossocheilus burmanicus

Folifer brevifilis

Botia rostrata

Botia sp.

Lepidocephalichtys berdmorei

Neonoemacheilus labeosus

Channa aurolineata Cryphiops sp.

Plate 1. Fish species recorded from Middle Ye Ywar Hydropower project area

Bufonaria sp.

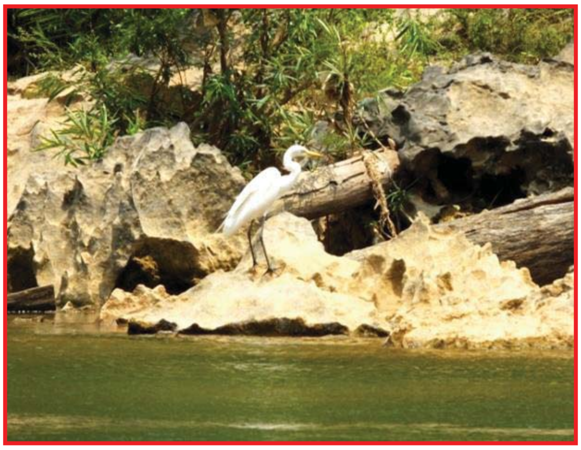
Fishing Type

Fishing Type

Fishing Net

Gallinula chloropus

Dendrocygna bicolor



Casmerodius albus

Halcyon smymensis

Treron curvirostra *Pycnonotus jocosus*

Plate 3. Bird species recorded from Middle YeYwar Hydropower Project Area

Spine of Porcupine
Hystrix brachyura

Long-winged Tomb bat
Taphozous longimanus

Skull and antla of Muntjac
Muntiacus muntjak

Macaca assamensis
Assamese Macaque

Foot print of Muntjac

Muntiacus muntjak

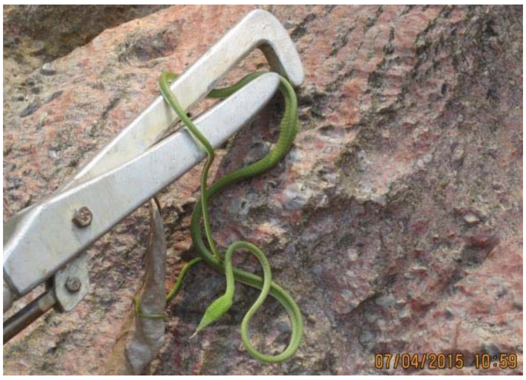
Pallas's Squirrel

Callosciurus erythraeus

Plate 4. Mammal species recorded from Middle Ye Ywar Hydropower project area

Calotes versicolar

Calotes emma



Fejervarya limnocharia limnocharis

Ahaetulla nasuta

Sphenomorphus sp

Indotestudo elongata

Plate 5. Herpet species recorded from Middle Ye Ywar Hydropower project area

Neptis hylas kamarupa

Graphium nomius swinhoei

Lassipa viraja virija

Papilio polytes romulus

Phalanta phalanta

Melanatis zitenius auletes

Plate 6. Insect species recorded from Middle Ye Ywar Hydropower project area

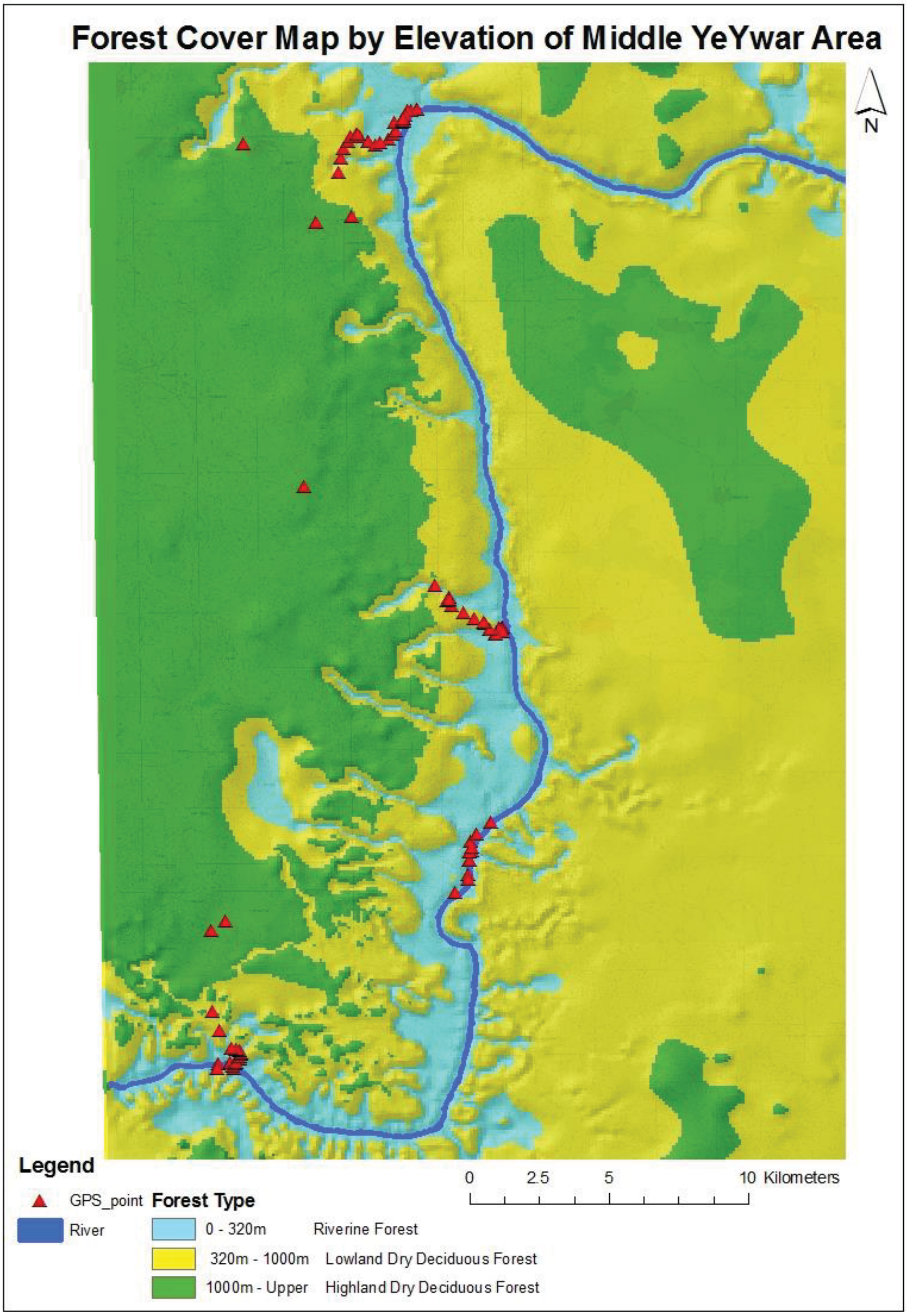
V. DISCUSSION AND CONCLUSION

The assessment was preliminary survey so that the existing environment in the direct impact zone (potential inundated area) had been studied. However for full environmental assessment, the indirect impact zone especially the catchment area of the river and the downstream ecology must be included. Because there may be the impacts in downstream especially the nutrient transport, the flow pattern of the river and dissolved oxygen concentration (DOC). Nutrient transport of the river is vital for both the aquatic organisms and river basin agriculture. It should be examined the threads to the forests in the catchment area since the maintainance of constant water level in the dam depend on the forest ecosystem services of the forests in the catchment area.

In the present survey, the tree species which are dominant in the riverine forest are *Eugenia densiflora* DC., *Schleichera oleosa* (Lour.) Oken, *Homonoia riparia* and *Crateva magna* (Lour.) DC.,. The 55% of the tree species are <40cm to 40-60cm in girth and <10m in height. This riverine forest is degraded due to logging. At present the illegal logging is practiced to get fire wood for the fuel of limestone kilns and brick kilns.

Some of the degraded indaing forest will be inundated after the dam is constructed. The loss of riverine forest may be seen in the photos of vegetation profile along the Dodtawaddy River.

Map III.


Forest Cover Map by Elevation of Middle YeYwar Area
N
Legend
GPS_point
River
Forest Type
0 - 320m Riverine Forest
320m - 1000m Lowland Dry Deciduous Forest
1000m - Upper Highland Dry Deciduous Forest
0 2.5 5 10 Kilometers

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ANNEX 2B

Biodiversity Impact Assessment of Middle Yeywa Hydropower Project, Left Bank of Myitnge River

Biodiversity Impact Assessment of Middle Yeywa Hydropower Project, Left Bank of Myitnge River

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1. INTRODUCTION

From March to May of 2015 and from September to October of the same year, stage one of the Environmental Impact Assessment (EIA) was conducted along the right bank of the Myitnge River in the project area of the Middle Yeywa Hydropower Project. In July and August of 2016 stage two of the EIA was conducted along the left bank of the Myitnge River using the same methodology. In both stages, the survey consisted of a series of point quadrants, line transects and wandering transects. Vegetation patterns and habitat types in each ecosystem were recorded. Habitats surveyed include, area along road sides, steep slopes of river banks and catchment areas. Data was collected via visual observations and supported by GPS positioning, photographs and taking physical specimens of plants and animals.

The following annex contains the findings from the left bank EIA and compares them to the findings from the right bank EIA. It is also important to note that the right bank EIA was conducted in dry season (March to May) and after rainy season (September to October) and the left bank EIA was conducted in rainy season. This allows for a better understanding of the change in vegetation coverage from season to season.

1.1. Objectives

The fieldwork conducted for the left bank EIA has four main objectives.

1. To collect and identify the plants and animal species in the area
2. To record the dominant tree species and evaluate the forest types
3. Compare data from the left bank and right bank EIA.
4. To assess the potential impacts and to suggest appropriate mitigation measures

1.2. Research Area, Topography and Surrounding Environs

The EIA research area falls between 22° 18' N to 21° 55' N Latitude and 96° 51' E to 96° 51' E longitude. This includes not only the proposed construction site of the dam but also the length of the dam reservoir. The elevation of the mountain ranges along the Myitnge River which comprise the catchment area is 1,000 meter in height. The river flows in a narrow V-shaped valley and has steep sloping banks. Therefore, the flooded area of the dam will be narrow and long, along the river. The catchment area is 10597.12 km2 and total flooded area is estimated to be approximately 1100 hectares. The normal pool level will be 320 masl. The river serves as the North Western boarder of Lawksawk Township. Consequently, the left bank EIA was conducted entirely in Lawksawk Township. Reserve forests in the Lawksawk total 473,293 acres. This includes North Lawksawk Reserve at 2,715 acres, Nantlan Reserve at 101,242 acres, Zawgyi Reserve at 153,156 acres, Indaw Reserve at 77,760 acres, Naung-Aoe Reserve at 46,720 acres and Naung-lone Reserve at 66,700 acres. (Source; Forest department)

The Lower Yeywa Dam is located 80.4 km downstream of the proposed Middle Yeywa HPP site. This dam was completed in 2010 and is currently in operation. The Upper Yeywa HPP is currently under construction, 49.6 km upstream of the proposed Middle Yeywa HPP site. Therefore, the tail of Lower Yeywa Dam will reach to the Middle Yeywa Dam and the tail of Middle Yeywa dam will also reach close to the Upper Yeywa Dam.

The lowest elevation of the river in the studied area is 218 masl near Yae Twin Gyi Village and highest is 325 masl near Naung Cho Gyi Village. The Middle Yeywa project area exists in a monsoon climate with three distinct seasons, cool, hot and wet. The average annual rain fall is 1,312mm. The geology of the project area is lime stone covered by Terra-rosa soil. Terra-rosa soil is derived from the weathering of lime stone. It is red in colour and has the consistency of silty clay. It favours the growing of teak and *Dipterocarpus tuberculatus*.

2. MATERIALS AND METHODOLOGY

2.1. EIA Team

From an operational perspective the EIA team can be divided into two sub-teams, flora and fauna. The teams were accompanied by an International Research Coordinator, Bart Robertson.

Flora

(1) U Nyo Maung (Retired Professor), Taxonomist

(2) Dr.Win Myint (Associated Professor, ex.), Ecologist

(3) Dr. Ei Ei Phyoe, Taxonomist

(4) U Tun Thura, Botanist & GIS/RS

(5) U Thein Phyo Aung, Assistant Botanist

Fauna

(1) U Nay Myo Aung, Field leader, Mammal and Insect Specialist

(2) Saw Aung Kyaw Htet, Reptile and Amphibian Specialist

(3) U Htet Hlaing Oo, Bird Specialist

(4) Ko Zin Ko Latt, Fish Specialist

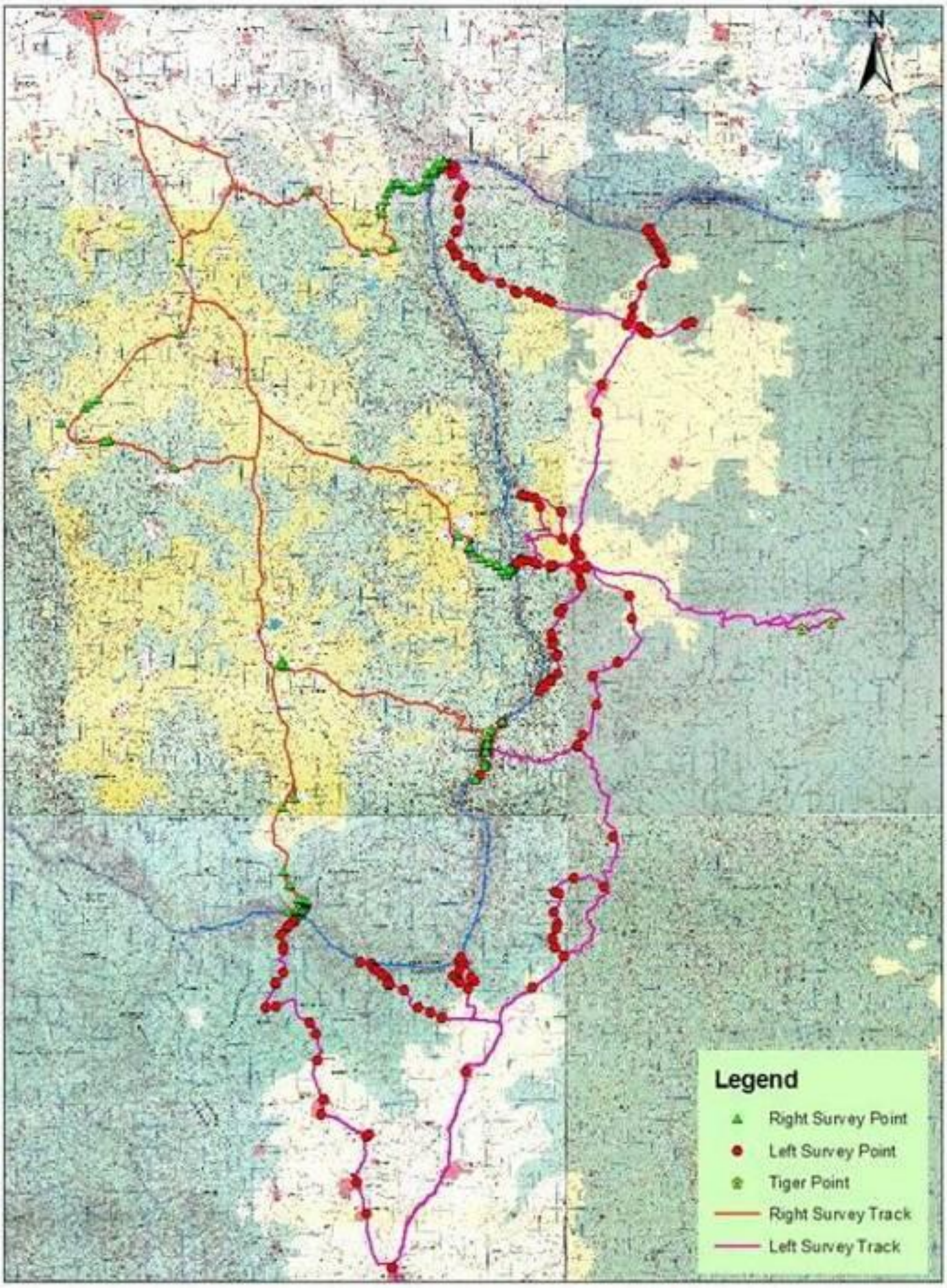
2.2. Methodology (Flora)

The EIA on the left bank of the river was divided into four research areas for the flora survey. Research area one includes the forested area close to the dam site near Phet Yin Kone Village. This is opposite to Yae Twin Gyi Village on the right bank. The lowest elevation of the river in this area is 218 masl. There were four study points in this area, namely near Kyauk Hson Village (opposite to Yae Twin Gyi), near the confluence of Nan-kan Stream and Myitnge Tu River, near Phet Yin Kone Village and near Naung Lone Reserve Forest.

Research area two includes the upstream portion of the river close to Nam Tu Bridge and its surrounding. The lowest elevation in this area is 270 masl. The third research area includes the portion of the river running North to South. This is upstream of Nam Tu Bridge and downstream of the confluence between Myitnge River and Gohteik Stream. The study points in this area are on the left bank opposite to Ma Gyi Yae Village, Meh Poke Village and Naung Lone Village.

The fourth research area includes the portion of the river running East to West upstream from the confluence of Myitnge River and Gohteik Stream and downstream of the Upper Yeywa HPP. The lowest elevation in this area is 325 masl. This is slightly above the estimated elevation of the reservoir water level for the Middle Yeywa HPP. This means that the water level in the reservoir will not be higher than the existing water level in rainy season. The first study point in the area is near the confluence of Gohteik stream and MyitngeRiver. The second study point in this area is on the right side of the river opposite to Pone Na Sate Village.

Map 1: Left and Right Bank of Project Area Transect Walks



2.2.1. Sample Plotting

The flora team conducted a total of 38 sample plots on the left bank. The Global Positioning System (GPS) was used to navigate and mark the coordinates of the sample plots. Lists of sample plots are given in the findings section of this report. In order to obtain essential data for predicting tree species composition in the forest and vegetation types, 20x20 and 30x30 meter quadrants were set up and tree species in the plots were recorded as well as total number (population) of each species and their circumference. In Bamboo forests, 30x30 meter quadrants were set up and bamboo species were recorded. The total clumps of each species were recorded. Species identification in the field was carried out by using keys to families of flowering plants and appropriate literature and later confirmed by matching with herbarium specimens of Department of Botany, University of Yangon. It is important to note that the water level in the Middle Yeywa Reservoir is anticipated to be 320 masl. As such, the team conducted several sample plots near 320 masl to understand the flora composition of the area that will be inundated if the project proceeds. As indicated in the map above, several transect walks and sample plots were taken directly across the river from where the right bank survey took place, allowing for more comparable data.

2.2.2. Random Transecting

To get representative checklists of flora species, specimen collection was also carried out by random transect lines along the banks of the river and between one sample plot and another wherever possible. Specimen collection was carried out within 10 meters of either sides of the transect line. Along the river, specimen collection was conducted from the edge of the water to the river bank to accurately capture the riverine forests. Much of the transecting was done below 320 masl to understand the flora composition of the area that will be inundated if the project proceeds.

2.2.3. Mapping

Location maps are based on Google Earth Map and UTM maps (UTM zone 47 N) coordinate system to determine the forests in the area.

2.2.4. Materials

Materials used for collecting data include strings for sample plotting and transecting, digital cameras, GPS, maps, heavy duty plastic bags, old newspapers, corrugated paper, alcohol, spray jug (for fixing specimens), 10x lens, permanent markers, field note books, field press, drying press and dryers.

2.2.5. Data Analysis

After the field survey, data entry was carried out in EXCEL. The IUCN Red List data version 2016.1 was compared to the collected data to identify any threatened species.

2.2.5.1. Population of Individual Tree Species (per hectare)

The population of species will show not only the composition of species but also the richness of the species in the study area. Data analysis used the following formula to determine the population of individual species per hectare.[1]

[1] This formula was developed by R.He'dl, M Sva'tek, M. Dancak, Rodzay A.W., M. Salleh A.B., Kamariah A.S.(2009)

$$\text{Population of Individual Species} = \frac{\text{Total Individual species}}{\text{Total Plots Area (m}^2)} \times 10000\text{m}^2\text{(1ha)}$$

2.2.5.2. Relative Density of Tree Species

The density of a species refers to the numerical representation of its individual and the availability of space in a unit area. The density index shows not only the richness of the species but also the relative distribution of the individuals. Data analysis used the following formula to determine the population of individual species per hectare. [2]

$$\text{Relative Density of Tree species} = \frac{\text{No. of Individual species}}{\text{Total no. of all individual Species}} \times 100$$

2.2.5.3. Relative Frequency of Tree Species

The relative frequency of a species refers to the percentage occurrence of its individuals and shows the frequency of different species growing in the study area. The species which fall in high frequency class can be considered as the most common species in the study area. According to Curtis (1959), the relative frequency is determined by the following formula.

$$\text{Relative frequency of Tree species} = \frac{\text{No. of sample plot occurs}}{\text{Total no. of all species occur}} \times 100$$

2.3. Methodology (Fauna)

The fauna team identified and recorded fauna species from the five main animal groups; mammals, birds, herpetiles, fishes and insects including other invertebrates. More detailed information on how data were collected on each of these animal groups is given in the following subsection. The fauna team travelled with the flora team, conducting the same transect walks noted in the map above. They also looked for locally caught wildlife in the local market (Kyauk Ku Market)[3] and at the fish caught by several fishermen along the river. The fauna team identified fauna species in the area using several methods. These include visual observation (VO) of the animals themselves and traces of the animal such as rubbings on trees or footprints. Voucher specimens (VS) were also a means of identification. This includes the whole animal itself in the case of insects and small animals (i.e. frogs, snakes, bats) and shed parts of animals such as skin or quills. The fauna team also conducted an interview survey (IS) with local hunters and fishermen to identify some species. A list of people interviewed is given below. Although this method was useful for identifying more commonly known species (i.e. king cobra, python, wild goats, leopards, certain fish, etc.), it should be noted that this method only indicates the possible existence of a given species' presence. Direct visual observations or collection of a voucher specimen by the fauna team confirm the presence of a given species in the area. Second-hand accounts are prone to human error and do not confirm the presence of a given species. The IUCN Red List data version

[2] This formula was developed by Curtis (1959).

[3] The team found no local wildlife being sold in Kyauk Ku Market. Fish sold in the market came from Yangon Region.

2016.1 was compared to the collected data to identify any threatened species. The list classifies species by conservation status. These are listed below in order of most to least severe.

Table 1: IUCN Red List Conservation Status[4]

Conservation Status	Abbreviation
Extinct	EX
Extinct in the Wild	EW
Critically Endangered	CR
Endangered	EN
Vulnerable	VU
Near Threatened	NT
Least Concern	LC
Data Deficient	DD
Not Evaluated	NE

2.3.1. People Interviewed

Interviewee	Village
U Tun Chaing	Kyauk Hson Village
U Sein Win	Kyauk Hson Village
U Myint Win	Phet Yin Kone Village
U Ba Win	Phet Yin Kone Village
Ko Kyaw Ye Aung	Phet Yin Kone Village
U Kyaw Lin	Phet Yin Kone Village
U Aik Lin	Ma Gyi Kone Village
U Ohn Lwin	Htaung Kham Village
U Shwe Than	Thazi Village

[4] No species were found in the survey with EX, EW or CR conservation status.

2.3.2. Data collection for each animal group

Mammals: Mammal data were recorded from four main methods, taking voucher specimens (VS) (for small mammals), visual observation (VO) (for monkeys, squirrels, that can be seen but are difficult to catch), collecting animal remains or observing the markings of animals (skin, footprints, animal rubbings on trees, porcupine quills, etc.). Mammal data were also recorded view interviews. During fieldwork, researchers used the 'Field guide to large mammals of Myanmar' as a reference.

Bird: Bird species were identified via visual observation (VO) as well as bird call recognition. During fieldwork, researchers used the 'Field guide book of Birds of Southeast Asia' as a reference.

Amphibians/Reptiles: The amphibians (frogs and toads, and salamanders) and reptiles were mainly collected via voucher specimens, and for some species that are well-known Pythons, king cobra etc.,) were identified via interview survey (IS).

Fish: Voucher specimens of fish were taken from the Myitnge River with the help of local fishermen, and some fish species that are well known, like snakehead or butterfish were identified via interview survey (IS). No locally caught fish were found in the local markets.

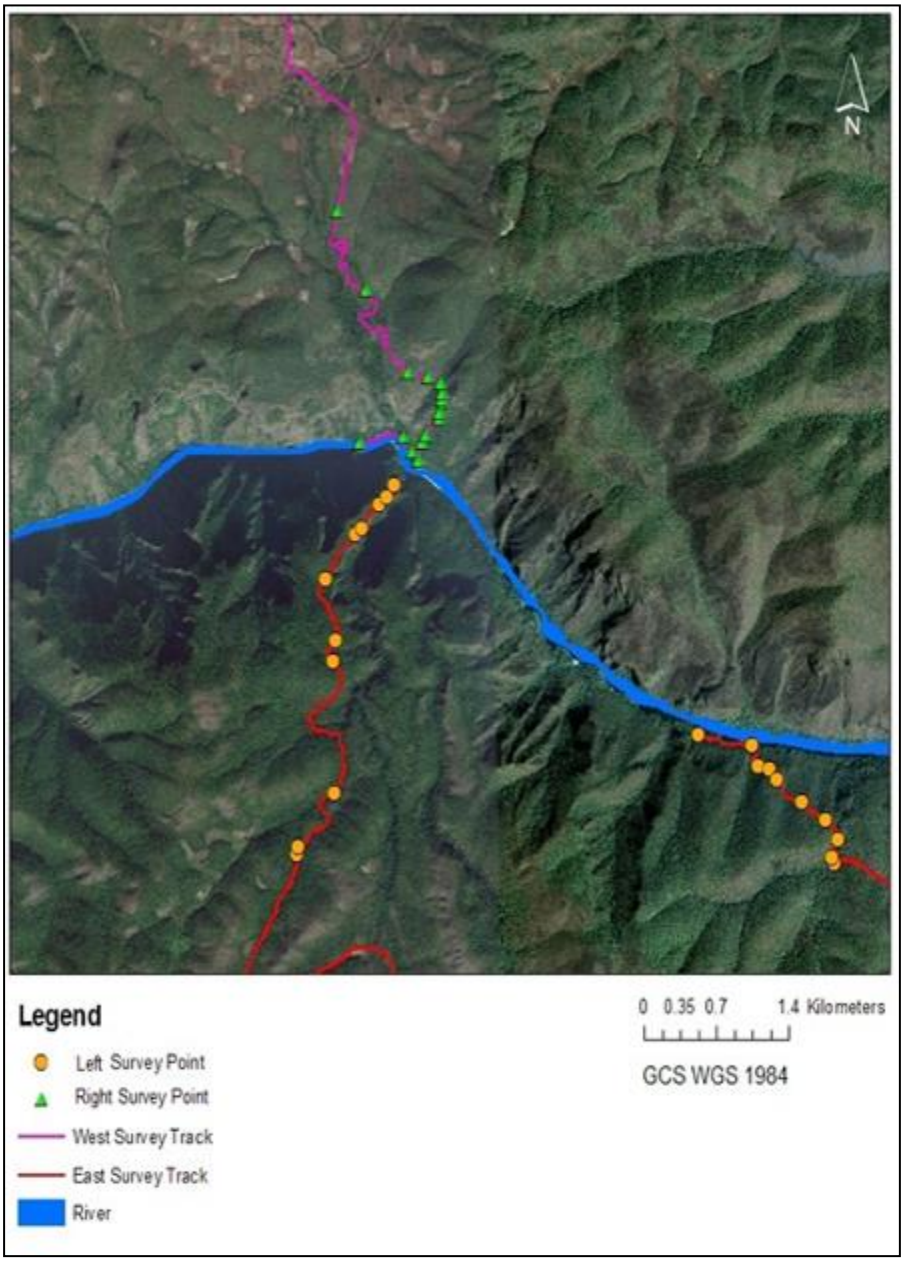
Insect and other invertebrates: Voucher specimens were taken of insects and other invertebrates. Some species were also identified via visual observation.

3. FLORA

As previously discussed in the methodology section, the fauna team divided the research area into four parts. Consequently, the 'Findings Flora' section below is also divided into four sections. Each section provides information regarding the flora species present in its respective research area including, total fauna species, a comparison of left bank and right bank species, detailed information on tree, orchid, mushroom and bamboo species and a list of species found on the IUCN Red List.

3.1 Research Area One

Map 2: Research Area One



Map 3: Reservoir Elevation Line

(Right Bank Forest) *(Left Bank Forest)*

3.1.1. Quadrant Location and Vegetation Type

A total of 10 sample plots were taken on the left bank, research area one. In each plot the vegetation type was Indine Forest. A summary of the sample plots is given below.

Table 2: Research Area One Sample Plots

No.	Sample Quadrant	Vegetation type	Latitude/Longitude	Altitude(m)	Dominant species
1	KGQ I	Indine Forest	N21 56 16.2 E96 55 04.6	368	*Shorea obtusa* Wall., *Shorea siamensis*(Kurz)Miq., *Buchanania latifolia* Roxb.,
2	KGQ II	Indine Forest	N21 56 15.6 E96 55 08.1	409	

3	KGQ III	Indine Forest	N21 56 12.7 E96 55 10.5	455	*Dalbergia oliveri* Gamble, *Emblica officinalis* Gaertn., *Terminalia alata* (Heyne) Roth, *Dipterocarpus tuberculatus* Roxb., *Tectona grandis* L. f., *Bridelia retusa* (L.) A. Juss., *Phyllanthus emblica* L., *Schrebera swietenioides* Roxb., *Spondias pinnata* (L. f.) Kurz., *Lagerstroemia villosa* Wall. ex Kurz
4	KGQ IV	Indine & Bamboo Forest	N21 55 56.9 E96 55 29.5	624	
5	KGQ V	Indine Forest	N21 56 17.6 E96 57 14.8	390	
6	KGQ VI	Indine & Bamboo Forest	N21 56 12.0 E96 57 13.1	465	
7	KGQ VII	Indine & Bamboo Forest	N21 56 00.2 E96 57 08.9	600	
8	KGQ X	Indine Forest	N21 57 05.0 E96 52 49.3	928	
9	KGQ XI	Indine Forest	N21 57 18.3 E96 53 00.6	691	
10	KGQ XII	Indine Forest	N21 57 14.9 E96 59 36.6	732	

3.1.2. Flora Species on Left and Right Banks

A total of 318 species were identified on both left and right banks combined. 161 of these species were found only on the left bank while 58 of these species were found only on the right bank. One-hundred of these species were found on both banks.

Table 3: Flora Species in Left Bank Research Area One

No.	Scientific Name	Common Name	Family Name	Habit
1	*Abelmoschus moschatus*	Taw-yon-pa-de	Malvaceae	S
2	*Acacia catechu* Willd.	Sha	Mimosaceae	T
3	*Acacia intsia* Willd.	Su-bok	Mimosaceae	CL
4	*Acacia pennata* (L.)Willd.	Su-yit	Mimosaceae	CL
5	*Adiantum latifolium*	Not known	Pteridaceae	F
6	*Aegiceras corniculatum* (L.) Blanco	Bu-ta-let	Myrsinaceae	ST
7	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae	H
8	*Albizia procera* (Roxb.) Benth.	Thit-phyu	Mimosaceae	T
9	*Alocasia macrorrhizos*	Pein-gyi	Araceae	H
10	*Alstonia scholaris*(L.) R. Br.	Taung-ma-yoe	Apocynaceae	ST
11	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	H
12	*Amalocalyx microlobus*	Not known	Apocynaceae	CL
13	*Amaranthus gracilis* Desf.	Hin-nu-nwe-yaing	Amaranthaceae	H
14	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae	H
15	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Wa-u	Araceae	H
16	*Ampelocissus barbata* Planch.	Not known	Vitaceae	CL
17	*Anogeissus acuminata* Wall.	Yon	Combretaceae	T
18	*Antidesma bunius*	Kin-ba-lin	Euphorbiaceae	S
19	*Aporusa dioica* (Roxb.) Mull.Arg.	Thit-khauk	Euphorbiaceae	ST
20	*Argyreia nervosa*	Ka-zun-nwee	Convolvulaceae	CL
21	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae	CL
22	*Artemisia vulgaris*	Not known	Asteraceae	H
23	*Artocarpus lakoocha*	Taung-pein-ne	Moraceae	T
24	*Asparagus densiflorus*	Shint-ma-tet	Asparagaceae	CL
25	*Asparagus filicinus* Buch.-Ham. ex D. Don	Ka-nyut	Asparagaceae	H
26	*Atalantia monopyhlla* A.DC.	Yin-kya\ Taw shuk-kha	Rutaceae	ST
27	*Auricularia auricula-judae* (Bull.) J.Schröt.	Kywet-na-ywet-hmo	Auriculariaceae	Mu

No.	Scientific Name	Common Name	Family Name	Habit
28	*Bambusa teres* Buch.-Ham. ex Wall.	Ta-bin-taing-wa	Poaceae	B
29	*Bambusa tulda* Roxb.	Theik-wa	Poaceae	B
30	*Barleria strigosa* Willd.	Not known	Acanthaceae	H
31	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae	CL
32	*Bauhinia ornata* Kurz	Myauk-hle-ga	Caesalpiniaceae	CL
33	*Bauhinia racemosa* Lam.	Pha-lan/Hta-la	Caesalpiniaceae	ST
34	*Bauhinia* sp.	Swe-daw-thay	Caesalpiniaceae	CL
35	*Begonia semperflorens*	Kyauk-chin-pan	Begoniaceae	H
36	*Bidens pilosa*	Hmwe-sok	Asteraceae	H
37	*Bischofia javanica*	Ye-pa-done	Euphorbiaceae	T
38	*Bliospermum axillare* Blume	Hnut-cho	Euphorbiaceae	S
39	*Blumea balsamifera* (L.) DC.	Phon-ma-thein	Asteraceae	ST
40	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae	H
41	*Bombax ceiba* L.	Let-pan	Bombacaceae	T
42	*Brachycorythis galeandra* (Rchb.f.) Summerh.	Not known	Orchidaceae	E
43	*Brachycorythis helferi* (Rchb.f.) Summerh.	Not known	Orchidaceae	E
44	*Bridelia retusa* (L.) A. Juss.	Myauk-zi/Seik-chi	Euphorbiaceae	T
45	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae	T
46	*Butea parviflora* L.	Pauk-home	Fabaceae	CL
47	*Butea superba* Roxb.	Pauk-nwee	Fabaceae	CL
48	*Callicarpa formosana*	Not known	Verbenaceae	ST
49	*Cananga latifolia*	Not known	Annonaceae	T
50	*Canavalia cathartica*	Not known	Fabaceae	CL
51	*Cantharellus aurantiacus* (Wulf.)Fr.	Not known	Cantharelleae	Mu
52	*Canthium parvifolium* Roxb.	Say-than-baya	Rubiaceae	ST
53	*Carex brizoides* L.	Taw-kyet-le-hlee	Cyperaceae	H
54	*Cassia fistula* L.	Ngu	Caesalpiniaceae	T
55	*Castanopsis diversifolia* King	Pa-phyu/Castanopsis	Fagaceae	T
56	*Celastrus monospermus* Roxb.	Not known	Celastracae	CL
57	*Chamaesyce thymifolia*	Not known	Euphorbiaceae	H
58	*Chenopodium acuminatum* subsp. *virgatum*	Not known	Chenopodiaceae	H
59	*Chromolaena odorata* (L.) R.M. King & H Robinson	Bi-zet	Asteraceae	S
60	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae	ST
61	*Cinnamomum parthenoxylon* Meissner	Ka-ra-way-yaing	Lauraceae	T
62	*Cissus discolor* Blume	Wa-yaung-chin	Vitaceae	CL
63	*Claoxylon indicum* Hassk.	Not known	Euphorbiaceae	S
64	*Clerodendrum serratum* L.	Yin-bya-net	Verbenaceae	S
65	*Clerodendrum villosum* Blume	Phet-kha	Verbenaceae	S
66	*Clitocybe caespitosa* Pk.	Wa-yin-hmo	Tricholomataceae	Mu
67	*Codonopsis lanceolata*	Ba-la-cheik	Campanulaceae	CL
68	*Colocasia esculenta*	Pein-yaing	Araceae	H

No.	Scientific Name	Common Name	Family Name	Habit
69	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae	ST
70	*Commelina diffusa* Burm.f.	Myet-kyut	Commelinaceae	H
71	*Coprinus disseminatus*	Not known	Psathyrellaceae	Mu
72	*Coprinus plicatilis* (Curt.) Fr.	Not known	Psathyrellaceae	Mu
73	*Costus specious* Sm.	Pha-lan-taung-hmwe	Costaceae	H
74	*Crassocephalum crepidioides*	Pan-zauk-htoe	Asteraceae	H
75	*Crateva magna* (Lour.) DC.	Ka-det	Capparaceae	ST
76	*Cratoxylum neriifolium* Kurz	Bae-bya	Hypericaceae	ST
77	*Cratoxylum polyanthum*Korth.	Bae-bya	Hypericaceae	ST
78	*Crotalaria multiflora* L.	Taw-paik-san	Fabaceae	H
79	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae	ST
80	*Curculigo orchioides* Gaertn.	Kywet-ma-lut-ohn	Hypoxidaceae	H
81	*Curcuma longa* L.	Na-nwin	Zingiberaceae	H
82	*Curcuma petiolata* Roxb.	Ma-lar	Zingiberaceae	H
83	*Cycas siamensis* Miq.	Mon-daing	Cycadaceae	ST
84	*Cymbidium aloifolium* (L.)Sw.	Thit-tet-lin-nae	Orchidaceae	E
85	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae	G
86	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	T
87	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae	ST
88	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	T
89	*Desmodium rufihirsutum* Craib	Not known	Fabaceae	S
90	*Desmodium triangulare* (Retz.) Merr.	Not known	Fabaceae	S
91	*Desmodium umbellatum* DC.	Kyee-hmi-apho	Fabaceae	S
92	*Dichrocephala integrifolia* (L.f.)Kuntze	Not known	Asteraceae	H
93	*Dillenia indica* L.	Tha-byu	Dilleniaceae	T
94	*Dillenia parviflora* Griff.	Phet-set/Zin-byun	Dilleniaceae	ST
95	*Dioscorea alata*	Myauk-u	Dioscoreaceae	CL
96	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae	CL
97	*Dioscorea cylindrica* Burm.	Kyway-thon-ywet	Dioscoreaceae	CL
98	*Dioscorea pentaphylla* L.	Kyway-ngar-ywet	Dioscoreaceae	CL
99	*Dioscorea sativa* L.	Kyauk-yin-nwee	Dioscoreaceae	CL
100	*Diospyros kaki* L.f.	Tae	Ebenaceae	T
101	*Dipterocarpus tuberculatus* Roxb.	In	Dipterocarpaceae	T
102	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae	F
103	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae	T
104	*Dunbaria punctata*	Not known	Fabaceae	CL
105	*Ehretia acuminata* R.Br	Taung-poe-lu-lin	Boraginaceae	T
106	*Elaeocarpus hainanensis* Oliv	Not known	Elaeocarpaceae	T
107	*Elatostema reticulatum*	Wet-sa	Urticaceae	H
108	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae	G
109	*Emblica officinalis* Gaertn.	Sha-phyu	Euphorbiaceae	ST

No.	Scientific Name	Common Name	Family Name	Habit
110	*Engelhardtia spicata*	Pan-swe-le	Juglandaceae	T
111	*Entada scandens* Benth.	Doe-nwee	Mimosaceae	CL
112	*Equisetum hyemale*	Not known	Equisetaceae	H
113	*Erythrina stricta* Roxb.	Ka-di\Ka-thit	Fabaceae	T
114	*Eugenia balsama* Wight	Ye-tha-bye	Myrtaceae	T
115	*Eugenia densiflora* DC.	Kyauk-tha-bye	Myrtaceae	T
116	*Euphorbia heterophylla*	Sae-pa-le	Euphorbiaceae	H
117	*Euphorbia hypericifolia* L.	Kywe-kyaung-hmin-se	Euphorbiaceae	H
118	*Ficus auriculata*	Sin-tha-phan	Moraceae	T
119	*Ficus glomerata* Roxb.	Ye-tha-phan	Moraceae	T
120	*Ficus hispida* L.	Kha-aung	Moraceae	ST
121	*Ficus pumila* L.	Kyauk-kat-nyaung	Moraceae	CL
122	*Ficus racemosa*	Not known	Moraceae	T
123	*Ficus semicordata*	Ka-dut	Moraceae	T
124	*Ficus variegate*	Kon-tha-phan	Moraceae	T
125	*Fimbristylis sieboldii*	Not known	Cyperaceae	H
126	*Flacourtia cataphracta* Roxb.	Na-ywe	Flacourtiaceae	T
127	*Flueggea leucopyrus* Willd	Ye-chin-ya	Euphorbiaceae	ST
128	*Ganoderma australe*	Not known	Ganodermataceae	Mu
129	*Gardenia coronaria* Buch-Ham.	Yin-khat-gyi	Rubiaceae	ST
130	*Garuga pinnata* Roxb.	Chin-yoke	Burseraceae	T
131	*Globba patens*	Pa-dein-ngo	Zingiberaceae	H
132	*Globba pendula*	Pa-dein-ngo-thay	Zingiberaceae	H
133	*Glochidion* sp.	Hta-min-sok	Euphorbiaceae	ST
134	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae	T
135	*Gochnatia decora*	Not known	Asteraceae	ST
136	*Gonostegia hirta*	Not known	Rubiaceae	H
137	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae	ST
138	*Grewia laevigata*	Not known	Tiliaceae	S
139	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae	S
140	*Hedyotis auricularia*	Not known	Rubiaceae	H
141	*Helicia erratica* Hook. f.	Dauk-yat	Proteaceae	ST
142	*Helicteres angustifolia* L.	Not known	Sterculiaceae	S
143	*Heliotropium indicum* L.	Sin-hna-maung	Boraginaceae	H
144	*Heteropanax fragrans* (Roxb. ex DC.) Seem.	Kyaung-dauk/La-ka-du	Araliaceae	ST
145	*Heterophragma adenophylla* (Wall.) Seem. ex Benth. & Hook.	Phet-than	Bignoniaceae	T
146	*Hiptage benghalensis* (L.) Kurz	Sar-say/Bein-nwee	Malpighiaceae	ST
147	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	ST
148	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	S
149	*Hydrocotyle sibthorpioides* Thunb	Myin-khwa	Apiaceae	H
150	*Hymenodictyon orixense* (Roxb.) Mabb.	Khu-than	Rubiaceae	T

No.	Scientific Name	Common Name	Family Name	Habit
151	*Impatiens chinensis* L.	Dan-pan	Balsaminaceae	H
152	*Imperata cylindrica* (L.) P. Beauv.	Thet-kae	Poaceae	G
153	*Inonotus hispidus*	Not known	Hymenochaetaceae	Mu
154	*Jasminum multiflorum*	Taw-sa-bei	Oleaceae	S
155	*Kyllinga brevifolia*	Not known	Cyperaceae	H
156	*Lactarius volemus* Fr.	Not known	Russulaceae	Mu
157	*Lagerstroemia macrocarpa* Kurz	Pyin-ma-ywet-gyi	Lythraceae	T
158	*Lagerstroemia speciosa* (L.) Pers.	Pyin-ma-ywet-thay	Lythraceae	T
159	*Lagerstroemia villosa* Wall. ex Kurz	Zaung-palae	Lythraceae	T
160	*Lannea coromandelica* (Houtt.) Merrr.	Na-be	Anacardiaceae	T
161	*Lantana camara* L.	Sein-na-pan	Verbenaceae	S
162	*Leea hirta* Banks	Na-ga-mauk-phyu	Leeaceae	S
163	*Leea macrophylla* Roxb.	Na-ga-mauk-gyi	Leeaceae	S
164	*Leea rubra*	Na-ga-mauk-ni	Leeaceae	S
165	*Lenzites betulina*	Not known	Polyporaceae	Mu
166	*Lepiota cristata*	Not known	Agaricaceae	Mu
167	*Litsea glutinosa*	On-don	Lauraceae	T
168	*Mallotus philippensis*	Taw-thi-din	Euphorbiaceae	T
169	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae	T
170	*Markhamia stipulata* (Wall.) Seem. Ex K.Schum.	Ma-hlwa	Bignoniaceae	T
171	*Melanorrhoea usitata* Wall.	Thit-si	Anacardiaceae	T
172	*Mesua ferrea* L.	Taw-gan-gaw	Hypericaceae	T
173	*Michelia baillonii* (Pierr)Finet & Gagnep.	Sa-ga-phyu	Magnoliaceae	T
174	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae	CL
175	*Millettia extensa* Benth.	Win-u	Fabaceae	CL
176	*Millettia ovalifolia* Kurz	Thin-win-pho	Fabaceae	T
177	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	H
178	*Mitragyna rotundifolia* (Roxb.) Kuntze	Bin-ga	Rubiaceae	T
179	*Morus indica* L.	Po-sa	Moraceae	T
180	*Mucuna pruriens* (L.)DC.	Khwe-la-ya	Fabaceae	CL
181	*Murdannia bracteata*	Not known	Commelinaceae	H
182	*Musa* sp.	Taw-nga-pyaw	Musaceae	H
183	*Mussaenda calycina* Wall. ex Kurz	Pwint-tu-ywet-tu	Rubiaceae	ST
184	*Myriopteron paniculatum* Griff	Ti-lay-na-tha	Asclepiadaceae	CL
185	*Nervilia plicata*	Ta-bin-taing-shwe-hti	Orchidaceae	H
186	*Operculina turpethum* (L.) Silva Mansa	Kyar-hin-nwee	Convolvulaceae	CL
187	*Oroxylum indicum* (L.)Kurz	Kyaung-sha	Bignoniaceae	ST
188	*Oxalis corniculata* L.	Hmo-chin	Oxalidaceae	H
189	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae	B
190	*Panus tigrinus*	Not known	Polyporaceae	Mu
191	*Passiflora foetida* L.	Taw-su-ka	Passifloraceae	CL

No.	Scientific Name	Common Name	Family Name	Habit
192	*Pennisetum purpureum*	Yon-sa-myet	Poaceae	G
193	*Peristylus affinis* (D.Don)Seidenf.	Not known	Orchidaceae	H
194	*Peristylus goodyeroides* (D.Don)Lindl.	Simidauk	Orchidaceae	H
195	*Persicaria odorata*	Kywe-hna-khaung-gyate	Polygonaceae	H
196	*Phaseolus velutina* Grah.	Pauk-net	Fabaceae	CL
197	*Phoenix loureiri* Kunth	Thin-baung	Arecaceae	ST
198	*Phyllanthus amarus*	Myay-zi-phyu	Euphorbiaceae	H
199	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	ST
200	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae	H
201	*Physalis minima* L.	Bauk-thi	Solanaceae	H
202	*Pilea scripta* Langtang	Phet-ya	Urticaceae	H
203	*Piper cubebe* L. f.	Peik-chin	Piperaceae	CL
204	*Pogostemon auricularius*	Not known	Lamiaceae	H
205	*Polyalthia viridis*	Not known	Annonaceae	T
206	*Polyporus ovinus* (Schaeff.)Fr.	Not known	Polyporaceae	Mu
207	*Pouzolzia zeylanica*	Not known	Urticaceae	H
208	*Premna amplectens* Wall	Yin-bya-phyu	Verbenaceae	S
209	*Pseuderanthemum polyanthum*	Not known	Acanthaceae	H
210	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	T
211	*Pterospermum acerifolium* (L.) Willd.	Taung-phet-wun	Sterculiaceae	T
212	*Pterospermum diversifolium*	Not known	Sterculiaceae	T
213	*Quercus mespilifolia* Wall.	Yin-gu	Fagaceae	T
214	*Randia uliginosa* DC.	Hman-ni	Rubiaceae	ST
215	*Rumex crispus* L.	Not known	Polygonaceae	H
216	*Rumex trisetiferus* Stokes	Not known	Polygonaceae	H
217	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae	ST
218	*Sapium baccata*	Aw-le	Euphorbiaceae	T
219	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	T
220	*Schrebera swietenioides* Roxb.	Thit-swe-le	Oleaceae	ST
221	*Scoparia dulcis* L.	Dana-thu-kha	Scrophulariaceae	H
222	*Selaginella willdenowii*	Not known	Selaginellaceae	F
223	*Senna hirsuta* (L.) Irwin & Barneby	Ka-thaw-hmwe-htu	Caesalpiniaceae	S
224	*Senna tora* (L.) Roxb	Dan-gwe	Caesalpiniaceae	S
225	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	T
226	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	T
227	*Sida rhombifolia* L.	Ta-byet-se-ywet-waing	Malvaceae	S
228	*Smilax aspericaulis* Wall ex A. D.C.	Sein-na-baw-thay	Smilacaceae	CL
229	*Smilax china* L.	Not known	Smilacaceae	CL
230	*Smilax macrophylla* Roxb.	Sein-na-baw-gyi	Smilacaceae	CL
231	*Solanum torvum* Swartz	Kha-yan-ka-zawt	Solanaceae	S
232	*Solanum verbascifolium*	Not known	Solanaceae	ST

No.	Scientific Name	Common Name	Family Name	Habit
233	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae	T
234	*Stemona tuberosa*	Tha-mya	Stemonaceae	CL
235	*Sterculia foetida* L.	Shaw-phyu	Sterculiaceae	ST
236	*Sterculia villosa*	Shaw	Sterculiaceae	T
237	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae	T
238	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae	CL
239	*Strychnos nux-blanda* A.W.Hill	Kha-baung	Loganiaceae	ST
240	*Syzygium grande* (Wight) Walp	Tha-bye	Myrtaceae	T
241	*Tamarindus indica* L.	Ma-gyi	Caesalpiniaceae	T
242	*Tectona grandis* L. f.	Kyun	Verbenaceae	T
243	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae	T
244	*Terminalia chebula* Retz.	Phan-kha	Combretaceae	T
245	*Terminalia tripteroides* Craib	Than-bae	Combretaceae	T
246	*Termitomyces albuminosa*	Taung-po-hmo	Agaricaceae	Mu
247	*Tetrastigma leucostaphylum*	Not known	Vitaceae	CL
248	*Thespesia lampas* Dalzell & A.Gibson	Taw-wa	Malvaceae	S
249	*Thunbergia fragrans* Roxb.	Pan-ye-sut	Acanthaceae	CL
250	*Thyrsostachys oliveri* Gamble	Tha-net-wa	Poaceae	B
251	*Trema orientalis* (L.) Blume	Khwe-sha	Ulmaceae	ST
252	*Triumfetta bartramia* L.	Kat-se-nae-thay	Tiliaceae	S
253	*Urena sinuata*	Kat-se nae-gyi	Malvaceae	S
254	*Vangueria spinosa* Roxb.	Ma-gyi-bauk	Rubiaceae	ST
255	*Verpa cornica*	Not known	Morchellaceae	Mu
256	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae	ST
257	*Vitex vestita* Wall.	Tauk-sha	Verbenaceae	ST
258	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae	ST
259	*Wrightia arborea* (Dennst.) Mabb.	Let-htok-thein	Apocynaceae	ST
260	*Xylia xylocarpa* (Roxb.) Taub.	Pyin-ka-doe	Mimosaceae	T
261	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	ST
	B=Bamboo,CL=Climber,E=Epiphyte,F=Fern, G=Grass,H=Herbs,Mu=Mushroom,S=Shrubs,ST=Small Tree, T=Tree			

Table 4: Right Bank and Left Bank Species

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
1	*Abelmoschus esculentus*	Not known	Malvaceae	√	
2	*Abelmoschus moschatus*	Taw-yon-pa-de	Malvaceae	√	√
3	*Acacia catechu* Willd.	Sha	Mimosaceae		√
4	*Acacia intsia* Willd.	Su-bok	Mimosaceae		√
5	*Acacia pennata* (L.)Willd.	Su-yit	Mimosaceae		√
6	*Acmella calva* (DC.) R.K. Jansen	Pe-le-nyin	Asteraceae	√	
7	*Adiantum latifolium*	Not known	Pteridaceae		√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
8	*Adiantum peruvianum*	Not known	Pteridaceae	√	
9	*Aegiceras corniculatum* (L.) Blanco	Bu-ta-let	Myrsinaceae		√
10	*Aeginetia indica* L.	Kauk-hlaing-di	Orobanchaceae	√	
11	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae	√	√
12	*Albizia chinensis* (Osbeck)Merr.	Bom-me-za	Mimosaceae	√	
13	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae	√	
14	*Albizia procera* (Roxb.) Benth.	Thit-phyu	Mimosaceae		√
15	*Alocasia macrorrhizos*	Pein-gyi	Araceae		√
16	*Alstonia scholaris*(L.) R. Br.	Taung-ma-yoe	Apocynaceae		√
17	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	√	√
18	*Alysicarpus vaginalis* (L.) Dc.	Than-ma-naing-kyauk-ma-naing	Fabaceae	√	
19	*Amalocalyx microlobus*	Not known	Apocynaceae		√
20	*Amaranthus gracilis* Desf.	Hin-nu-nwe-yaing	Amaranthaceae	√	√
21	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae	√	√
22	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Wa-u	Araceae	√	√
23	*Ampelocissus barbata* Planch.	Not known	Vitaceae		√
24	*Anogeissus acuminata* Wall.	Yon	Combretaceae		√
25	*Antidesma bunius*	Kin-ba-lin	Euphorbiaceae		√
26	*Aporusa dioica* (Roxb.) Mull.Arg.	Thit-khauk	Euphorbiaceae		√
27	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae	√	
28	*Argyreia nervosa*	Ka-zun-nwee	Convolvulaceae	√	√
29	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae	√	√
30	*Artemisia vulgaris*	Not known	Asteraceae	√	√
31	*Artocarpus lakoocha*	Taung-pein-ne	Moraceae		√
32	*Asparagus densiflorus*	Shint-ma-tet	Asparagaceae	√	√
33	*Asparagus filicinus* Buch.-Ham. ex D. Don	Ka-nyut	Asparagaceae		√
34	*Atalantia monopyhlla* A.DC.	Yin-kya\ Taw shuk-kha	Rutaceae		√
35	*Auricularia auricula-judae* (Bull.) J.Schröt.	Kywet-na-ywet-hmo	Auriculariaceae		√
36	*Bambusa bambos*(L.)Voss.	Kya-khat-wa	Poaceae	√	
37	*Bambusa teres* Buch.-Ham. ex Wall.	Ta-bin-taing-wa	Poaceae		√
38	*Bambusa tulda* Roxb.	Theik-wa	Poaceae		√
39	*Barleria strigosa* Willd.	Not known	Acanthaceae	√	√
40	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae	√	√
41	*Bauhinia ornata* Kurz	Myauk-hle-ga	Caesalpiniaceae		√
42	*Bauhinia racemosa* Lam.	Pha-lan/Hta-la	Caesalpiniaceae		√
43	*Bauhinia* sp.	Swe-daw-thay	Caesalpiniaceae	√	√
44	*Begonia semperflorens*	Kyauk-chin-pan	Begoniaceae		√
45	*Bidens pilosa*	Hmwe-sok	Asteraceae	√	√
46	*Bischofia javanica*	Ye-pa-done	Euphorbiaceae	√	√
47	*Bliospermum axillare* Blume	Hnut-cho	Euphorbiaceae		√
48	*Blumea balsamifera* (L.) DC.	Phon-ma-thein	Asteraceae	√	√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
49	*Boerhavia chinensis* (L.) Asch. & Schw.	Not known	Nyctaginaceae	√	
50	*Boerhavia diffusa* L.	Pa-yan-na-wa	Nyctaginaceae	√	
51	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae		√
52	*Bombax ceiba* L.	Let-pan	Bombacaceae	√	√
53	*Bombax insigne* Wall.	De-du	Bombacaceae	√	
54	*Brachycorythis galeandra* (Rchb.f.) Summerh.	Not known	Orchidaceae		√
55	*Brachycorythis helferi* (Rchb.f.) Summerh.	Not known	Orchidaceae		√
56	*Bridelia retusa* (L.) A. Juss.	Myauk-zi/Seik-chi	Euphorbiaceae		√
57	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae	√	√
58	*Buddleja asiatica* Lour	Not known	Buddlejaceae	√	
59	*Butea parviflora* L.	Pauk-home	Fabaceae		√
60	*Butea superba* Roxb.	Pauk-nwee	Fabaceae		√
61	*Callicarpa formosana*	Not known	Verbenaceae		√
62	*Calycopteris floribunda* Lam.	Kyun-khaung-nwee	Combretaceae	√	
63	*Cananga latifolia*	Not known	Annonaceae		√
64	*Canavalia cathartica*	Not known	Fabaceae	√	√
65	*Canscora diffusa* (Vahl) R.Br.	Kyauk-pan	Gentianaceae	√	
66	*Cantharellus aurantiacus* (Wulf.)Fr.	Not known	Cantharelleae		√
67	*Canthium parvifolium* Roxb.	Say-than-baya	Rubiaceae		√
68	*Carex brizoides* L.	Taw-kyet-le-hlee	Cyperaceae		√
69	*Careya arborea* Roxb.	Ban-bwe	Lecythidaceae	√	
70	*Cassia fistula* L.	Ngu	Caesalpiniaceae	√	√
71	*Castanopsis diversifolia* King	Pa-phyu/Castanopsis	Fagaceae		√
72	*Celastrus monospermus* Roxb.	Not known	Celastracae		√
73	*Centratherum punctatum*	Not known	Asteraceae	√	
74	*Chamaesyce hypericifolia*	Not known	Euphorbiaceae	√	
75	*Chamaesyce thymifolia*	Not known	Euphorbiaceae		√
76	*Chenopodium acuminatum* subsp. *virgatum*	Not known	Chenopodiaceae		√
77	*Chromolaena odorata* (L.) R.M. King & H Robinson	Bi-zet	Asteraceae	√	√
78	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae	√	√
79	*Cibotium barometz* (Linn.) J. Sm.	Da-yin-kauk	Dicksoniaceae	√	
80	*Cinnamomum parthenoxylon* Meissner	Ka-ra-way-yaing	Lauraceae		√
81	*Cissus discolor* Blume	Wa-yaung-chin	Vitaceae	√	√
82	*Cissus hastata* Miq.	Sa-pyit-yaing	Vitaceae	√	
83	*Claoxylon indicum* Hassk.	Not known	Euphorbiaceae		√
84	*Clerodendrum serratum* L.	Yin-bya-net	Verbenaceae	√	√
85	*Clerodendrum villosum* Blume	Phet-kha	Verbenaceae		√
86	*Clitocybe caespitosa* Pk.	Wa-yin-hmo	Tricholomataceae	√	√
87	*Codonopsis lanceolata*	Ba-la-cheik	Campanulaceae		√
88	*Colocasia esculenta*	Pein-yaing	Araceae	√	√
89	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae		√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
90	*Combretum alfredii* Hance	Not known	Combretaceae	√	
91	*Commelina diffusa* Burm.f.	Myet-kyut	Commelinaceae		√
92	*Coprinus disseminatus*	Not known	Psathyrellaceae		√
93	*Coprinus plicatilis* (Curt.) Fr.	Not known	Psathyrellaceae		√
94	*Costus specious* Sm.	Pha-lan-taung-hmwe	Costaceae		√
95	*Crassocephalum crepidioides*	Pan-zauk-htoe	Asteraceae		√
96	*Crateva magna* (Lour.) DC.	Ka-det	Capparaceae		√
97	*Cratoxylum neriifolium* Kurz	Bae-bya	Hypericaceae		√
98	*Cratoxylum polyanthum*Korth.	Bae-bya	Hypericaceae		√
99	*Crotalaria multiflora* L.	Taw-paik-san	Fabaceae	√	√
100	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae	√	√
101	*Curculigo orchioides* Gaertn.	Kywet-ma-lut-ohn	Hypoxidaceae		√
102	*Curcuma longa* L.	Na-nwin	Zingiberaceae		√
103	*Curcuma petiolata* Roxb.	Ma-lar	Zingiberaceae		√
104	*Curcuma* sp.	Mar-la	Zingiberaceae	√	
105	*Cycas siamensis* Miq.	Mon-daing	Cycadaceae		√
106	*Cymbidium aloifolium* (L.)Sw.	Thit-tet-lin-nae	Orchidaceae		√
107	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae	√	√
108	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	√	√
109	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae	√	√
110	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	√	√
111	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	√	
112	*Dendrophthoe pentandra* (L.) Miq.	Kyi-paung	Loranthaceae	√	
113	*Desmodium gangeticum* L.	Not known	Fabaceae	√	
114	*Desmodium pulchellum* Benth.	Taung-damin	Fabaceae	√	
115	*Desmodium rufihirsutum* Craib	Not known	Fabaceae	√	√
116	*Desmodium triangulare* (Retz.) Merr.	Not known	Fabaceae		√
117	*Desmodium triflorum*	Not known	Fabaceae	√	
118	*Desmodium umbellatum* DC.	Kyee-hmi-apho	Fabaceae	√	√
119	*Dichrocephala integrifolia* (L.f.)Kuntze	Not known	Asteraceae		√
120	*Dillenia indica* L.	Tha-byu	Dilleniaceae		√
121	*Dillenia parviflora* Griff.	Phet-set/Zin-byun	Dilleniaceae		√
122	*Dioscorea alata*	Myauk-u	Dioscoreaceae	√	√
123	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae	√	√
124	*Dioscorea cylindrica* Burm.	KYwary-thon-ywet	Dioscoreaceae	√	√
125	*Dioscorea pentaphylla* L.	KYwary-ngar-ywet	Dioscoreaceae	√	√
126	*Dioscorea sativa* L.	Kyauk-yin-nwee	Dioscoreaceae	√	√
127	*Diospyros kaki* L.f.	Tae	Ebenaceae	√	√
128	*Dipterocarpus tuberculatus* Roxb.	In	Dipterocarpaceae		√
129	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae	√	√
130	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae	√	√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
131	*Dunbaria punctata*	Not known	Fabaceae	√	√
132	*Ehretia acuminata* R.Br	Taung-poe-lu-lin	Boraginaceae	√	√
133	*Elaeocarpus hainanensis* Oliv	Not known	Elaeocarpaceae		√
134	*Elatostema reticulatum*	Wet-sa	Urticaceae		√
135	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae	√	√
136	*Emblica officinalis* Gaertn.	Sha-phyu	Euphorbiaceae	√	√
137	*Engelhardtia spicata*	Pan-swe-le	Juglandaceae		√
138	*Entada scandens* Benth.	Doe-nwee	Mimosaceae		√
139	*Equisetum hyemale*	Not known	Equisetaceae		√
140	*Erythrina stricta* Roxb.	Ka-di\Ka-thit	Fabaceae	√	√
141	*Eugenia balsama* Wight	Ye-tha-bye	Myrtaceae		√
142	*Eugenia densiflora* DC.	Kyauk-tha-bye	Myrtaceae	√	√
143	*Euphorbia antiquorum* L.	Tazaung-gyi	Euphorbiaceae	√	
144	*Euphorbia heterophylla*	Sae-pa-le	Euphorbiaceae		√
145	*Euphorbia hypericifolia* L.	Kywe-kyaung-hmin-se	Euphorbiaceae		√
146	*Ficus auriculata*	Sin-tha-phan	Moraceae		√
147	*Ficus bengalensis* L.	Pyin-nyaung	Moraceae	√	
148	*Ficus glomerata* Roxb.	Ye-tha-phan	Moraceae		√
149	*Ficus hispida* L.	Kha-aung	Moraceae	√	√
150	*Ficus pumila* L.	Creeping fig.	Moraceae	√	√
151	*Ficus racemosa*	Not known	Moraceae		√
152	*Ficus semicordata*	Ka-dut	Moraceae		√
153	*Ficus variegate*	Kon-tha-phan	Moraceae		√
154	*Fimbristylis sieboldii*	Not known	Cyperaceae		√
155	*Flacourtia cataphracta* Roxb.	Na-ywe	Flacourtiaceae		√
156	*Flueggea leucopyrus* Willd	Ye-chin-ya	Euphorbiaceae		√
157	*Gagea reticulata* (Pall.) Schult.	Not known	Liliaceae	√	
158	*Ganoderma australe*	Not known	Ganodermataceae		√
159	*Gardenia coronaria* Buch-Ham.	Yin-khat-gyi	Rubiaceae	√	√
160	*Garuga pinnata* Roxb.	Chin-yoke	Burseraceae		√
161	*Getonia floribunda* Roxb.	Kywet-nwee	Combretaceae	√	
162	*Globba patens*	Pa-dein-ngo	Zingiberaceae	√	√
163	*Globba pendula*	Pa-dein-ngo-thay	Zingiberaceae		√
164	*Glochidion* sp.	Hta-min-sok	Euphorbiaceae		√
165	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae	√	√
166	*Gochnatia decora*	Not known	Asteraceae	√	√
167	*Gonostegia hirta*	Not known	Rubiaceae		√
168	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae	√	√
169	*Grewia laevigata*	Not known	Tiliaceae		√
170	*Habenaria chlorina* Par. & Rchb.f.	Not known	Orchidaceae	√	
171	*Habenaria hosseusii* Schltr.	Not known	Orchidaceae	√	

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
172	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae		√
173	*Hedyotis auricularia*	Not known	Rubiaceae		√
174	*Hedyotis diffusa*	Not known	Rubiaceae	√	
175	*Helicia erratica* Hook. f.	Dauk-yat	Proteaceae		√
176	*Helicteres angustifolia* L.	Not known	Sterculiaceae	√	√
177	*Heliotropium indicum* L.	Sin-hna-maung	Boraginaceae		√
178	*Heteropanax fragrans* (Roxb. ex DC.) Seem.	Kyaung-dauk/La-ka-du	Araliaceae		√
179	*Heterophragma adenophylla* (Wall.) Seem. ex Benth. & Hook.	Phet-than	Bignoniaceae		√
180	*Hiptage benghalensis* (L.) Kurz	Sar-say/Bein-nwee	Malpighiaceae	√	√
181	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	√	√
182	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	√	√
183	*Hydrocotyle sibthorpioides* Thunb	Myin-khwa	Apiaceae		√
184	*Hymenodictyon orixense* (Roxb.) Mabb.	Khu-than	Rubiaceae		√
185	*Impatiens chinensis* L.	Dan-pan	Balsaminaceae		√
186	*Imperata cylindrica* (L.) P. Beauv.	Thet-kae	Poaceae		√
187	*Indigofera tinctoria*	Me-yaing	Fabaceae	√	
188	*Inonotus hispidus*	Not known	Hymenochaetaceae		√
189	*Ipomoea cairica*	Ka-zun	Convolvulaceae	√	
190	*Ipomoea cordatotriloba*	Ka-zun	Convolvulaceae	√	
191	*Isachne albens* Trin.	Myet	Poaceae	√	
192	*Ischaemum ciliare*	Not known	Poaceae	√	
193	*Ischnoderma benzoinum*	Hmo	Fomitopsidaceae	√	
194	*Jasminum multiflorum*	Taw-sa-bei	Oleaceae		√
195	*Kyllinga brevifolia*	Not known	Cyperaceae		√
196	*Lactarius volemus* Fr.	Not known	Russulaceae		√
197	*Lagerstroemia macrocarpa* Kurz	Pyin-ma-ywet-gyi	Lythraceae		√
198	*Lagerstroemia speciosa* (L.) Pers.	Pyin-ma-ywet-thay	Lythraceae		√
199	*Lagerstroemia villosa* Wall. ex Kurz	Zaung-palae	Lythraceae		√
200	*Lannea coromandelica* (Houtt.) Merrr.	Na-be	Anacardiaceae	√	√
201	*Lantana camara* L.	Sein-na-pan	Verbenaceae		√
202	*Leea hirta* Banks	Na-ga-mauk-phyu	Leeaceae		√
203	*Leea macrophylla* Roxb.	Na-ga-mauk-gyi	Leeaceae		√
204	*Leea rubra*	Na-ga-mauk-ni	Leeaceae		√
205	*Lenzites betulina*	Not known	Polyporaceae		√
206	*Lepiota cristata*	Not known	Agaricaceae		√
207	*Litsea glutinosa*	On-don	Lauraceae		√
208	*Ludwigia hyssopifolia*	Lay-nyin-thay	Onagraceae	√	
209	*Ludwigia octovalvis*	Lay-nyin-gyi	Onagraceae	√	
210	*Mallotus philippensis*	Taw-thi-din	Euphorbiaceae		√
211	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae		√
212	*Markhamia stipulata* (Wall.) Seem. Ex K.Schum.	Ma-hlwa	Bignoniaceae		√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
213	*Melanorrhoea usitata* Wall.	Thit-si	Anacardiaceae	√	√
214	*Mesua ferrea* L.	Taw-gan-gaw	Hypericaceae		√
215	*Michelia baillonii* (Pierr)Finet & Gagnep.	Sa-ga-phyu	Magnoliaceae		√
216	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae		√
217	*Millettia extensa* Benth.	Win-u	Fabaceae		√
218	*Millettia ovalifolia* Kurz	Thin-win-pho	Fabaceae	√	√
219	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	√	√
220	*Mitragyna rotundifolia* (Roxb.) Kuntze	Bin-ga	Rubiaceae		√
221	*Morus indica* L.	Po-sa	Moraceae		√
222	*Mucuna pruriens* (L.)DC.	Khwe-la-ya	Fabaceae	√	√
223	*Murdannia bracteata*	Not known	Commelinaceae	√	√
224	*Musa* sp.	Taw-nga-pyaw	Musaceae		√
225	*Mussaenda calycina* Wall. ex Kurz	Pwint-tu-ywet-tu	Rubiaceae		√
226	*Myriopteron paniculatum* Griff	Ti-lay-na-tha	Asclepiadaceae	√	√
227	*Nervilia plicata*	Ta-bin-taing-shwe-hti	Orchidaceae		√
228	*Ochna integerrima*	Indaing-seni	Ochnaceae	√	
229	*Operculina turpethum* (L.) Silva Mansa	Kyar-hin-nwee	Convolvulaceae		√
230	*Oroxylum indicum* (L.)Kurz	Kyaung-sha	Bignoniaceae	√	√
231	*Oxalis corniculata* L.	Hmo-chin	Oxalidaceae	√	√
232	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae	√	√
233	*Paederia foetida*	Pe-bok-nwee-thay	Rubiaceae	√	
234	*Paederia scandens* Lour.	Pe-bok-nwee-gyi	Rubiaceae	√	
235	*Panus tigrinus*	Not known	Polyporaceae		√
236	*Passiflora foetida* L.	Taw-su-ka	Passifloraceae		√
237	*Pennisetum purpureum*	Yon-sa-myet	Poaceae		√
238	*Peristylus affinis* (D.Don)Seidenf.	Not known	Orchidaceae		√
239	*Peristylus goodyeroides* (D.Don)Lindl.	Simidauk	Orchidaceae		√
240	*Persicaria odorata*	Kywe-hna-khaung-gyate	Polygonaceae		√
241	*Phaseolus sp.*	Not known	Fabaceae	√	
242	*Phaseolus velutina* Grah.	Pauk-net	Fabaceae	√	√
243	*Phoenix loureiri* Kunth	Thin-baung	Arecaceae		√
244	*Phyllanthus amarus*	Myay-zi-phyu	Euphorbiaceae	√	√
245	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	√	√
246	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae	√	√
247	*Physalis minima* L.	Bauk-thi	Solanaceae	√	√
248	*Pilea scripta* Langtang	Phet-ya	Urticaceae		√
249	*Piper cubebe* L. f.	Peik-chin	Piperaceae		√
250	*Pogostemon auricularius*	Not known	Lamiaceae	√	√
251	*Polyalthia viridis*	Not known	Annonaceae		√
252	*Polyporus ovinus* (Schaeff.)Fr.	Not known	Polyporaceae		√
253	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	√	

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
254	*Pouzolzia zeylanica*	Not known	Urticaceae		√
255	*Premna amplectens* Wall	Yin-bya-phyu	Verbenaceae		√
256	*Pseuderanthemum polyanthum*	Not known	Acanthaceae		√
257	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	√	√
258	*Pterospermum acerifolium* (L.) Willd.	Taung-phet-wun	Sterculiaceae		√
259	*Pterospermum diversifolium*	Not known	Sterculiaceae	√	√
260	*Pycnoporus sanguineus*	Hmo	Polyporaceae	√	
261	*Quercus mespilifolia* Wall.	Yin-gu	Fagaceae		√
262	*Randia uliginosa* DC.	Hman-ni	Rubiaceae	√	√
263	*Rumex crispus* L.	Not known	Polygonaceae	√	√
264	*Rumex trisetiferus* Stokes	Not known	Polygonaceae	√	√
265	*Saccharum spontaneum* L.	Kaing	Poaceae	√	
266	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae	√	√
267	*Sapium baccata*	Aw-le	Euphorbiaceae		√
268	*Schima wallichii* (DC.) Korth.	Lauk-ya	Theaceae	√	
269	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	√	√
270	*Schrebera swietenioides* Roxb.	Thit-swe-le	Oleaceae	√	√
271	*Scoparia dulcis* L.	Dana-thu-kha	Scrophulariaceae	√	√
272	*Scurrula parasitica* L.	Kyi-paung	Loranthaceae	√	
273	*Selaginella willdenowii*	Not known	Selaginellaceae	√	√
274	*Senna hirsuta* (L.) Irwin & Barneby	Ka-thaw-hmwe-htu	Caesalpiniaceae		√
275	*Senna tora* (L.) Roxb	Dan-gwe	Caesalpiniaceae		√
276	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	√	√
277	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	√	√
278	*Sida rhombifolia* L.	Ta-byet-se-ywet-waing	Malvaceae		√
279	*Smilax aspericaulis* Wall ex A. D.C.	Sein-na-baw-thay	Smilacaceae		√
280	*Smilax china* L.	Not known	Smilacaceae		√
281	*Smilax macrophylla* Roxb.	Sein-na-baw-gyi	Smilacaceae		√
282	*Solanum torvum* Swartz	Kha-yan-ka-zawt	Solanaceae		√
283	*Solanum verbascifolium*	Not known	Solanaceae		√
284	*Spirogyra* sp.	Algae	Zygnemataceae	√	
285	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae	√	√
286	*Stemona tuberosa*	Tha-mya	Stemonaceae	√	√
287	*Sterculia foetida* L.	Shaw-phyu	Sterculiaceae	√	√
288	*Sterculia villosa*	Shaw	Sterculiaceae	√	√
289	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae	√	√
290	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae	√	√
291	*Strychnos nux-blanda* A.W.Hill	Kha-baung	Loganiaceae	√	√
292	*Syzygium grande* (Wight) Walp	Tha-bye	Myrtaceae		√
293	*Tamarindus indica* L.	Ma-gyi	Caesalpiniaceae		√
294	*Tectona grandis* L. f.	Kyun	Verbenaceae		√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
295	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae	√	√
296	*Terminalia chebula* Retz.	Phan-kha	Combretaceae		√
297	*Terminalia tripteroides* Craib	Than-bae	Combretaceae		√
298	*Termitomyces albuminosa*	Taung-po-hmo	Agaricaceae		√
299	*Tetrastigma leucostaphylum*	Not known	Vitaceae		√
300	*Thespesia lampas* Dalzell & A.Gibson	Taw-wa	Malvaceae	√	√
301	*Thunbergia fragrans* Roxb.	Pan-ye-sut	Acanthaceae		√
302	*Thyrsostachys oliveri* Gamble	Tha-net-wa	Poaceae		√
303	*Tithonia diversifolia* A. Gray	Nay-kyar-yaing	Asteraceae	√	
304	*Trema orientalis* (L.) Blume	Khwe-sha	Ulmaceae		√
305	*Triumfetta bartramia* L.	Kat-se-nae-thay	Tiliaceae		√
306	*Tylophora ovata*	Not known	Asclepiadaceae	√	
307	*Urena sinuata*	Kat-se nae-gyi	Malvaceae		√
308	*Utricularia caerulea*	Ye-bu-baung	Lentibulariaceae	√	
309	*Uvaria cordata* Schum. & Thonn.	Tha-but-gyi	Annonaceae	√	
310	*Vanda coerulescens* Griff.	Mo-lon-hmying-apyar-lay	Orchidaceae	√	
311	*Vangueria spinosa* Roxb.	Ma-gyi-bauk	Rubiaceae	√	√
312	*Verpa cornica*	Not known	Morchellaceae		√
313	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae	√	√
314	*Vitex vestita* Wall.	Tauk-sha	Verbenaceae	√	√
315	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae	√	√
316	*Wrightia arborea* (Dennst.) Mabb.	Let-htok-thein	Apocynaceae		√
317	*Xylia xylocarpa* (Roxb.) Taub.	Pyin-ka-doe	Mimosaceae		√
318	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	√	√

3.1.3. Tree Species

A total of 37 tree species belonging to 34 genera were collected in the left bank research area one. The dominant tree species in this area are *Shorea obtusa* Wall. (Thit-ya) followed by *Shorea siamensis* (Kurz)Miq. (In-gyin) and *Buchanania latifolia* Roxb. (Lun-pho), *Dalbergia oliveri* Gamble (Ta-ma-lan), and *Emblica officinalis* Gaertn. (Sha-phyu).

Table 5: Tree Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha (%)
1	*Albizia procera* (Roxb.) Benth.	2	2.17	0.36
2	*Anogeissus acuminata* Wall.	1	1.09	0.18
3	*Antidesma bunius*	2	2.17	0.36
4	*Bombax ceiba* L.	2	2.17	0.36
5	*Bridelia retusa* (L.) A. Juss.	12	13.04	2.17
6	*Buchanania latifolia* Roxb.	54	58.70	9.75

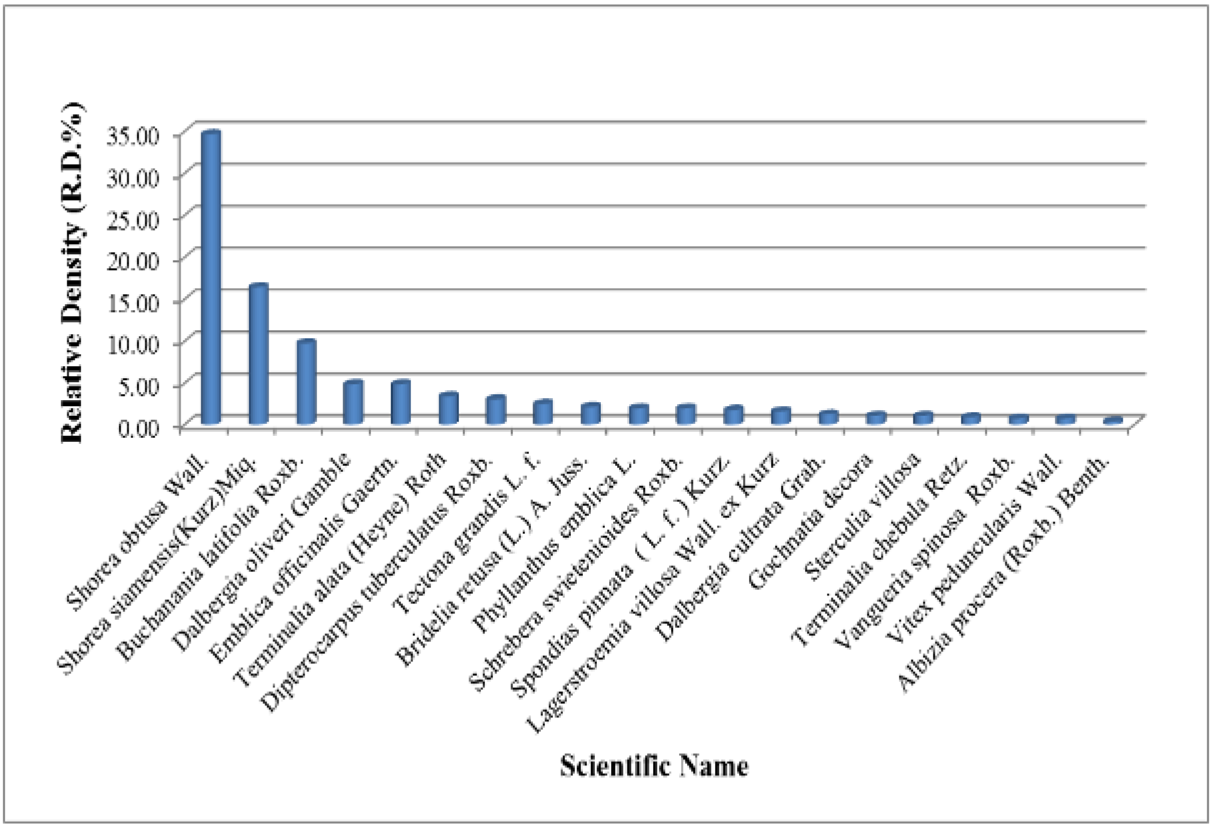
7	*Chukrasia velutina* Roem.	2	2.17	0.36
8	*Croton oblongifolius* Roxb.	2	2.17	0.36
9	*Dalbergia cultrata* Grah.	7	7.61	1.26
10	*Dalbergia oliveri* Gamble	27	29.35	4.87
11	*Dipterocarpus tuberculatus* Roxb.	17	18.48	3.07
12	*Emblica officinalis* Gaertn.	27	29.35	4.87
13	*Erythrina stricta* Roxb.	2	2.17	0.36
14	*Flacourtia cataphracta* Roxb.	2	2.17	0.36
15	*Flueggea leucopyrus* Willd	1	1.09	0.18
16	*Gochnatia decora*	6	6.52	1.08
17	*Grewia eriocarpa Juss.*	1	1.09	0.18
18	*Harrisonia perforata* Merr.	1	1.09	0.18
19	*Lagerstroemia villosa* Wall. ex Kurz	9	9.78	1.62
20	*Melanorrhoea usitata* Wall.	2	2.17	0.36
21	*Phyllanthus emblica* L.	11	11.96	1.99
22	*Pterocarpus indicus*Willd.	1	1.09	0.18
23	*Quercus mespilifolia* Wall.	1	1.09	0.18
24	*Schleichera oleosa* (Lour.) Oken	2	2.17	0.36
25	*Schrebera swietenioides* Roxb.	11	11.96	1.99
26	*Shorea obtusa* Wall.	192	208.70	34.66
27	*Shorea siamensis*(Kurz)Miq.	91	98.91	16.43
28	*Spondias pinnata* (L. f.) Kurz.	10	10.87	1.81
29	*Sterculia villosa*	6	6.52	1.08
30	*Syzygium grande* (Wight) Walp	2	2.17	0.36
31	*Tectona grandis* L. f.	14	15.22	2.53
32	*Terminalia alata* (Heyne) Roth	19	20.65	3.43
33	*Terminalia chebula* Retz.	5	5.43	0.90
34	*Vangueria spinosa* Roxb.	4	4.35	0.72
35	*Vitex peduncularis* Wall.	4	4.35	0.72
36	*Vitex vestita* Wall.	1	1.09	0.18
37	*Xylia xylocarpa* (Roxb.) Taub.	1	1.09	0.18
	Total	**554**	**602.17**	**100.00**

Among the sample plots species density per hectare varied. The highest density was observed *Shorea obtuse* Wall., *Shorea siamensis* (Kurz) Miq., *Buchanania latifolia* Roxb., *Dalbergia oliveri* Gamble and *Emblica officinalis* Gaertn., followed by *Terminalia alata* (Heyne) Roth, *Dipterocarpus tuberculatus* Roxb., and *Tectona grandis* L. f.. This shows that these eight species are abundant in this area.

Table 6: Tree Species Relative Density

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Shorea obtusa* Wall.	19.2	34.66
2	*Shorea siamensis*(Kurz)Miq.	9.1	16.43
3	*Buchanania latifolia* Roxb.	5.4	9.75
4	*Dalbergia oliveri* Gamble	2.7	4.87
5	*Emblica officinalis* Gaertn.	2.7	4.87
6	*Terminalia alata* (Heyne) Roth	1.9	3.43
7	*Dipterocarpus tuberculatus* Roxb.	1.7	3.07
8	*Tectona grandis* L. f.	1.4	2.53
9	*Bridelia retusa* (L.) A. Juss.	1.2	2.17
10	*Phyllanthus emblica* L.	1.1	1.99
11	*Schrebera swietenioides* Roxb.	1.1	1.99
12	*Spondias pinnata* (L. f.) Kurz.	1	1.81
13	*Lagerstroemia villosa* Wall. ex Kurz	0.9	1.62
14	*Dalbergia cultrata* Grah.	0.7	1.26
15	*Gochnatia decora*	0.6	1.08
16	*Sterculia villosa*	0.6	1.08
17	*Terminalia chebula* Retz.	0.5	0.90
18	*Vangueria spinosa* Roxb.	0.4	0.72
19	*Vitex peduncularis* Wall.	0.4	0.72
20	*Albizia procera* (Roxb.) Benth.	0.2	0.36
21	*Antidesma bunius*	0.2	0.36
22	*Bombax ceiba* L.	0.2	0.36
23	*Chukrasia velutina* Roem.	0.2	0.36
24	*Croton oblongifolius* Roxb.	0.2	0.36
25	*Erythrina stricta* Roxb.	0.2	0.36
26	*Flacourtia cataphracta* Roxb.	0.2	0.36
27	*Melanorrhoea usitata* Wall.	0.2	0.36
28	*Schleichera oleosa* (Lour.) Oken	0.2	0.36
29	*Syzygium grande* (Wight) Walp	0.2	0.36
30	*Anogeissus acuminata* Wall.	0.1	0.18
31	*Flueggea leucopyrus* Willd	0.1	0.18
32	*Grewia eriocarpa Juss.*	0.1	0.18
33	*Harrisonia perforata* Merr.	0.1	0.18
34	*Pterocarpus indicus*Willd.	0.1	0.18
35	*Quercus mespilifolia* Wall.	0.1	0.18
36	*Vitex vestita* Wall.	0.1	0.18
37	*Xylia xylocarpa* (Roxb.) Taub.	0.1	0.18

Chart 1: Tree Species Relative Density



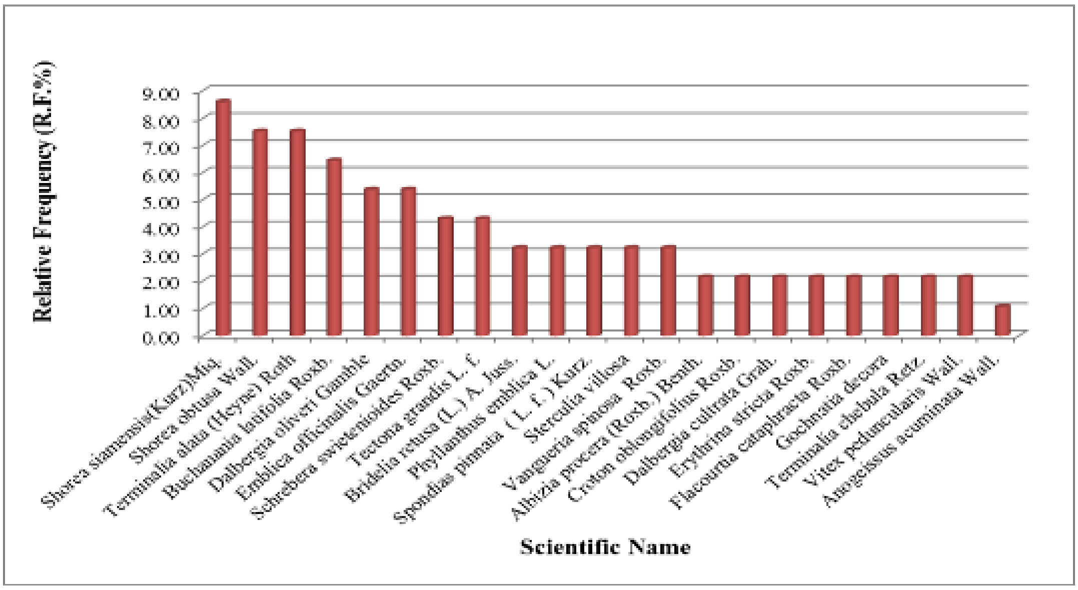
Relative frequency is the frequency of one species compared to the total frequency of all the species. According to the results**,** *Shorea siamensis* (Kurz) Miq., has the highest relative frequency value (9%) followed by *Shora obtuse* Wall and *Terminalia alata* (Heyne) Roth both at (8%), *Buchanania latifolia* Roxb. (6%) and *Dalbergia oliveri* Gamble and *Emblica officinalis* Gaertn. at (5%). These species are ubiquitous across the study area. The lower frequency of some species, such as *Anogeissus acuminata* Wall., *Lagerstroemia villosa* Wall. ex Kurz, and *Xylia xylocarpa* (Roxb.) Taub., are demarcated as rare species in the area.

Table 7: Tree Species Relative Frequency

No.	Scientific Name	Frequency (F)	Relative Frequency (R.F.%)
1	*Shorea siamensis*(Kurz)Miq.	0.80	8.60
2	*Shorea obtusa* Wall.	0.70	7.53
3	*Terminalia alata* (Heyne) Roth	0.70	7.53
4	*Buchanania latifolia* Roxb.	0.60	6.45

5	*Dalbergia oliveri* Gamble	0.50	5.38
6	*Emblica officinalis* Gaertn.	0.50	5.38
7	*Schrebera swietenioides* Roxb.	0.40	4.30
8	*Tectona grandis* L. f.	0.40	4.30
9	*Bridelia retusa* (L.) A. Juss.	0.30	3.23
10	*Phyllanthus emblica* L.	0.30	3.23
11	*Spondias pinnata* (L. f.) Kurz.	0.30	3.23
12	*Sterculia villosa*	0.30	3.23
13	*Vangueria spinosa* Roxb.	0.30	3.23
14	*Albizia procera* (Roxb.) Benth.	0.20	2.15
15	*Croton oblongifolius* Roxb.	0.20	2.15
16	*Dalbergia cultrata* Grah.	0.20	2.15
17	*Erythrina stricta* Roxb.	0.20	2.15
18	*Flacourtia cataphracta* Roxb.	0.20	2.15
19	*Gochnatia decora*	0.20	2.15
20	*Terminalia chebula* Retz.	0.20	2.15
21	*Vitex peduncularis* Wall.	0.20	2.15
22	*Anogeissus acuminata* Wall.	0.10	1.08
23	*Antidesma bunius*	0.10	1.08
24	*Bombax ceiba* L.	0.10	1.08
25	*Chukrasia velutina* Roem.	0.10	1.08
26	*Dipterocarpus tuberculatus* Roxb.	0.10	1.08
27	*Flueggea leucopyrus* Willd	0.10	1.08
28	*Grewia eriocarpa Juss.*	0.10	1.08
29	*Harrisonia perforata* Merr.	0.10	1.08
30	*Lagerstroemia villosa* Wall. ex Kurz	0.10	1.08
31	*Melanorrhoea usitata* Wall.	0.10	1.08
32	*Pterocarpus indicus*Willd.	0.10	1.08
33	*Quercus mespilifolia* Wall.	0.10	1.08
34	*Schleichera oleosa* (Lour.) Oken	0.10	1.08
35	*Syzygium grande* (Wight) Walp	0.10	1.08
36	*Vitex vestita* Wall.	0.10	1.08
37	*Xylia xylocarpa* (Roxb.) Taub.	0.10	1.08

Chart 2: Tree Species Relative Frequency



3.1.4. Orchid Species

Peristylus affinis (D.Don) Seidenf.

Peristylus goodyeroides (D.Don) Lindl.

Table 8: Orchid Species

No.	Scientific Name	Common Name	Family Name
1	*Brachycorythis galeandra* (Rchb.f.) Summerh.	Not known	Orchidaceae
2	*Brachycorythis helferi* (Rchb.f.) Summerh.	Not known	Orchidaceae
3	*Cymbidium aloifolium* (L.)Sw.	Thit-tet-lin-nae	Orchidaceae
4	*Nervilia plicata*	Ta-bin-taing-shwe-hti	Orchidaceae
5	*Peristylus affinis* (D.Don)Seidenf.	Not known	Orchidaceae
6	*Peristylus goodyeroides* (D.Don)Lindl.	Simidauk	Orchidaceae

3.1.5. Mushroom Species

Cantharellus aurantiacus (Wulf.)Fr.

Coprinus disseminates

Table 9: Mushroom Species

No.	Scientific Name	Common Name	Family Name
1	*Auricularia auricula-judae* (Bull.) J.Schröt.	Kywet-na-ywet-hmo	Auriculariaceae
2	*Cantharellus aurantiacus* (Wulf.)Fr.	Not known	Cantharelleae
3	*Clitocybe caespitosa* Pk.	Wa-yin-hmo	Tricholomataceae
4	*Coprinus disseminatus*	Not known	Psathyrellaceae
5	*Coprinus plicatilis* (Curt.) Fr.	Not known	Psathyrellaceae
6	*Ganoderma australe*	Not known	Ganodermataceae
7	*Inonotus hispidus*	Not known	Hymenochaetaceae
8	*Lactarius volemus* Fr.	Not known	Russulaceae
9	*Lenzites betulina*	Not known	Polyporaceae
10	*Lepiota cristata*	Not known	Agaricaceae
11	*Panus tigrinus*	Not known	Polyporaceae
12	*Polyporus ovinus* (Schaeff.)Fr.	Not known	Polyporaceae
13	*Termitomyces albuminosa*	Taung-po-hmo	Agaricaceae
14	*Verpa cornica*	Not known	Morchellaceae

3.1.6. Bamboo Species

(Right Bank Bamboo Forest) *(Left Bank Bamboo Forest)*

Three species of Bamboo were identified on the left bank research area one. Their total population and relative density are given below.

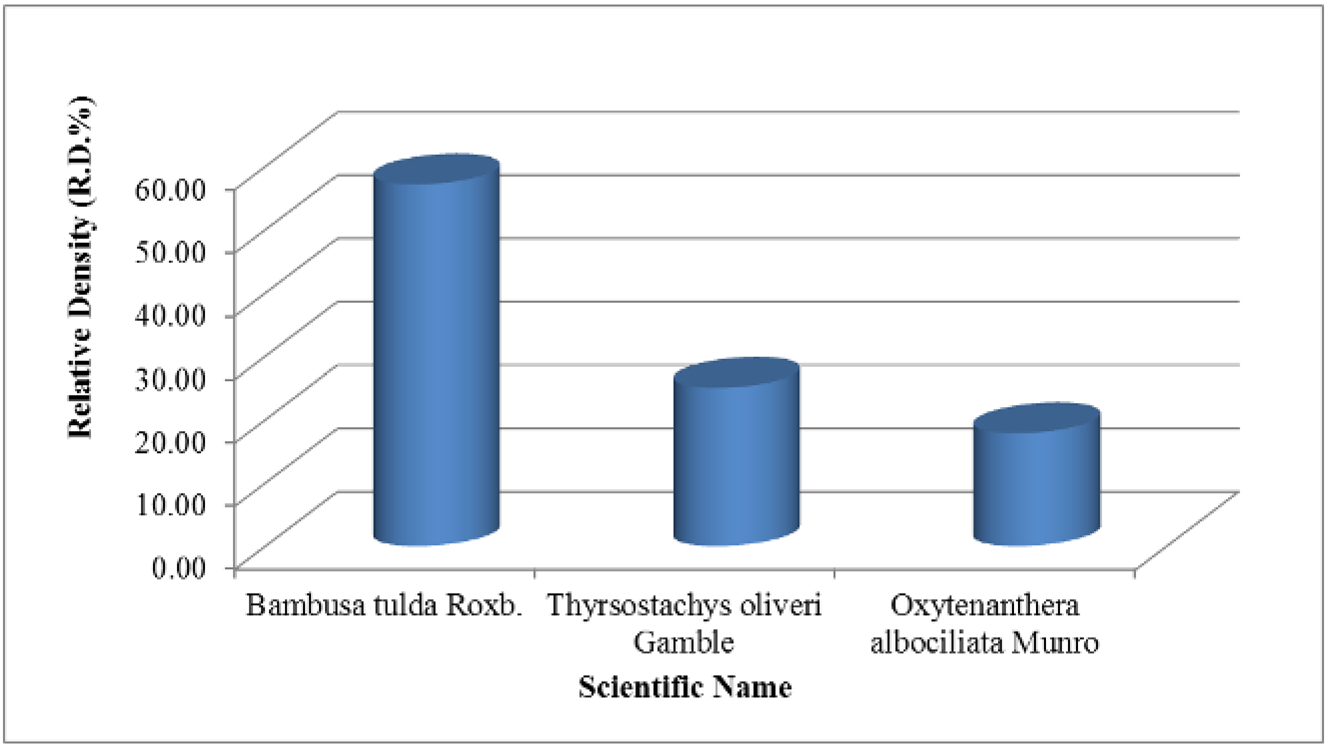
Table 10: Bamboo Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Bambusa tulda* Roxb.	5	18.52	17.86
2	*Thyrsostachys oliveri* Gamble	7	25.93	25.00
3	*Oxytenanthera albociliata* Munro	16	59.26	57.14
	Total	**28**	**103.70**	**100.00**

Table 11: Bamboo Species Relative Density

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Bambusa tulda* Roxb.	5.33	57.14
2	*Thyrsostachys oliveri* Gamble	2.33	25.00
3	*Oxytenanthera albociliata* Munro	1.67	17.86

Chart 3: Bamboo Species Relative Density



3.1.7. Flora IUCN Status

Of the flora species identified on the left bank research area one, 14 species are on the IUCN Red List. They are listed below. Most notably, *Dalbergia oliveri* Gamble is classified as EN

A1cd, *Cycas siamensis* Miq. is classified as VU A2cd, and *Dalbergia cultrata* Grah. is classified as NT. The other 11 species are classified as species of least concern or low risk/least concern.

Table 12: Flora IUCN Status

No.	Scientific Name	Common Name	Family Name	IUCN Status
1	*Bauhinia ornata* Kurz	Myauk-hle-ga	Caesalpiniaceae	LC
2	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae	LC
3	*Cycas siamensis* Miq.	Mon-daing	Cycadaceae	VU A2cd
4	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	NT
5	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	EN A1cd
6	*Dipterocarpus tuberculatus* Roxb.	In	Dipterocarpaceae	LR/Lc
7	*Engelhardtia spicata*	Pan-swe-le	Juglandaceae	LR/Lc
8	*Equisetum hyemale*	Not known	Equisetaceae	LC
9	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	LC
10	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	LC
11	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae	LR/Lc
12	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	LC
13	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	LR/Lc
14	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/Lc
EN=Endangered, VU=Vulnerable, NT=Near Threatened, LC=Least Concern, LR/Lc=Lower Risk/Least concern				

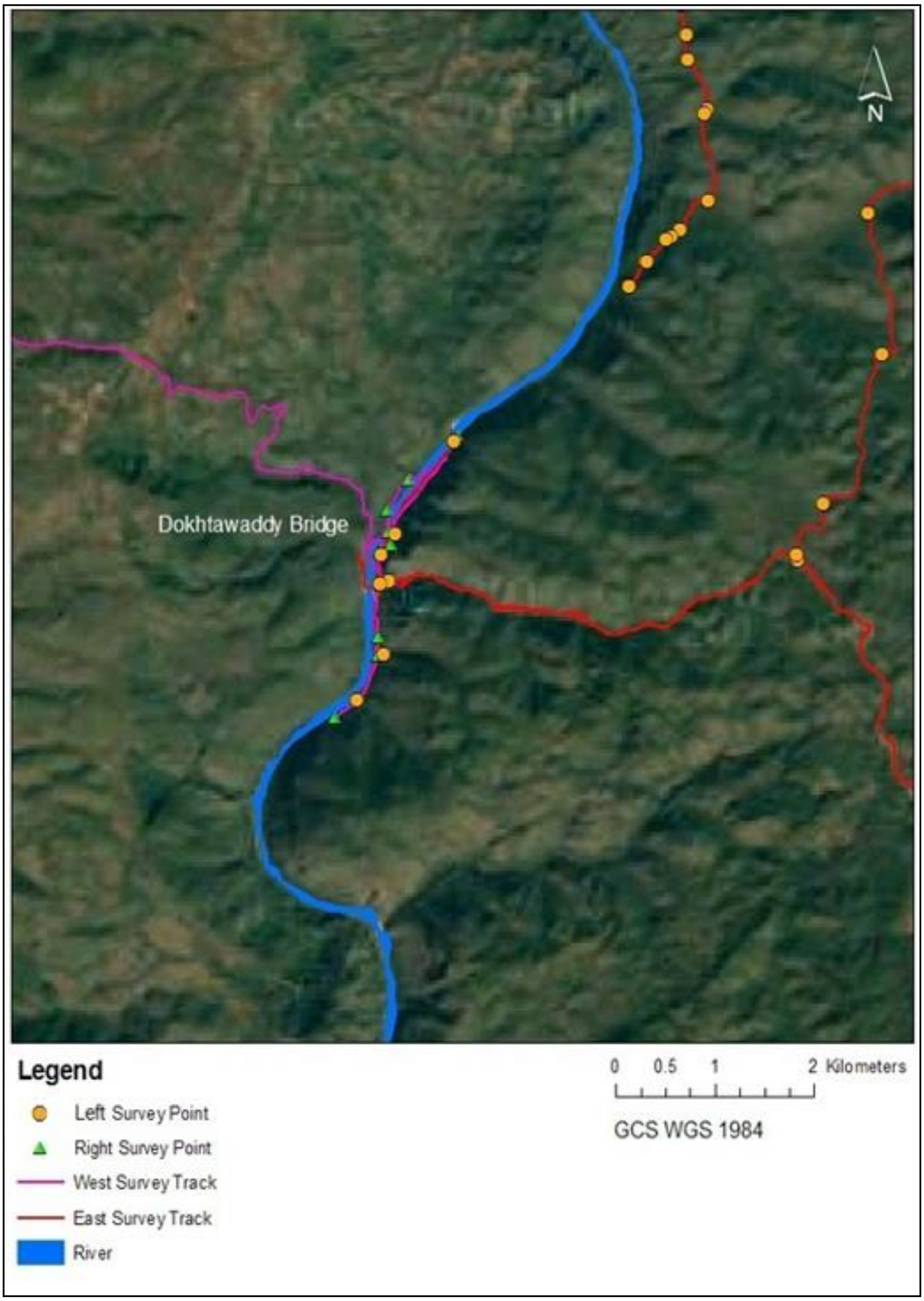
Bauhinia ornata Kurz

Holarrhena pubescens Wall. ex G. Don

Cycas siamensis Miq. *Shorea siamensis*(Kurz)Miq.

3.2 Research Area Two

Map 4: Research Area Two



Map 5: Reservoir Elevation Line

(Right Bank Forest)

(Left Bank Forest)

3.2.1. Quadrant Location and Vegetation Type

Two sample plots were taken in research area two on the left bank. In each plot the vegetation type was Riverine Forest. A summary of the sample plots and relevant data is given below.

Table 13: Research Area Two Sample Plots

No.	Sample Quadrant	Vegetation type	Latitude/Longitude	Altitude(m)	Dominant species
1	KGQ VIII	Riverine Forest	N22 01 52.0 E96 57 56.9	322	*Sterculia villosa*, *Shorea siamensis*(Kurz)Miq.,*Shorea obtusa* Wall., *Xylia xylocarpa* (Roxb.) Taub.,*Terminalia alata* (Heyne) Roth, *Tetrameles nudiflora* R.Br., *Bombax ceiba* L.
2	KGQ IX	Riverine Forest	N22 01 15.8 E96 57 52.9	330	

3.2.2. Flora Species on Left and Right Banks

A total of 171 flora species were identified in research area two on the left bank, compared to 176 on the right bank. There were 46 flora species found only on the left bank and 51 flora species only found on the right bank. 125 flora species were present on both banks. This yields a total of 222 flora species present on either the left bank, right bank or both banks.

Table 14: Flora Species in Left Bank Research Area Two

No.	Scientific Name	Common Name	Family Name	Habit
1	*Acacia concinna* (Willd.) DC.	Ka-mon-chin	Mimosaceae	S
2	*Acacia intsia* Willd.	Su-bok	Mimosaceae	S
3	*Acer laurinum* Hassk.	Not known	Aceraceae	ST
4	*Acer negunda*	Not known	Aceraceae	ST
5	*Acmella calva* (DC.) R.K. Jansen	Pe-le-nyin	Asteraceae	H
6	*Adenostemma viscosum*	Not known	Asteraceae	H
7	*Agaricus silvicola*	Not known	Agaricaceae	Mu
8	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae	H
9	*Albatrellus ovinus*	Not known	Albatrellaceae	Mu
10	*Albizia chinensis* (Osbeck)Merr.	Bom-me-za	Mimosaceae	T
11	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae	T
12	*Alphonsea boniana*	Not known	Annonaceae	T
13	*Alstonia scholaris*(L.) R. Br.	Taung-ma-yoe	Apocynaceae	T
14	*Alternanthera nodiflora* R.Br.	Ka-na-phaw-yaing	Amaranthaceae	H
15	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	CL
16	*Amaranthus gracilis* Desf.	Hin-nu-nwe-yaing	Amaranthaceae	H
17	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae	H
18	*Anogeissus acuminata* Wall.	Yon	Combretaceae	T
19	*Argyreia nervosa* (Burm.f.)Bojer	Kazun-gyi	Convolvulaceae	CL
20	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae	CL
21	*Artemisia* sp.	Not known	Asteraceae	H
22	*Artemisia vulgaris*	Not known	Asteraceae	H
23	*Asparagus filicinus* Buch.-Ham. ex D. Don	Ka-nyut	Asparagaceae	H
24	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae	ST
25	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae	S
26	*Bauhinia* sp.	Swe-daw	Caesalpiniaceae	CL
27	*Bidens pilosa*	Hmwe-sok	Asteraceae	H
28	*Blumea balsamifera*	Not known	Asteraceae	H
29	*Boerhavia diffusa* L.	Pa-yan-na-wa	Nyctaginaceae	H
30	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae	H
31	*Bombax ceiba* L.	Let-pan	Bombacaceae	T
32	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae	T
33	*Buddleja asiatica* Lour	Not known	Buddlejaceae	S
34	*Cananga latifolia*	Not known	Annonaceae	S

No.	Scientific Name	Common Name	Family Name	Habi t
35	*Cantharellus aurantiacus* (Wulf.)Fr.	Not known	Cantharelleae	Mu
36	*Carex brizoides* L.	Taw-kyet-le-hlee	Cyperaceae	H
37	*Careya arborea* Roxb.	Ban-bwe	Lecythidaceae	T
38	*Cassia fistula* L.	Ngu	Caesalpiniaceae	T
39	*Chenopodium acuminatum* subsp. virgatum	Not known	Chenopodiaceae	H
40	*Chromolaena odorata* (L.) R.M. King & H Robinson	Bi-zet	Asteraceae	S
41	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae	ST
42	*Cissus hastata* Miq.	Sa-pyit-yaing	Vitaceae	CL
43	*Clerodendrum villosum* Blume	Phet-kha	Verbenaceae	S
44	*Collybia cirrhata*	Not known	Tricholomataceae	Mu
45	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae	ST
46	*Crateva magna* (Lour.) DC.	Ka-det	Capparaceae	ST
47	*Crotalaria multiflora* L.	Taw-paik-san	Fabaceae	H
48	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae	ST
49	*Cymbidium aloifolium* (L.)Sw.	Thit-tat-lin-nay	Orchidaceae	E
50	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae	G
51	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	T
52	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae	ST
53	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	T
54	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	B
55	*Desmodium rufihirsutum* Craib	Not known	Fabaceae	S
56	*Desmodium triangulare* (Retz.) Merr.	Not known	Fabaceae	S
57	*Dichanthium caricosum* (L.)A.Camus	Pa-daw-myet	Poaceae	G
58	*Dichrocephala integrifolia (*L.f.)Kuntze	Not known	Asteraceae	H
59	*Dicliptera neesii* Trimen.	Not known	Acanthaceae	S
60	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae	CL
61	*Dioscorea cylindrica* Burm.	Kyway-thon-ywet	Dioscoreaceae	CL
62	*Dioscorea pentaphylla* L.	Kyway-ngar-ywet	Dioscoreaceae	CL
63	*Diospyros kaki* L.f.	Tae	Ebenaceae	T
64	*Dracaena sanderiana*	Zaw-sein	Asparagaceae	H
65	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae	F
66	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae	T
67	*Eclipta alba* (L.) Hassk.	Kyeik-hman	Asteraceae	H
68	*Elaeocarpus hainanensis* Oliv.	Kywe-pan-pin	Elaeocarpaceae	ST
69	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae	G
70	*Entada scandens* Benth.	Doe-nwee	Mimosaceae	CL
71	*Equisetum hyemale*	Not known	Equisetaceae	H
72	*Erythrina stricta* Roxb.	Ka-thit	Fabaceae	ST
73	*Eugenia densiflora* DC.	Kyauk-tha-bye	Myrtaceae	ST
74	*Euphorbia antiquorum* L.	Tazaung-gyi	Euphorbiaceae	S
75	*Euphorbia hypericifolia* L.	Kywe-kyaung-hmin-se	Euphorbiaceae	H

No.	Scientific Name	Common Name	Family Name	Habit
76	*Ficus glomerata* Roxb.	Ye-tha-phan	Moraceae	T
77	*Ficus hispida* L.	Kha-aung	Moraceae	ST
78	*Ficus pumila* L.	Creeping fig.	Moraceae	S
79	*Ficus racemosa*	Not known	Moraceae	T
80	*Ficus variegate*	Kon-tha-phan	Moraceae	T
81	*Flacourtia cataphracta* Roxb.	Na-ywe	Flacourtiaceae	T
82	*Flueggea leucopyrus* Willd	Ye-chin-ya	Euphorbiaceae	S
83	*Fomes fomentarius*	Not known	Polyporaceae	Mu
84	*Ganoderma austral*	Not known	Ganodermataceae	Mu
85	*Garcinia cowa* Roxb.	Taung-tha-lae	Hypericaceae	ST
86	*Gardenia coronaria* Buch-Ham.	Yin-khat-gyi	Rubiaceae	ST
87	*Globba pendula*	Pa-dein-ngo-thay	Zingiberaceae	H
88	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae	T
89	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae	ST
90	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae	S
91	*Heliotropium indicum* L.	Sin-hna-maung	Boraginaceae	H
92	*Hibiscus ficulneus* L.	Taw-yon-pade	Malvaceae	S
93	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	ST
94	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	ST
95	*Hydrocotyle sibthorpioides* Thunb	Myin-khwa	Apiaceae	H
96	*Hygrophorus limacinus*	Not known	Hygrophoraceae	Mu
97	*Hypericum japonicum* Thunb. ex Murray	Not known	Hypericaceae	H
98	*Hypholoma incertum* Pk.	Not known	Microthyriaceae	Mu
99	*Inonotus hispidus*	Not known	Hymenochaetaceae	Mu
100	*Lagerstroemia speciosa* (L.) Pers.	Pyin-ma	Lythraceae	T
101	*Lannea coromandelica* (Houtt.) Merrr.	Na-be	Anacardiaceae	T
102	*Leea hirta* Banks	Naga-mauk-aphu	Leeaceae	ST
103	*Lentinus squarrosulus*	Not known	Polyporaceae	Mu
104	*Leucaena leucocephala* (Lam.) De.Wit	Baw-sa-gaing	Mimosaceae	ST
105	*Ludwigia hyssopifolia*	Lay-nyin-thay	Onagraceae	H
106	*Luffa aegyptiaca* Mill.	Tha-but	Cucurbitaceae	CL
107	*Lygodium japonicum*(Thunb.)Sw.	Not known	Lygodiaceae	F
108	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae	T
109	*Markhamia stipulata* (Wall.) Seem. Ex K.Schum.	Ma-hlwa	Bignoniaceae	T
110	*Mesua ferrea* L.	Taw-gan-gaw	Hypericaceae	ST
111	*Microporus xanthopus* (Fr.) Kuntze	Not known	Polyporaceae	Mu
112	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae	CL

No.	Scientific Name	Common Name	Family Name	Habit
113	*Millettia extensa* Benth.	Win-u	Fabaceae	CL
114	*Millettia ovalifolia* Kurz	Thin-win	Fabaceae	T
115	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	H
116	*Morus indica* L.	Po-sa	Moraceae	ST
117	*Myriopteron paniculatum* Griff	Ti-lay-na-tha	Asclepiadaceae	CL
118	*Nervilia plicata*	Tabin-ting-shwe-hti	Orchidaceae	H
119	*Oxalis corniculata* L.	Hmo-chin	Oxalidaceae	H
120	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae	B
121	*Pandanus odoratissimus* L.f.	Sat-tha-phu	Pandanaceae	ST
122	*Passiflora foetida* L.	Taw-su-ka	Passifloraceae	CL
123	*Pennisetum purpureum*	Yon-sa-myet	Poaceae	G
124	*Persicaria odorata*	Kywe-hna-khaung-gyate	Polygonaceae	H
125	*Pholiota flammas* Pk	Hmo	Strophariaceae	Mu
126	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	ST
127	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae	H
128	*Physalis minima* L.	Bauk-thi	Solanaceae	H
129	*Pleurotus cornucopiae*	Not known	Pleurotaceae	Mu
130	*Ploiarium alternifolium*	Not known	Theaceae	S
131	*Polyalthia viridis*	Not known	Annonaceae	T
132	*Polygonum plebeium*	Not known	Polygonaceae	H
133	*Pseuderanthemum polyanthum*	Not known	Acanthaceae	H
134	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	T
135	*Pterospermum diversifolium*	Not known	Sterculiaceae	T
136	*Rumex crispus* L.	Not known	Polygonaceae	H
137	*Rumex trisetiferus* Stokes	Not known	Polygonaceae	H
138	*Saccharum spontaneum* L.	Kaing	Poaceae	G
139	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae	T
140	*Schima wallichii* (DC.) Korth.	Lauk-ya	Theaceae	T
141	*Schizophyllum commune*	Not known	Schizophyllaceae	Mu
142	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	T
143	*Scoparia dulcis* L.	Dana-thu-kha	Scrophulariaceae	H

No.	Scientific Name	Common Name	Family Name	Habit
144	*Selaginella willdenowii*	Not known	Selaginellaceae	F
145	*Senna hirsuta* (L.) Irwin & Barneby	Ka-thaw-hmwe-htu	Caesalpiniaceae	S
146	*Senna tora* (L.) Roxb	Dan-gwe	Caesalpiniaceae	S
147	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	T
148	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	T
149	*Solanum aculeatissimum* Jacq.	Not known	Solanaceae	H
150	*Solanum indicum* L.	Ka-zaw-kha	Solanaceae	S
151	*Solanum nigrum* L.	Baung-laung-nyo	Solanaceae	S
152	*Solanum torvum* Swartz	Kha-yan-ka-zawt	Solanaceae	S
153	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae	T
154	*Stemona burkillii* Prain	Tha-mya	Stemonaceae	H
155	*Sterculia villosa*	Shaw	Sterculiaceae	T
156	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae	T
157	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae	CL
158	*Tanacetum tibeticum* Hook.f. & Thomson	Not known	Asteraceae	H
159	*Taraxacum officinale*	Not known	Asteraceae	H
160	*Tectona grandis* L. f.	Kyun	Verbenaceae	T
161	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae	T
162	*Terminalia oliveri* Brandis	Than	Combretaceae	T
163	*Tetrameles nudiflora* R.Br.	Thit-pok	Datiscaceae	T
164	*Thyrsostachys oliveri* Gamble	Tha-net-wa	Poaceae	B
165	*Trametes versicolor*	Taung-po-hmo	Polyporaceae	Mu
166	*Tylophora indica*	Not known	Apocynaceae	H
167	*Vangueria spinosa* Roxb.	Ma-gyi-bauk	Rubiaceae	ST
168	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae	ST
169	*Vitex vestita* Wall.	Tauk-sha	Verbenaceae	ST
170	*Wrightia arborea* (Dennst.) Mabb.	Let-htok-thein	Apocynaceae	ST
171	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	ST
B=Bamboo,CL=Climber,E=Epiphyte,F=Fern, G=Grass,H=Herbs,Mu=Mushroom,S=Shrubs,ST=Small Tree, T=Tree				

Table 15: Right Bank and Left Bank Species

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
1	*Abelmoschus moschatus*	Taw-yon-pa-de	Malvaceae	√	
2	*Abutilon indicum*	Bauk-khwe	Malvaceae	√	
3	*Acacia concinna* (Willd.) DC.	Ka-mon-chin	Mimosaceae	√	√
4	*Acacia intsia* Willd.	Su-bok	Mimosaceae	√	√
5	*Acer laurinum* Hassk.	Not known	Aceraceae	√	√
6	*Acer negunda*	Not known	Aceraceae	√	√
7	*Acmella calva* (DC.) R.K. Jansen	Pe-le-nyin	Asteraceae	√	√
8	*Adenostemma viscosum*	Not known	Asteraceae	√	√
9	*Adiantum latifolium*	Not known	Pteridaceae	√	
10	*Adiantum peruvianum*	Not known	Pteridaceae	√	
11	*Adiantum tenerum*	Not known	Pteridaceae	√	
12	*Agaricus silvicola*	Not known	Agaricaceae		√
13	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae	√	√
14	*Albatrellus ovinus*	Not known	Albatrellaceae		√
15	*Albizia chinensis* (Osbeck)Merr.	Bom-me-za	Mimosaceae	√	√
16	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae	√	√
17	*Alphonsea boniana*	Not known	Annonaceae		√
18	*Alstonia scholaris*(L.) R. Br.	Taung-ma-yoe	Apocynaceae	√	√
19	*Alternanthera nodiflora* R.Br.	Ka-na-phaw-yaing	Amaranthaceae	√	√
20	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	√	√
21	*Amaranthus gracilis* Desf.	Hin-nu-nwe-yaing	Amaranthaceae	√	√
22	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae	√	√
23	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Wa-u	Araceae	√	
24	*Anogeissus acuminata* Wall.	Yon	Combretaceae	√	√
25	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae	√	
26	*Argyreia nervosa* (Burm.f.)Bojer	Kazun-gyi	Convolvulaceae	√	√
27	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae		√
28	*Artemisia* sp.	Not known	Asteraceae	√	√
29	*Artemisia vulgaris*	Not known	Asteraceae		√
30	*Asparagus filicinus* Buch.-Ham. ex D. Don	Ka-nyut	Asparagaceae	√	√
31	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae	√	√
32	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae	√	√
33	*Bauhinia* sp.	Swe-daw	Caesalpiniaceae	√	√
34	*Bidens pilosa*	Hmwe-sok	Asteraceae	√	√
35	*Blumea balsamifera*	Not known	Asteraceae	√	√
36	*Boerhavia chinensis* (L.) Asch. & Schw.	Not known	Nyctaginaceae	√	
37	*Boerhavia coccinea*	Pa-yan-na-war	Nyctaginaceae	√	
38	*Boerhavia diffusa* L.	Pa-yan-na-wa	Nyctaginaceae		√
39	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae		√
40	*Bombax ceiba* L.	Let-pan	Bombacaceae	√	√
41	*Bombax insigne* Wall.	De-du	Bombacaceae	√	

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
42	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae		√
43	*Buddleja asiatica* Lour	Not known	Buddlejaceae	√	√
44	*Calotropis gigantea* (L.) Dryand. ex W.T. Aiton	Ma-yoe-gyi	Asclepiadaceae	√	
45	*Calycopteris floribunda* Lam.	Kyun-khaung-nwee	Combretaceae	√	
46	*Cananga latifolia*	Not known	Annonaceae	√	√
47	*Canavalia cathartica*	Not known	Fabaceae	√	
48	*Cantharellus aurantiacus* (Wulf.)Fr.	Not known	Cantharelleae		√
49	*Carex brizoides* L.	Taw-kyet-le-hlee	Cyperaceae		√
50	*Careya arborea* Roxb.	Ban-bwe	Lecythidaceae	√	√
51	*Carissa spinarum* A. DC.	Taw-khan-pin	Apocynaceae	√	
52	*Cassia fistula* L.	Ngu	Caesalpiniaceae	√	√
53	*Celosia argentea* L.	Taw-kyet-mauk	Amaranthaceae	√	
54	*Chenopodium acuminatum* subsp. virgatum	Not known	Chenopodiaceae	√	√
55	*Chromolaena odorata* (L.) R.M. King & H Robinson	Bi-zet	Asteraceae	√	√
56	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae	√	√
57	*Cibotium barometz* (Linn.) J. Sm.	Da-yin-kauk	Dicksoniaceae	√	
58	*Cissus hastata* Miq.	Sa-pyit-yaing	Vitaceae	√	√
59	*Claoxylon indicum* Hassk.	Not known	Euphorbiaceae	√	
60	*Clerodendrum villosum* Blume	Phet-kha	Verbenaceae	√	√
61	*Collybia cirrhata*	Not known	Tricholomataceae		√
62	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae	√	√
63	*Commelina persicariaefolia* Wright.	Wet-kyut	Commelinaceae	√	
64	*Corchorus olitorius* L.	Pi-law-yaing	Tiliaceae	√	
65	*Crateva magna* (Lour.) DC.	Ka-det	Capparaceae	√	√
66	*Crotalaria multiflora* L.	Taw-paik-san	Fabaceae		√
67	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae	√	√
68	*Cymbidium aloifolium* (L.)Sw.	Thit-tat-lin-nay	Orchidaceae		√
69	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae	√	√
70	*Dactyloctenium aegyptium* (L.) Willd.	Myet-lay-gwa	Poaceae	√	
71	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	√	√
72	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae	√	√
73	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	√	√
74	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	√	√
75	*Desmodium gangeticum* L.	Not known	Fabaceae	√	
76	*Desmodium rufihirsutum* Craib	Not known	Fabaceae		√
77	*Desmodium triangulare* (Retz.) Merr.	Not known	Fabaceae	√	√
78	*Dichanthium caricosum* (L.)A.Camus	Pa-daw-myet	Poaceae	√	√
79	*Dichrocephala integrifolia* (L.f.)Kuntze	Not known	Asteraceae	√	√
80	*Dicliptera neesii* Trimen.	Not known	Acanthaceae	√	√
81	*Dioscorea alata*	Myauk-u	Dioscoreaceae	√	
82	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae	√	√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
83	*Dioscorea cylindrica* Burm.	KYwary-thon-ywet	Dioscoreaceae	√	√
84	*Dioscorea pentaphylla* L.	Kyway-ngar-ywet	Dioscoreaceae	√	√
85	*Diospyros kaki* L.f.	Tae	Ebenaceae	√	√
86	*Dracaena sanderiana*	Zaw-sein	Asparagaceae		√
87	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae	√	√
88	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae	√	√
89	*Eclipta alba* (L.) Hassk.	Kyeik-hman	Asteraceae		√
90	*Elaeocarpus hainanensis* Oliv.	Kywe-pan-pin	Elaeocarpaceae	√	√
91	*Elatostema reticulatum*	Wet-sa	Urticaceae	√	
92	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae	√	√
93	*Entada scandens* Benth.	Doe-nwee	Mimosaceae	√	√
94	*Equisetum hyemale*	Not known	Equisetaceae	√	√
95	*Eragrostis tef* (Zucc.)Trotter	Myet	Poaceae	√	
96	*Erythrina stricta* Roxb.	Ka-thit	Fabaceae	√	√
97	*Eugenia densiflora* DC.	Kyauk-tha-bye	Myrtaceae	√	√
98	*Euphorbia antiquorum* L.	Tazaung-gyi	Euphorbiaceae	√	√
99	*Euphorbia heterophylla*	Sae-pa-le	Euphorbiaceae	√	
100	*Euphorbia hypericifolia* L.	Kywe-kyaung-hmin-se	Euphorbiaceae	√	√
101	*Ficus glomerata* Roxb.	Ye-tha-phan	Moraceae		√
102	*Ficus hispida* L.	Kha-aung	Moraceae		√
103	*Ficus pumila* L.	Creeping fig.	Moraceae	√	√
104	*Ficus racemosa*	Tha-phan	Moraceae	√	√
105	*Ficus variegate*	Kon-tha-phan	Moraceae	√	√
106	*Flacourtia cataphracta* Roxb.	Na-ywe	Flacourtiaceae		√
107	*Flueggea leucopyrus* Willd	Ye-chin-ya	Euphorbiaceae	√	√
108	*Fomes fomentarius*	Not known	Polyporaceae		√
109	*Ganoderma austral*	Not known	Ganodermataceae		√
110	*Garcinia cowa* Roxb.	Taung-tha-lae	Hypericaceae		√
111	*Gardenia coronaria* Buch-Ham.	Yin-khat-gyi	Rubiaceae		√
112	*Getonia floribunda* Roxb.	Kywet-nwee	Combretaceae	√	
113	*Globba patens*	Pa-dein-ngo	Zingiberaceae	√	
114	*Globba pendula*	Pa-dein-ngo-thay	Zingiberaceae		√
115	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae		√
116	*Gonostegia hirta*	Not known	Rubiaceae	√	
117	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae		√
118	*Habenaria chlorina* Par. & Rchb.f.	Not known	Orchidaceae	√	
119	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae	√	√
120	*Helicteres angustifolia* L.	Not known	Sterculiaceae	√	
121	*Heliotropium indicum* L.	Sin-hna-maung	Boraginaceae	√	√
122	*Hemigraphis repanda*	Not known	Acanthaceae	√	
123	*Hibiscus ficulneus* L.	Taw-yon-pade	Malvaceae	√	√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
124	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	√	√
125	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	√	√
126	*Hydrocotyle sibthorpioides* Thunb	Myin-khwa	Apiaceae	√	√
127	*Hygrophorus limacinus*	Not known	Hygrophoraceae		√
128	*Hypericum japonicum* Thunb. ex Murray	Not known	Hypericaceae	√	√
129	*Hypholoma incertum* Pk.	Not known	Microthyriaceae		√
130	*Inonotus hispidus*	Not known	Hymenochaetaceae		√
131	*Lagerstroemia speciosa* (L.) Pers.	Pyin-ma	Lythraceae	√	√
132	*Lannea coromandelica* (Houtt.) Merrr.	Na-be	Anacardiaceae	√	√
133	*Lantana camara* L.	Sein-na-pan	Verbenaceae	√	
134	*Leea hirta* Banks	Naga-mauk-aphu	Leeaceae	√	√
135	*Lentinus squarrosulus*	Not known	Polyporaceae		√
136	*Leucaena leucocephala* (Lam.) De.Wit	Baw-sa-gaing	Mimosaceae	√	√
137	*Lithocarpus craibianus* Barnett	Thit-ae	Fagaceae	√	
138	*Ludwigia hyssopifolia*	Lay-nyin-thay	Onagraceae	√	√
139	*Ludwigia octovalvis*	Lay-nyin-gyi	Onagraceae	√	
140	*Luffa aegyptiaca* Mill.	Tha-but	Cucurbitaceae		√
141	*Lygodium circinnatum*	Not known	Lygodiaceae	√	
142	*Lygodium japonicum*(Thunb.)Sw.	Not known	Lygodiaceae		√
143	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae	√	√
144	*Markhamia stipulata* (Wall.) Seem. Ex K.Schum.	Ma-hlwa	Bignoniaceae		√
145	*Merremia vitifolia* (Burm.f.) Hallier. f.	Kyet-hinga-lae-new	Convolvulaceae	√	
146	*Mesua ferrea* L.	Taw-gan-gaw	Hypericaceae	√	√
147	*Microporus xanthopus* (Fr.) Kuntze	Hmo	Polyporaceae	√	√
148	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae	√	√
149	*Millettia extensa* Benth.	Win-u	Fabaceae	√	√
150	*Millettia ovalifolia* Kurz	Thin-win	Fabaceae	√	√
151	*Mimosa pudica* L.	Hti-ka-yon	Mimosaceae	√	√
152	*Morus indica* L.	Po-sa	Moraceae	√	√
153	*Myriopteron paniculatum* Griff	Ti-lay-nantha	Asclepiadaceae	√	√
154	*Nervilia plicata*	Tabin-ting-shwe-hti	Orchidaceae	√	√
155	*Operculina turpethum* (L.) Silva Mansa	Kyar-hin-nwee	Convolvulaceae	√	
156	*Oxalis corniculata* L.	Hmo-chin	Oxalidaceae	√	√
157	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae	√	√
158	*Pandanus odoratissimus* L.f.	Sat-tha-phu	Pandanaceae	√	√
159	*Passiflora foetida* L.	Taw-su-ka	Passifloraceae	√	√
160	*Pennisetum purpureum*	Yon-sa-myet	Poaceae	√	√
161	*Peperomia pellucida*	Thit-ye-kyi	Piperaceae	√	
162	*Pericampylus glaucus* L.	Not known	Menispermaceae	√	
163	*Peristrophe roxburghiana*	Not known	Acanthaceae	√	

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
164	*Persicaria odorata*	Kywe-hna-khaung-gyate	Polygonaceae	√	√
165	*Pholiota flammas* Pk.	Hmo	Strophariaceae	√	√
166	*Phyllanthus amarus*	Myay-zi-phyu	Euphorbiaceae	√	
167	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	√	√
168	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae	√	√
169	*Physalis minima* L.	Bauk-thi	Solanaceae	√	√
170	*Pleurotus cornucopiae*	Not known	Pleurotaceae		√
171	*Ploiarium alternifolium*	Not known	Theaceae	√	√
172	*Polyalthia viridis*	Not known	Annonaceae		√
173	*Polygonum plebeium*	Not known	Polygonaceae	√	√
174	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	√	
175	*Pseuderanthemum polyanthum*	Not known	Acanthaceae		√
176	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	√	√
177	*Pterospermum acerifolium*	Not known	Sterculiaceae	√	
178	*Pterospermum diversifolium*	Not known	Sterculiaceae	√	√
179	*Rumex crispus* L.	Not known	Polygonaceae	√	√
180	*Rumex trisetiferus* Stokes	Not known	Polygonaceae	√	√
181	*Saccharum spontaneum* L.	Kaing	Poaceae	√	√
182	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae	√	√
183	*Schima wallichii* (DC.) Korth.	Lauk-ya	Theaceae	√	√
184	*Schizophyllum commune*	Not known	Schizophyllaceae	√	√
185	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	√	√
186	*Scindapsus officinalis* (Roxb.) Schott	Sin-peik-chin	Araceae	√	
187	*Scoparia dulcis* L.	Dana-thu-kha	Scrophulariaceae	√	√
188	*Scurrula parasitica* L.	Kyi-paung	Loranthaceae	√	
189	*Selaginella willdenowii*	Not known	Selaginellaceae	√	√
190	*Senna hirsuta* (L.) Irwin & Barneby	Ka-thaw-hmwe-htu	Caesalpiniaceae	√	√
191	*Senna tora* (L.) Roxb	Dan-gwe	Caesalpiniaceae	√	√
192	*Setaria palmifolia* Stapf.	Myet	Poaceae	√	
193	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae		√
194	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	√	√
195	*Solanum aculeatissimum* Jacq.	Not known	Solanaceae	√	√
196	*Solanum indicum* L.	Ka-zaw-kha	Solanaceae	√	√
197	*Solanum nigrum* L.	Baung-laung-nyo	Solanaceae		√
198	*Solanum torvum* Swartz	Kha-yan-ka-zawt	Solanaceae	√	√
199	*Spermacoce remota*	Not known	Rubiaceae	√	
200	*Spirogyra* sp.	Algae	Zygnemataceae	√	
201	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae		√
202	*Stemona burkillii* Prain	Tha-mya	Stemonaceae		√
203	*Sterculia foetida* L.	Shaw-phyu	Sterculiaceae	√	
204	*Sterculia villosa*	Shaw	Sterculiaceae		√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
205	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae	√	√
206	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae	√	√
207	*Tanacetum tibeticum* Hook.f. & Thomson	Not known	Asteraceae	√	√
208	*Taraxacum officinale*	Not known	Asteraceae	√	√
209	*Tectona grandis* L. f.	Kyun	Verbenaceae	√	√
210	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae		√
211	*Terminalia oliveri* Brandis	Than	Combretaceae	√	√
212	*Tetrameles nudiflora* R.Br.	Thit-pok	Datiscaceae	√	√
213	*Tetrastigma leucostaphylum*	Not known	Vitaceae	√	
214	*Thyrsostachys oliveri* Gamble	Tha-net-wa	Poaceae		√
215	*Tithonia diversifolia* A. Gray	Nay-kyar-yaing	Asteraceae	√	
216	*Trametes versicolor*	Taung-po-hmo	Polyporaceae	√	√
217	*Tylophora indica*	Not known	Apocynaceae	√	√
218	*Vangueria spinosa* Roxb.	Ma-gyi-bauk	Rubiaceae		√
219	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae	√	√
220	*Vitex vestita* Wall.	Tauk-sha	Verbenaceae		√
221	*Wrightia arborea* (Dennst.) Mabb.	Let-htok-thein	Apocynaceae		√
222	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	√	√

3.2.3. Tree Species

A total of 14 tree species belonging to 13 genera were identified in two sample plots in research area two. The dominant tree species in this area are *Sterculia villosa* (shaw) followed by *Shorea siamensis* (Kurz)Miq. (In-gyin), and *Shorea obtusa* Wall. (Thit-ya), *Xylia xylocarpa* (Roxb.) Taub., (Pyin-ka-doe).

Table 16: Tree Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Bombax ceiba* L.	1	5.56	1.37
2	*Buchanania latifolia* Roxb.	1	5.56	1.37
3	*Flacourtia cataphracta* Roxb.	1	5.56	1.37
4	*Garcinia cowa* Roxb.	1	5.56	1.37
5	*Holarrhena pubescens* Wall. ex G. Don	1	5.56	1.37
6	*Millettia ovalifolia* Kurz	1	5.56	1.37
7	*Samadera indica* Gaertn.	1	5.56	1.37
8	*Shorea obtusa* Wall.	9	50.00	12.33
9	*Shorea siamensis*(Kurz)Miq.	15	83.33	20.55
10	*Spondias pinnata* (L. f.) Kurz.	1	5.56	1.37

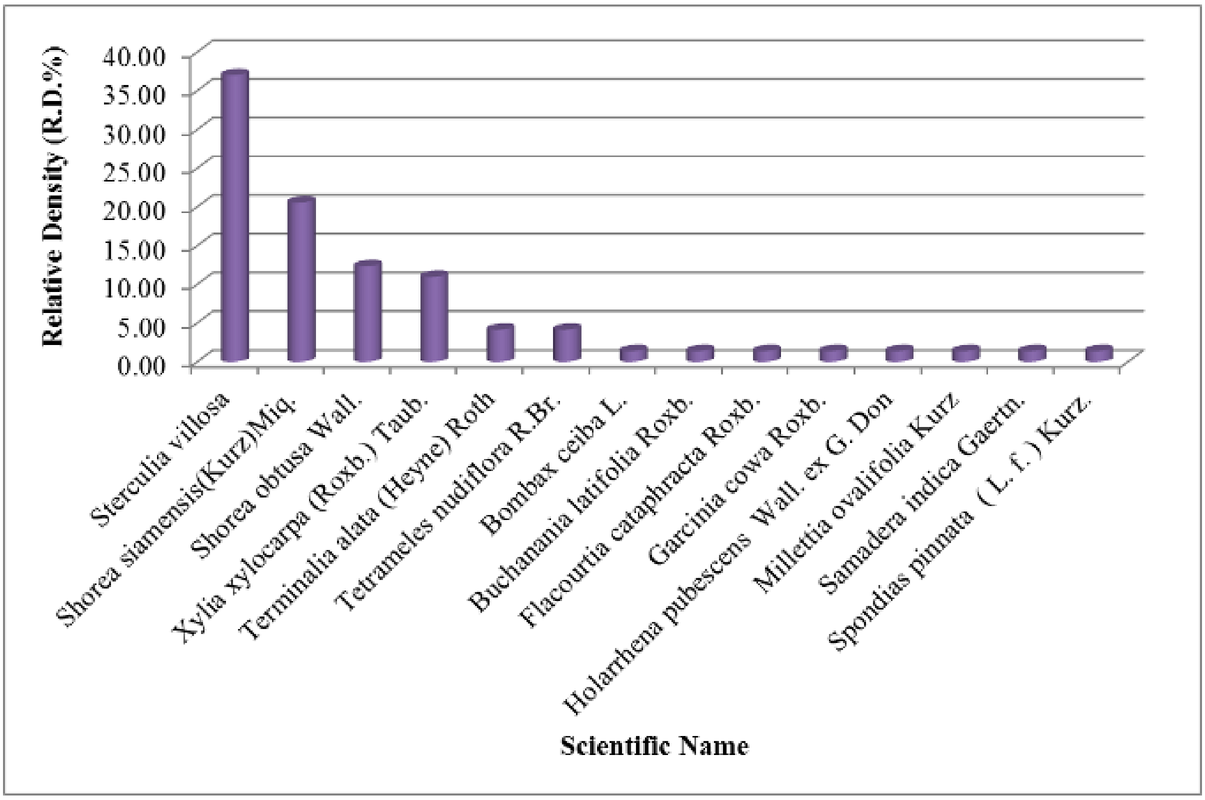
11	*Sterculia villosa*	27	150.00	36.99
12	*Terminalia alata* (Heyne) Roth	3	16.67	4.11
13	*Tetrameles nudiflora* R.Br.	3	16.67	4.11
14	*Xylia xylocarpa* (Roxb.) Taub.	8	44.44	10.96
	Total	**73**	**405.56**	**100.00**

Among the sample plots, the species density per hectare is varied and the highest density is observed *Sterculia villosa*, *Shorea siamensis* (Kurz)Miq., *Shorea obtusa* Wall., and *Xylia xylocarpa* (Roxb.) Taub., followed by *Terminalia alata* (Heyne) Roth, and *Tetrameles nudiflora* R.Br.,. This shows that these six species are abundant in this area.

Table 17: Tree Species Relative Density

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Sterculia villosa*	13.5	36.99
2	*Shorea siamensis*(Kurz)Miq.	7.5	20.55
3	*Shorea obtusa* Wall.	4.5	12.33
4	*Xylia xylocarpa* (Roxb.) Taub.	4	10.96
5	*Terminalia alata* (Heyne) Roth	1.5	4.11
6	*Tetrameles nudiflora* R.Br.	1.5	4.11
7	*Bombax ceiba* L.	0.5	1.37
8	*Buchanania latifolia* Roxb.	0.5	1.37
9	*Flacourtia cataphracta* Roxb.	0.5	1.37
10	*Garcinia cowa* Roxb.	0.5	1.37
11	*Holarrhena pubescens* Wall. ex G. Don	0.5	1.37
12	*Millettia ovalifolia* Kurz	0.5	1.37
13	*Samadera indica* Gaertn.	0.5	1.37
14	*Spondias pinnata* (L. f.) Kurz.	0.5	1.37

Chart 4: Tree Species Relative Density

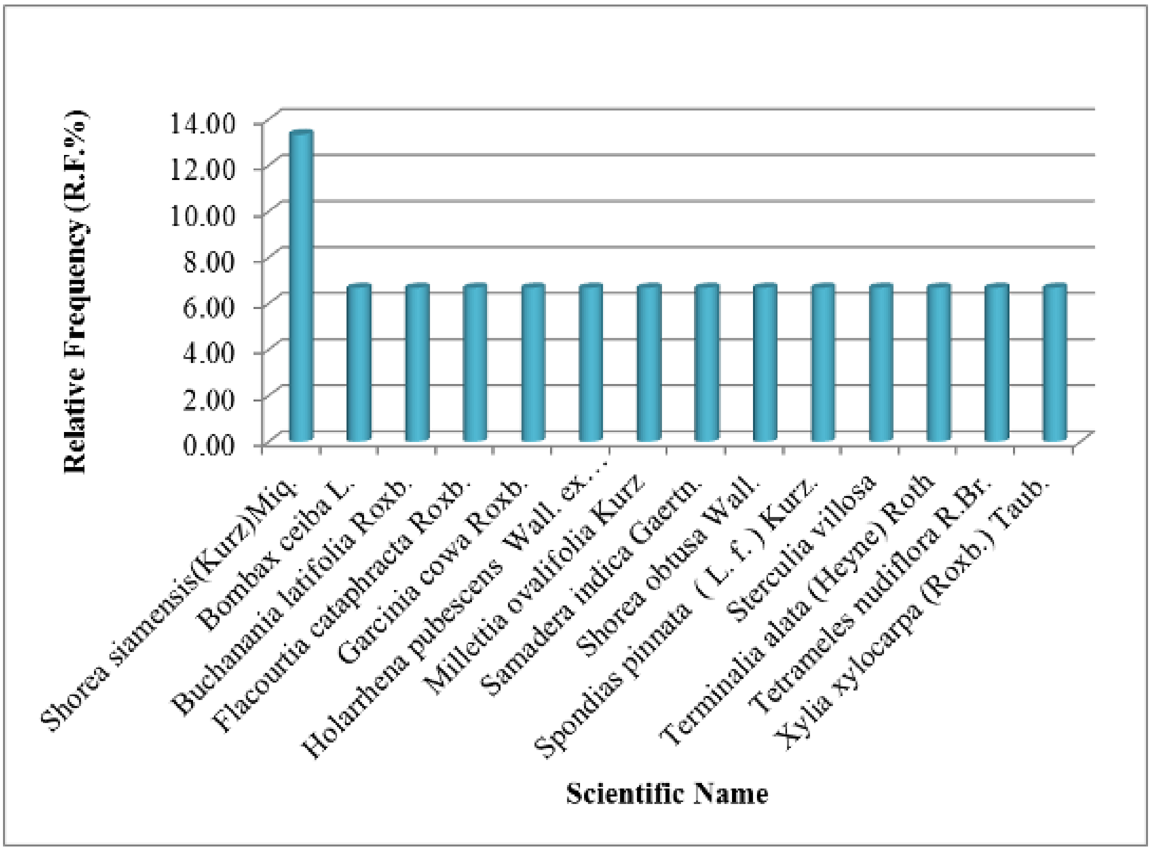


Relative frequency is the frequency of one species compared to the total frequency of all the species. According to the results**,** *Shorea siamensis* (Kurz)Miq., is high relative frequency value (13%). Therefore, these species are occurred everywhere in the study area. The lower frequencies of other species are demarcated as rare species in the area.

Table 18: Relative Frequency

No.	Scientific Name	Frequency (F)	Relative Frequency (R.F.%)
1	*Shorea siamensis*(Kurz)Miq.	1	13.33
2	*Bombax ceiba* L.	0.5	6.67
3	*Buchanania latifolia* Roxb.	0.5	6.67
4	*Flacourtia cataphracta* Roxb.	0.5	6.67
5	*Garcinia cowa* Roxb.	0.5	6.67
6	*Holarrhena pubescens* Wall. ex G. Don	0.5	6.67
7	*Millettia ovalifolia* Kurz	0.5	6.67
8	*Samadera indica* Gaertn.	0.5	6.67
9	*Shorea obtusa* Wall.	0.5	6.67
10	*Spondias pinnata* (L. f.) Kurz.	0.5	6.67
11	*Sterculia villosa*	0.5	6.67
12	*Terminalia alata* (Heyne) Roth	0.5	6.67
13	*Tetrameles nudiflora* R.Br.	0.5	6.67
14	*Xylia xylocarpa* (Roxb.) Taub.	0.5	6.67

Chart 5: Tree Species Relative Frequency



3.2.4. Orchid Species

Cymbidium aloifolium (L.)Sw.

Nervilia plicata

Table 19: Orchid Species

No.	Scientific Name	Common Name	Family Name
1	*Cymbidium aloifolium* (L.)Sw.	Thit-tat-lin-nay	Orchidaceae
2	*Nervilia plicata*	Tabin-ting-shwe-hti	Orchidaceae

3.2.5. Mushroom Species

Pholiota flammas Pk

Hypholoma incertum Pk.

Table 20: Mushroom Species

No.	Scientific Name	Common Name	Family Name
1	*Agaricus silvicola*	Not known	Agaricaceae
2	*Albatrellus ovinus*	Not known	Albatrellaceae
3	*Cantharellus aurantiacus* (Wulf.)Fr.	Not known	Cantharelleae
4	*Collybia cirrhata*	Not known	Tricholomataceae
5	*Fomes fomentarius*	Not known	Polyporaceae
6	*Ganoderma austral*	Not known	Ganodermataceae
7	*Hygrophorus limacinus*	Not known	Hygrophoraceae
8	*Hypholoma incertum* Pk.	Not known	Microthyriaceae
9	*Inonotus hispidus*	Not known	Hymenochaetaceae
10	*Lentinus squarrosulus*	Not known	Polyporaceae
11	*Microporus xanthopus* (Fr.) Kuntze	Not known	Polyporaceae
12	*Pholiota flammas* Pk	Hmo	Strophariaceae
13	*Pleurotus cornucopiae*	Not known	Pleurotaceae
14	*Schizophyllum commune*	Not known	Schizophyllaceae
15	*Trametes versicolor*	Taung-po-hmo	Polyporaceae

3.2.6. Flora IUCN Status

Of the flora species identified on the left bank research area two, 12 species are on the IUCN Red List. They are listed below. Most notably, *Dalbergia oliveri* Gamble is classified as EN A1cd and *Dalbergia cultrata* Grah.is classified as NT. The other 10 species are classified as species of least concern or low risk/least concern.

Table 21: Threatened Flora Species

No.	Scientific Name	Common Name	Family Name	IUCN Status
1	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae	LC
2	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	NT

3	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	EN A1cd
4	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	LC
5	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	LC
6	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	LC
7	*Ludwigia hyssopifolia*	Lay-nyin-thay	Onagraceae	LC
8	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae	LR/Lc
9	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	LC
10	*Saccharum spontaneum* L.	Kaing	Poaceae	LC
11	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	LR/Lc
12	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/Lc
EN=Endangered, LC=Least Concern, LR/Lc=Lower Risk/Least concern, NT=Near Threatened				

Boesenbergia rotunda (L.) Mansf.

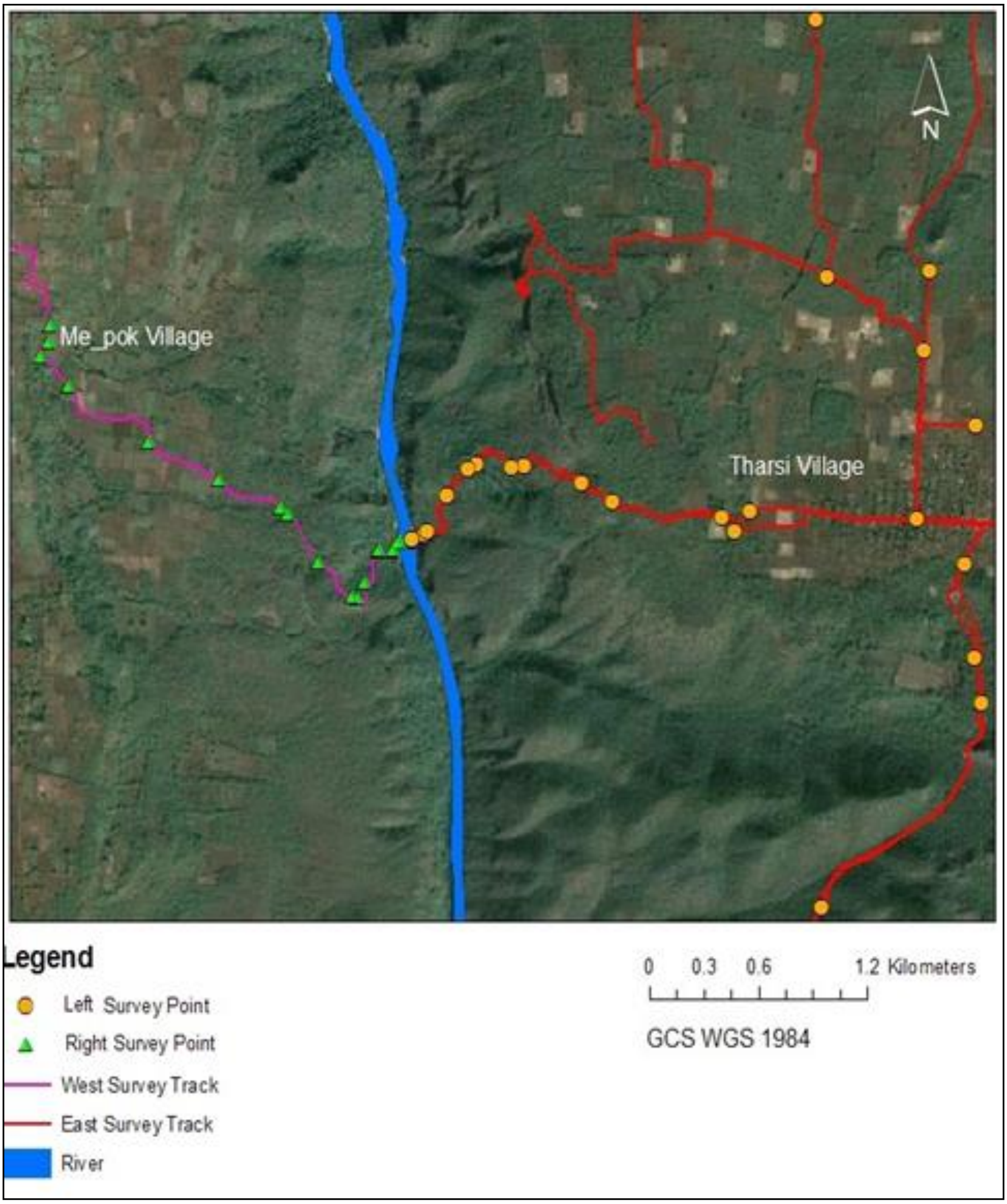
Dendrocalamus membranaceus Munro

Homonoia riparia

Ludwigia hyssopifolia

3.3. Research Area Three

Map 6: Research Area Three



Map 7: Reservoir Elevation Line

(*Right Bank Forest)* *(Left Bank Forest)*

3.3.1. Quadrant Location and Vegetation Type

A total of 13 sample plots were taken in the left bank research area three. Vegetation in each of the plots consisted solely of Indine forest. Relevant data is summarized in the table below.

Table 22: Research Area Three Sample Plots

No.	Sample Quadrant	Vegetation type	Latitude/Longitude	Altitude(m)	Dominant species
1	KGQ XIII	Indine Forest	N22 06 15.5 E96 59 08.3	692	*Shorea obtusa* Wall., *Buchanania latifolia* Roxb. ,*Shorea siamensis*(Kurz)Miq., *Dalbergia oliveri* Gamble, *Grewia eriocarpa* Juss., *Terminalia alata* (Heyne) Roth, *Dipterocarpus*
2	KGQ XIV	Indine & Bamboo Forest	N22 06 21.1 E96 58 50.3	472	
3	KGQ XV	Indine & Bamboo Forest	N22 06 20.7 E96 58 42.6	452	
4	KGQ XVI	Indine & Bamboo Forest	N22 06 10.7 E96 58 35.5	338	
5	KGQ XVII	Indine Forest	N22 05 50.6 E97 00 12.9	740	
6	KGQ XVIII	Indine & Bamboo Forest	N22 05 10.4 E96 59 45.7	634	

7	KGQ XIX	Indine & Bamboo Forest	N22 04 15.0 E96 59 32.1	538	*tuberculatus* Roxb., *Strychnos nux-blanda* A.W.Hill, *Sterculia villosa*, *Phyllanthus emblica* L.
8	KGQ XX	Indine & Bamboo Forest	N22 03 32.5 E96 59 38.8	495	
9	KGQ XXI	Indine & Bamboo Forest	N22 03 14.4 E96 59 19.1	473	
10	KGQ XXII	Bamboo Forest	N22 03 21.7 E96 59 26.9	483	
11	KGQ XXIII	Indine Forest	N22 03 21.0 E96 59 25.3	479	
12	KGQ XXIV	Indine & Bamboo Forest	N22 03 06.9 E96 59 13.0	405	
13	KGQ XXV	Indine & Bamboo Forest	N22 07 57.5 E96 58 46.6	668	

3.3.2. Flora Species on Left and Right Banks

A total of 176 flora species were identified in research area three on the left bank, compared to 113 on the right bank. There were 123 flora species found only on the left bank and 60 flora species found only on the right bank. 53 flora species were present on both banks. This yields a total of 236 flora species present on the left bank, right bank or both banks.

Table 23: Flora Species in Left Bank Research Area Three

No	Scientific Name	Common Name	Family Name	Habit
1	*Abelmoschus moschatus*	Taw-yon-pa-de	Malvaceae	S
2	*Acacia pennata* (L.)Willd.	Su-yit	Mimosaceae	CL
3	*Adiantum latifolium*	Not known	Pteridaceae	F
4	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae	H
5	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae	T
6	*Albizia procera* (Roxb.) Benth.	Thit-phyu	Mimosaceae	T
7	*Amalocalyx microlobus*	Not known	Apocynaceae	CL
8	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Wa-u	Araceae	H
9	*Anneslea fragrans* Wall.	Pan-ma	Theaceae	T
10	*Anogeissus acuminata* Wall.	Yon	Combretaceae	T
11	*Antidesma bunius*	Kin-ba-lin	Euphorbiaceae	S
12	*Aporusa dioica* (Roxb.) Mull.Arg.	Thit-khauk	Euphorbiaceae	ST
13	*Appendicula* sp.	Not known	Orchidaceae	E
14	*Ardisia* sp.	Kyet-ma-ok	Myrsinaceae	S
15	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae	CL
16	*Artemisia vulgaris*	Not known	Asteraceae	H
17	*Asparagus densiflorus*	Shint-ma-tet	Asparagaceae	CL
18	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae	ST
19	*Auricularia auricula-judae* (Bull.) J.Schröt.	Kywet-na-ywet-hmo	Auriculariaceae	Mu
20	*Bambusa tulda* Roxb.	Theik-wa	Poaceae	B
21	*Bauhinia racemosa* Lam.	Pha-lan/Hta-la	Caesalpiniaceae	ST
22	*Bauhinia* sp.	Swe-daw	Caesalpiniaceae	CL
23	*Begonia semperflorens*	Kyauk-chin-pan	Begoniaceae	H
24	*Berrya mollis*	Not known	Tiliaceae	T
25	*Bliospermum axillare* Blume	Hnut-cho	Euphorbiaceae	S
26	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae	H

No	Scientific Name	Common Name	Family Name	Habit
27	*Bombax ceiba* L.	Let-pan	Bombacaceae	T
28	*Brachycorythis galeandra* (Rchb.f.) Summerh.	Not known	Orchidaceae	E
29	*Brachycorythis helferi* (Rchb.f.) Summerh.	Not known	Orchidaceae	E
30	*Bridelia retusa* (L.) A. Juss.	Myauk-zi/Seik-chi	Euphorbiaceae	T
31	*Buchanania latifolia* Roxb.	Lun	Anacardiaceae	T
32	*Bulbophyllum* sp.	Not known	Orchidaceae	E
33	*Butea parviflora* L.	Pauk-home	Fabaceae	CL
34	*Butea superba* Roxb.	Pauk-nwee	Fabaceae	CL
35	*Calvatia gigantean* (Batsch.)Fr.	Not known	Agaricaceae	Mu
36	*Carex brizoides* L.	Taw-kyet-le-hlee	Cyperaceae	H
37	*Careya arborea* Roxb.	Ban-bwe	Lecythidaceae	T
38	*Cassia fistula* L.	Ngu	Caesalpiniaceae	T
39	*Celosia argentea* L.	Taw-kyet-mauk	Amaranthaceae	H
40	*Chromolaena odorata* (L.) R.M. King & H Robinson	Bi-zet	Asteraceae	S
41	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae	ST
42	*Cleisostoma williamsonii* (Rchb.f.)Garay.	Not known	Orchidaceae	E
43	*Clerodendrum serratum* L.	Yin-bya-net	Verbenaceae	S
44	*Codonopsis lanceolata*	Ba-la-cheik	Campanulaceae	CL
45	*Colocasia esculenta*	Pein-yaing	Araceae	H
46	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae	ST
47	*Costus specious* Sm.	Pha-lan-taung-hmwe	Costaceae	H
48	*Crateva magna* (Lour.) DC.	Ka-det	Capparaceae	ST
49	*Cratoxylum neriifolium* Kurz	Bae-bya	Hypericaceae	ST
50	*Cratoxylum polyanthum*Korth.	Bae-bya	Hypericaceae	ST
51	*Croton joufra* Roxb.	Tha-yin-ka-doe	Euphorbiaceae	ST
52	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae	ST
53	*Curcuma aromatica*	Mar-la	Zingiberaceae	H
54	*Cycas siamensis* Miq.	Mon-daing	Cycadaceae	ST
55	*Cymbidium aloifolium* (L.)Sw.	Thit-tet-lin-nae	Orchidaceae	E
56	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae	G
57	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	T
58	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	T
59	*Dendrobium* sp.	Not known	Orchidaceae	E
60	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	B
61	*Desmodium rufihirsutum* Craib	Not known	Fabaceae	S
62	*Desmodium umbellatum* DC.	Kyee-hmi-apho	Fabaceae	S
63	*Dillenia parviflora* Griff.	Zin-byun	Dilleniaceae	ST
64	*Dioscorea alata*	Myauk-u	Dioscoreaceae	CL
65	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae	CL
66	*Dioscorea cylindrica* Burm.	Kyway-thon-ywet	Dioscoreaceae	CL
67	*Dioscorea pentaphylla* L.	Kyway-ngar-ywet	Dioscoreaceae	CL

No	Scientific Name	Common Name	Family Name	Habit
68	*Diospyros kaki* L.f.	Tae	Ebenaceae	CL
69	*Dipterocarpus tuberculatus* Roxb.	In	Dipterocarpaceae	T
70	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae	T
71	*Dysolobium grande* Prain	Khwe-la-byut	Fabaceae	CL
72	*Ehretia acuminata* R.Br	Taung-poe-lu-lin	Boraginaceae	T
73	*Emblica officinalis* Gaertn.	Sha-phyu	Euphorbiaceae	ST
74	*Eugenia balsama* Wight	Ye-tha-bye	Myrtaceae	T
75	*Euphorbia heterophylla*	Sae-pa-le	Euphorbiaceae	H
76	*Euphorbia hypericifolia* L.	Kywe-kyaung-hmin-se	Euphorbiaceae	H
77	*Ficus glomerata* Roxb.	Ye-tha-phan	Moraceae	T
78	*Ficus hispida* L.	Kha-aung	Moraceae	ST
79	*Ficus religiosa* L.	Baw-di-nyaung	Moraceae	T
80	*Ficus semicordata*	Ka-dut	Moraceae	T
81	*Flacourtia cataphracta* Roxb.	Na-ywe	Flacourtiaceae	T
82	*Flueggea leucopyrus* Willd	Ye-chin-ya	Euphorbiaceae	ST
83	*Ganoderma australe*	Not known	Ganodermataceae	Mu
84	*Gardenia turgida* Roxb.	Hman-phyu/ Hnan-khaung-chauk	Rubiaceae	ST
85	*Garuga pinnata* Roxb.	Chin-yoke	Burseraceae	T
86	*Gastrochilus* sp.	Not known	Orchidaceae	E
87	*Globba patens*	Pa-dein-ngo	Zingiberaceae	H
88	*Globba pendula*	Pa-dein-ngo-thay	Zingiberaceae	H
89	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae	T
90	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae	ST
91	*Habenaria procera*	Not known	Orchidaceae	E
92	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae	S
93	*Hedyotis auricularia*	Not known	Rubiaceae	H
94	*Heliotropium indicum* L.	Sin-hna-maung	Boraginaceae	H
95	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	ST
96	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	S
97	*Hymenodictyon orixense* (Roxb.) Mabb.	Khu-than	Rubiaceae	T
98	*Imperata cylindrica* (L.)P. Beauv.	Thet-ke	Poaceae	G
99	*Indigofera tinctoria* L.	Taw-hne	Fabaceae	S
100	*Lactarius volemus* Fr.	Not known	Russulaceae	Mu
101	*Lagerstroemia macrocarpa* Kurz	Pyin-ma-ywet-gyi	Lythraceae	T
102	*Lagerstroemia speciosa* (L.) Pers.	Pyin-ma-ywet-thay	Lythraceae	T
103	*Lagerstroemia villosa* Wall.ex Kurz	Let-khwe	Lythraceae	T
104	*Lantana camara* L.	Sein-na-pan	Verbenaceae	S
105	*Leea hirta* Banks	Naga-mauk-phyu/Hta-min-yae	Leeaceae	S
106	*Leea macrophylla* Roxb.	Na-ga-mauk-gyi	Leeaceae	S
107	*Leea rubra*	Naga-mauk-ni/Hta-min-yae	Leeaceae	S
108	*Lepiota morgani* Pk.	Not known	Agraricaceae	Mu

No	Scientific Name	Common Name	Family Name	Habit
109	*Leptadenia reticulata* Wight & Arn.	Gon-kha	Asclepiadaceae	CL
110	*Leucas cephalotes* Spreng.	Pin-gu-hteik-peik	Lamiaceae	S
111	*Litsea glutinosa*	On-don	Lauraceae	T
112	*Lycoperdon pyriforme*	Not known	Agaricaceae	Mu
113	*Mallotus philippensis*	Taw-thi-din	Euphorbiaceae	T
114	*Marasmius foetidum* Fr.	Not known	Marasmiaceae	Mu
115	*Microporus xanthopus* (Fr.) Kuntze	Not known	Polyporaceae	Mu
116	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae	CL
117	*Millettia extensa* Benth.	Win-u	Fabaceae	CL
118	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	H
119	*Musa* sp.	Nga-pyaw-yaing	Musaceae	H
120	*Myriopteron paniculatum* Griff	Ti-lay-na-tha	Asclepiadaceae	CL
121	*Nervilia plicata*	Ta-bin-taing-shwe-hti	Orchidaceae	H
122	*Ophioglossum nudicaule*	Addler's Tongue Fern	Ophioglossaceae	F
123	*Oroxylum indicum* (L.)Kurz	Kyaung-sha	Bignoniaceae	ST
124	*Phoenix loureiri* Kunth	Thin-baung	Arecaceae	ST
125	*Pholiota flammas* Pk	Hmo	Strophariaceae	Mu
126	*Phyllanthus amarus*	Myay-zi-phyu	Euphorbiaceae	H
127	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	ST
128	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae	H
129	*Portulaca grandiflora* Hook.	Shan-hnin-si	Portulacaceae	H
130	*Premna amplectens* Wall	Yin-bya-phyu	Verbenaceae	S
131	*Psalliota placomyces* (Pk.) Kauffm.	Not known	Agaricaceae	Mu
132	*Psalliota silvatica* (Schaeff.) Quel.	Not known	Agaricaceae	Mu
133	*Pseuderanthemum polyanthum*	Not known	Acanthaceae	H
134	*Pycnoporus cinnabarinus*	Not known	Polyporaceae	Mu
135	*Quercus mespilifolia* Wall.	Yin-gu	Fagaceae	T
136	*Schizophyllum commune*	Not known	Schizophyllaceae	Mu
137	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	T
138	*Schrebera swietenioides* Roxb.	Thit-swe-le	Oleaceae	ST
139	*Selaginella willdenowii*	Not known	Selaginellaceae	F
140	*Senna hirsuta* (L.) Irwin & Barneby	Ka-thaw-hmwe-htu	Caesalpiniaceae	S
141	*Senna tora* (L.) Roxb	Dan-gwe	Caesalpiniaceae	S
142	*Sesbania* sp.	Nyan	Fabaceae	S
143	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	T
144	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	T
145	*Sida acuta* Burm.f.	Ta-byet-si-bin	Malvaceae	S
146	*Smilax aspericaulis* Wall ex A. D.C.	Sein-na-baw-thay	Smilacaceae	CL
147	*Smilax macrophylla* Roxb.	Sein-na-baw-gyi	Smilacaceae	CL
148	*Solanum aculeatissimum* Jacq.	Not known	Solanaceae	H
149	*Solanum torvum* Swartz	Kha-yan-ka-zawt	Solanaceae	S

No	Scientific Name	Common Name	Family Name	Habit
150	*Solanum verbascifolium*	Not known	Solanaceae	ST
151	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae	T
152	*Stemona burkillii* Prain	Tha-mya	Stemonaceae	H
153	*Sterculia villosa*	Shaw	Sterculiaceae	T
154	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae	T
155	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae	CL
156	*Strobilanthes isophyllus*	Not known	Acanthaceae	S
157	*Strophanthus wallichii* A.DC.	Na-sha-gyi	Apocynaceae	CL
158	*Strychnos nux-blanda* A.W.Hill	Kha-baung	Loganiaceae	ST
159	*Syzygium grande* (Wight) Walp	Nay-yaing-pin/Tha-bye	Myrtaceae	T
160	*Tectona grandis* L. f.	Kyun	Verbenaceae	T
161	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae	T
162	*Terminalia chebula* Retz.	Phan-kha	Combretaceae	T
163	*Thespesia lampas* Dalzell & A.Gibson	Taw-wa	Malvaceae	S
164	*Thyrsostachys oliveri* Gamble	Tha-net-wa	Poaceae	B
165	*Tithonia diversifolia* A. Gray	Nay-kyar-yaing	Asteraceae	S
166	*Tristaniopsis burmanica* (griff.)P.G.Wilson & J.T. Waterh.	Dauk-yat	Myrtaceae	T
167	*Triumfetta bartramia* L.	Kat-se-nae-thay	Tiliaceae	S
168	*Uraria lagopodioides* (L.)Desv.ex DC.	Not known	Fabaceae	H
169	*Vangueria spinosa* Roxb.	Ma-gyi-bauk	Rubiaceae	ST
170	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae	ST
171	*Vitex vestita* Wall.	Tauk-sha	Verbenaceae	ST
172	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae	ST
173	*Wrightia arborea* (Dennst.) Mabb.	Let-htok-thein	Apocynaceae	ST
174	*Zephyranthes carinata* Herb.	Hnin-pan	Amaryllidaceae	H
175	*Zingibr zerumbet*	Linne-gyi	Zingiberaceae	H
176	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	ST
B=Bamboo,CL=Climber,E=Epiphyte,F=Fern, G=Grass,H=Herbs,Mu=Mushroom,S=Shrubs,ST=Small Tree, T=Tree				

Table 24: Right Bank and Left Bank Species

No	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
1	*Abelmoschus moschatus*	Taw-yon-pa-de	Malvaceae	√	√
2	*Acacia pennata* (L.)Willd.	Su-yit	Mimosaceae		√
3	*Acmella calva* (DC.) R.K. Jansen	Pe-le-nyin	Asteraceae	√	
4	*Adenostemma viscosum*	Not known	Asteraceae	√	
5	*Adiantum latifolium*	Not known	Pteridaceae		√
6	*Adiantum peruvianum*	Not known	Pteridaceae	√	
7	*Adiantum tenerum*	Not known	Pteridaceae	√	
8	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae	√	√
9	*Albizia chinensis* (Osbeck)Merr.	Bom-me-za	Mimosaceae	√	

No	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
10	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae	√	√
11	*Albizia procera* (Roxb.) Benth.	Thit-phyu	Mimosaceae		√
12	*Alternanthera nodiflora* R.Br.	Ka-na-phaw-yaing	Amaranthaceae	√	
13	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	√	
14	*Amalocalyx microlobus*	Not known	Apocynaceae		√
15	*Amaranthus gracilis* Desf.	Hin-nu-nwe-yaing	Amaranthaceae	√	
16	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae	√	
17	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Wa-u	Araceae		√
18	*Anneslea fragrans* Wall.	Pan-ma	Theaceae		√
19	*Anogeissus acuminata* Wall.	Yon	Combretaceae		√
20	*Antidesma bunius*	Kin-ba-lin	Euphorbiaceae		√
21	*Aporusa dioica* (Roxb.) Mull.Arg.	Thit-khauk	Euphorbiaceae		√
22	*Appendicula* sp.	Not known	Orchidaceae		√
23	*Ardisia* sp.	Kyet-ma-ok	Myrsinaceae		√
24	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae	√	
25	*Argyreia nervosa* (Burm.f.)Bojer	Kazun-gyi	Convolvulaceae	√	
26	*Aristolochia acuminata*	Eik-tha-ya-mu-li	Aristolochiaceae	√	
27	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae		√
28	*Artemisia* sp.	Not known	Asteraceae	√	
29	*Artemisia vulgaris*	Not known	Asteraceae	√	√
30	*Asparagus densiflorus*	Shint-ma-tet	Asparagaceae		√
31	*Asparagus filicinus* Buch.-Ham. ex D. Don	Ka-nyut	Asparagaceae	√	
32	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae		√
33	*Auricularia auricula-judae* (Bull.) J.Schröt.	Kywet-na-ywet-hmo	Auriculariaceae		√
34	*Bambusa bambos*(L.)Voss.	Kya-khat-wa	Poaceae	√	
35	*Bambusa tulda* Roxb.	Theik-wa	Poaceae		√
36	*Barleria strigosa* Willd.	Not known	Acanthaceae	√	
37	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae	√	
38	*Bauhinia racemosa* Lam.	Pha-lan/Hta-la	Caesalpiniaceae		√
39	*Bauhinia* sp.	Swe-daw	Caesalpiniaceae	√	√
40	*Begonia semperflorens*	Kyauk-chin-pan	Begoniaceae	√	√
41	*Berrya mollis*	Not known	Tiliaceae		√
42	*Bidens pilosa*	Hmwe-sok	Asteraceae	√	
43	*Bliospermum axillare* Blume	Hnut-cho	Euphorbiaceae	√	√
44	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae		√
45	*Bombax ceiba* L.	Let-pan	Bombacaceae		√
46	*Brachycorythis galeandra* (Rchb.f.) Summerh.	Not known	Orchidaceae		√
47	*Brachycorythis helferi* (Rchb.f.) Summerh.	Not known	Orchidaceae		√
48	*Bridelia retusa* (L.) A. Juss.	Myauk-zi/Seik-chi	Euphorbiaceae		√
49	*Buchanania latifolia* Roxb.	Lun	Anacardiaceae	√	√
50	*Buddleja asiatica* Lour	Not known	Buddlejaceae	√	

No	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
51	*Bulbophyllum* sp.	Not known	Orchidaceae		√
52	*Butea parviflora* L.	Pauk-home	Fabaceae		√
53	*Butea superba* Roxb.	Pauk-nwee	Fabaceae		√
54	*Calvatia gigantean* (Batsch.)Fr.	Not known	Agaricaceae		√
55	*Calycopteris floribunda* Lam.	Kyun-khaung-nwee	Combretaceae	√	
56	*Carduus pycnocephalus*	Not known	Asteraceae	√	
57	*Carex brizoides* L.	Taw-kyet-le-hlee	Cyperaceae		√
58	*Careya arborea* Roxb.	Ban-bwe	Lecythidaceae		√
59	*Cassia fistula* L.	Ngu	Caesalpiniaceae		√
60	*Celosia argentea* L.	Taw-kyet-mauk	Amaranthaceae		√
61	*Chromolaena odorata* (L.) R.M. King & H Robinson	Bi-zet	Asteraceae	√	√
62	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae	√	√
63	*Cissus hastata* Miq.	Sa-pyit-yaing	Vitaceae	√	
64	*Clausena excavata* var.*villosa* Hook. f.	Taw-pyin-daw-thein	Rutaceae	√	
65	*Cleisostoma williamsonii* (Rchb.f.)Garay.	Not known	Orchidaceae		√
66	*Clerodendrum serratum* L.	Yin-bya-net	Verbenaceae	√	√
67	*Codonopsis lanceolata*	Ba-la-cheik	Campanulaceae	√	√
68	*Colocasia esculenta*	Pein-yaing	Araceae	√	√
69	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae		√
70	*Convolvulus parviflorus* Vahl	Not known	Convolvulaceae	√	
71	*Costus specious* Sm.	Pha-lan-taung-hmwe	Costaceae		√
72	*Crateva magna* (Lour.) DC.	Ka-det	Capparaceae		√
73	*Cratoxylum neriifolium* Kurz	Bae-bya	Hypericaceae		√
74	*Cratoxylum polyanthum*Korth.	Bae-bya	Hypericaceae		√
75	*Crotalaria sericea* Retz	Taw-paik-san	Fabaceae	√	
76	*Croton joufra* Roxb.	Tha-yin-ka-doe	Euphorbiaceae		√
77	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae	√	√
78	*Curcuma aromatica*	Mar-la	Zingiberaceae		√
79	*Curcuma* sp.	Mar-la	Zingiberaceae	√	
80	*Cycas siamensis* Miq.	Mon-daing	Cycadaceae		√
81	*Cymbidium aloifolium* (L.)Sw.	Thit-tet-lin-nae	Orchidaceae		√
82	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae	√	√
83	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	√	√
84	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	√	√
85	*Dendrobium* sp.	Not known	Orchidaceae		√
86	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	√	√
87	*Desmodium gangeticum* L.	Not known	Fabaceae	√	
88	*Desmodium rufihirsutum* Craib	Not known	Fabaceae	√	√
89	*Desmodium triflorum*	Not known	Fabaceae	√	
90	*Desmodium umbellatum* DC.	Kyee-hmi-apho	Fabaceae		√
91	*Dillenia parviflora* Griff.	Zin-byun	Dilleniaceae		√

No	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
92	*Dioscorea alata*	Myauk-u	Dioscoreaceae	√	√
93	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae	√	√
94	*Dioscorea cylindrica* Burm.	Kyway-thon-ywet	Dioscoreaceae	√	√
95	*Dioscorea pentaphylla* L.	KYwary-ngar-ywet	Dioscoreaceae	√	√
96	*Dioscorea sativa* L.	Kyauk-yin-nwee	Dioscoreaceae	√	
97	*Diospyros kaki* L.f.	Tae	Ebenaceae	√	√
98	*Dipterocarpus tuberculatus* Roxb.	In	Dipterocarpaceae		√
99	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae	√	√
100	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae	√	
101	*Dunbaria punctata*	Not known	Fabaceae	√	
102	*Dysolobium grande* Prain	Khwe-la-byut	Fabaceae		√
103	*Ehretia acuminata* R.Br	Taung-poe-lu-lin	Boraginaceae		√
104	*Emblica officinalis* Gaertn.	Sha-phyu	Euphorbiaceae		√
105	*Eugenia balsama* Wight	Ye-tha-bye	Myrtaceae		√
106	*Euphorbia heterophylla*	Sae-pa-le	Euphorbiaceae		√
107	*Euphorbia hypericifolia* L.	Kywe-kyaung-hmin-se	Euphorbiaceae		√
108	*Ficus glomerata* Roxb.	Ye-tha-phan	Moraceae		√
109	*Ficus hispida* L.	Kha-aung	Moraceae		√
110	*Ficus religiosa* L.	Baw-di-nyaung	Moraceae		√
111	*Ficus semicordata*	Ka-dut	Moraceae		√
112	*Flacourtia cataphracta* Roxb.	Na-ywe	Flacourtiaceae		√
113	*Flueggea leucopyrus* Willd	Ye-chin-ya	Euphorbiaceae		√
114	*Ganoderma australe*	Not known	Ganodermataceae		√
115	*Gardenia turgida* Roxb.	Hman-phyu/ Hnan-khaung-chauk	Rubiaceae		√
116	*Garuga pinnata* Roxb.	Chin-yoke	Burseraceae		√
117	*Gastrochilus* sp.	Not known	Orchidaceae		√
118	*Globba patens*	Pa-dein-ngo	Zingiberaceae	√	√
119	*Globba pendula*	Pa-dein-ngo-thay	Zingiberaceae	√	√
120	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae		√
121	*Gochnatia decora*	Not known	Asteraceae	√	
122	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae	√	√
123	*Grewia laevigata* Vahl	Ta-yaw	Tiliaceae	√	
124	*Habenaria hosseusii* Schltr.	Not known	Orchidaceae	√	
125	*Habenaria procera*	Not known	Orchidaceae		√
126	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae	√	√
127	*Hedyotis auricularia*	Not known	Rubiaceae		√
128	*Helicteres angustifolia L.*	Not known	Sterculiaceae	√	
129	*Heliotropium indicum* L.	Sin-hna-maung	Boraginaceae		√
130	*Hiptage benghalensis* (L.) Kurz	Sar-say/Bein-nwee	Malpighiaceae	√	
131	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	√	√

No	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
132	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	√	√
133	*Hymenodictyon orixense* (Roxb.) Mabb.	Khu-than	Rubiaceae		√
134	*Imperata cylindrica* (L.)P. Beauv.	Thet-ke	Poaceae		√
135	*Indigofera tinctoria* L.	Taw-hne	Fabaceae	√	√
136	*Ipomoea cordatotriloba*	Ka-zun	Convolvulaceae	√	
137	*Justicia procumbens*	Not known	Acanthaceae	√	
138	*Lactarius volemus* Fr.	Not known	Russulaceae		√
139	*Lagerstroemia macrocarpa* Kurz	Pyin-ma-ywet-gyi	Lythraceae		√
140	*Lagerstroemia speciosa* (L.) Pers.	Pyin-ma-ywet-thay	Lythraceae		√
141	*Lagerstroemia villosa* Wall.ex Kurz	Let-khwe	Lythraceae		√
142	*Lantana camara* L.	Sein-na-pan	Verbenaceae		√
143	*Leea hirta* Banks	Naga-mauk-phyu/Hta-min-yae	Leeaceae		√
144	*Leea macrophylla* Roxb.	Na-ga-mauk-gyi	Leeaceae		√
145	*Leea rubra*	Naga-mauk-ni/Hta-min-yae	Leeaceae		√
146	*Lepiota morgani* Pk.	Not known	Agraricaceae		√
147	*Leptadenia reticulata* Wight & Arn.	Gon-kha	Asclepiadaceae		√
148	*Leucas cephalotes* Spreng.	Pin-gu-hteik-peik	Lamiaceae		√
149	*Litsea glutinosa*	On-don	Lauraceae		√
150	*Lycoperdon pyriforme*	Not known	Agaricaceae		√
151	*Mallotus philippensis*	Taw-thi-din	Euphorbiaceae		√
152	*Marasmius foetidum* Fr.	Not known	Marasmiaceae		√
153	*Melanorrhoea usitata* Wall.	Thit-si	Anacardiaceae	√	
154	*Microporus xanthopus* (Fr.) Kuntze	Not known	Polyporaceae		√
155	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae		√
156	*Millettia extensa* Benth.	Win-u	Fabaceae	√	√
157	*Millettia ovalifolia* Kurz	Thin-win	Fabaceae	√	
158	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae		√
159	*Musa* sp.	Nga-pyaw-yaing	Musaceae		√
160	*Myriopteron paniculatum* Griff	Ti-lay-na-tha	Asclepiadaceae	√	√
161	*Nervilia plicata*	Ta-bin-taing-shwe-hti	Orchidaceae		√
162	*Ochna integerrima*	Indaing-seni	Ochnaceae	√	
163	*Ophioglossum nudicaule*	Addler's Tongue Fern	Ophioglossaceae		√
164	*Oroxylum indicum* (L.)Kurz	Kyaung-sha	Bignoniaceae		√
165	*Oxalis corniculata* L.	Hmo-chin	Oxalidaceae	√	
166	*Paxillus involutus* (Batsch.)Fr.	Hmo	Paxillaceae	√	
167	*Peristrophe roxburghiana*	Not known	Acanthaceae	√	
168	*Phoenix loureiri* Kunth	Thin-baung	Arecaceae		√
169	*Pholiota flammas* Pk	Hmo	Strophariaceae		√
170	*Phyllanthus amarus*	Myay-zi-phyu	Euphorbiaceae		√
171	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	√	√

No	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
172	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae	√	√
173	*Poa sylvestris*	Myet	Poaceae	√	
174	*Portulaca grandiflora* Hook.	Shan-hnin-si	Portulacaceae		√
175	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	√	
176	*Pouzolzia zeylanica*	Not known	Urticaceae	√	
177	*Premna amplectens* Wall	Yin-bya-phyu	Verbenaceae		√
178	*Psalliota placomyces* (Pk.) Kauffm.	Not known	Agaricaceae		√
179	*Psalliota silvatica* (Schaeff.) Quel.	Not known	Agaricaceae		√
180	*Pseuderanthemum polyanthum*	Not known	Acanthaceae	√	√
181	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	√	
182	*Pterospermum diversifolium*	Not known	Sterculiaceae	√	
183	*Pycnoporus cinnabarinus*	Not known	Polyporaceae		√
184	*Quercus mespilifolia* Wall.	Yin-gu	Fagaceae		√
185	*Rumex crispus* L.	Not known	Polygonaceae	√	
186	*Rumex trisetiferus* Stokes	Not known	Polygonaceae	√	
187	*Saccharum spontaneum* L.	Kaing	Poaceae	√	
188	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae	√	
189	*Schima wallichii* (DC.) Korth.	Lauk-ya	Theaceae	√	
190	*Schizophyllum commune*	Not known	Schizophyllaceae		√
191	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	√	√
192	*Schrebera swietenioides* Roxb.	Thit-swe-le	Oleaceae		√
193	*Selaginella willdenowii*	Not known	Selaginellaceae	√	√
194	*Senna hirsuta* (L.) Irwin & Barneby	Ka-thaw-hmwe-htu	Caesalpiniaceae		√
195	*Senna tora* (L.*)* Roxb	Dan-gwe	Caesalpiniaceae		√
196	*Sesbania* sp.	Nyan	Fabaceae		√
197	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	√	√
198	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	√	√
199	*Sida acuta* Burm.f.	Ta-byet-si-bin	Malvaceae		√
200	*Smilax aspericaulis* Wall ex A. D.C.	Sein-na-baw-thay	Smilacaceae		√
201	*Smilax macrophylla* Roxb.	Sein-na-baw-gyi	Smilacaceae		√
202	*Smilax*sp.	Sein-na-baw	Smilacaceae	√	
203	*Solanum aculeatissimum* Jacq.	Not known	Solanaceae		√
204	*Solanum torvum* Swartz	Kha-yan-ka-zawt	Solanaceae		√
205	*Solanum verbascifolium*	Not known	Solanaceae		√
206	*Spirogyra* sp.	Algae	Zygnemataceae	√	
207	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae	√	√
208	*Stemona burkillii* Prain	Tha-mya	Stemonaceae		√
209	*Sterculia foetida* L.	Shaw-phyu	Sterculiaceae	√	
210	*Sterculia villosa*	Shaw	Sterculiaceae	√	√
211	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae	√	√
212	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae	√	√

No	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
213	*Strobilanthes isophyllus*	Not known	Acanthaceae		√
214	*Strophanthus wallichii* A.DC.	Na-sha-gyi	Apocynaceae		√
215	*Strychnos nux-blanda* A.W.Hill	Kha-baung	Loganiaceae	√	√
216	*Syzygium grande* (Wight) Walp	Tha-bye	Myrtaceae	√	√
217	*Tanacetum tibeticum* Hook.f. & Thomson	Not known	Asteraceae	√	
218	*Taraxacum officinale*	Not known	Asteraceae	√	
219	*Tectona grandis* L. f.	Kyun	Verbenaceae		√
220	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae	√	√
221	*Terminalia chebula* Retz.	Phan-kha	Combretaceae		√
222	*Thespesia lampas* Dalzell & A.Gibson	Taw-wa	Malvaceae	√	√
223	*Thyrsostachys oliveri* Gamble	Tha-net-wa	Poaceae		√
224	*Tithonia diversifolia* A. Gray	Nay-kyar-yaing	Asteraceae	√	√
225	*Tristaniopsis burmanica* (griff.)P.G.Wilson & J.T. Waterh.	Dauk-yat	Myrtaceae		√
226	*Triumfetta bartramia* L.	Kat-se-nae-thay	Tiliaceae		√
227	*Uraria lagopodioides* (L.)Desv.ex DC.	Not known	Fabaceae		√
228	*Vanda coerulescens* Griff.	Mo-lon-hmying-apyar-lay	Orchidaceae	√	
229	*Vangueria spinosa* Roxb.	Ma-gyi-bauk	Rubiaceae	√	√
230	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae	√	√
231	*Vitex vestita* Wall.	Tauk-sha	Verbenaceae		√
232	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae	√	√
233	*Wrightia arborea* (Dennst.) Mabb.	Let-htok-thein	Apocynaceae		√
234	*Zephyranthes carinata* Herb.	Hnin-pan	Amaryllidaceae		√
235	*Zingibr zerumbet*	Linne-gyi	Zingiberaceae		√
236	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae		√

3.3.3. Tree Species

A total of 40 tree species belonging to 35 genera were identified in 12 sample plots in research area three on the left bank. The dominant tree species in this area are *Shorea obtusa* Wall. (Thit-ya), *Buchanania latifolia* Roxb. (Lun-pho), *Shorea siamensis* (Kurz)Miq. (In-gyin), and *Dalbergia oliveri* Gamble (Ta-ma-lan).

Table 25: Tree Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Albizia lebbekoides* (DC.) Benth.	10	9.26	2.31
2	*Albizia procera* (Roxb.) Benth.	1	0.93	0.23
3	*Anogeissus acuminata* Wall.	5	4.63	1.16
4	*Antidesma bunius*	7	6.48	1.62
5	*Aporusa dioica* (Roxb.) Mull.Arg.	1	0.93	0.23
6	*Bombax ceiba* L.	1	0.93	0.23
7	*Bridelia retusa* (L.) A. Juss.	5	4.63	1.16

8	*Buchanania latifolia* Roxb.	62	57.41	14.35
9	*Careya arborea* Roxb.	2	1.85	0.46
10	*Chukrasia velutina* Roem.	1	0.93	0.23
11	*Croton joufra* Roxb.	3	2.78	0.69
12	*Croton oblongifolius* Roxb.	2	1.85	0.46
13	*Dalbergia cultrata* Grah.	2	1.85	0.46
14	*Dalbergia oliveri* Gamble	30	27.78	6.94
15	*Dillenia parviflora* Griff.	1	0.93	0.23
16	*Diospyros kaki* L.f.	8	7.41	1.85
17	*Dipterocarpus tuberculatus* Roxb.	18	16.67	4.17
18	*Emblica officinalis* Gaertn.	4	3.70	0.93
19	*Ficus semicordata*	1	0.93	0.23
20	*Flacourtia cataphracta* Roxb.	7	6.48	1.62
21	*Gardenia turgida* Roxb.	2	1.85	0.46
22	*Grewia eriocarpa Juss.*	25	23.15	5.79
23	*Hymenodictyon orixense* (Roxb.) Mabb.	6	5.56	1.39
24	*Lagerstroemia macrocarpa* Kurz	2	1.85	0.46
25	*Oroxylum indicum* (L.)Kurz	1	0.93	0.23
26	*Phyllanthus emblica* L.	11	10.19	2.55
27	*Quercus mespilifolia* Wall.	1	0.93	0.23
28	*Schleichera oleosa* (Lour.) Oken	11	10.19	2.55
29	*Shorea obtusa* Wall.	66	61.11	15.28
30	*Shorea siamensis*(Kurz)Miq.	47	43.52	10.88
31	*Spondias pinnata* (L. f.) Kurz.	9	8.33	2.08
32	*Sterculia villosa*	13	12.04	3.01
33	*Stereospermum suaveolens* (Roxb.) DC.	1	0.93	0.23
34	*Strychnos nux-blanda* A.W.Hill	18	16.67	4.17
35	*Syzygium grande* (Wight) Walp	5	4.63	1.16
36	*Tectona grandis* L. f.	10	9.26	2.31
37	*Terminalia alata* (Heyne) Roth	23	21.30	5.32
38	*Terminalia chebula* Retz.	2	1.85	0.46
39	*Vitex peduncularis* Wall.	6	5.56	1.39
40	*Wendlandia tinctoria* DC.	2	1.85	0.46
	Total	**432**	**400.00**	**100.00**

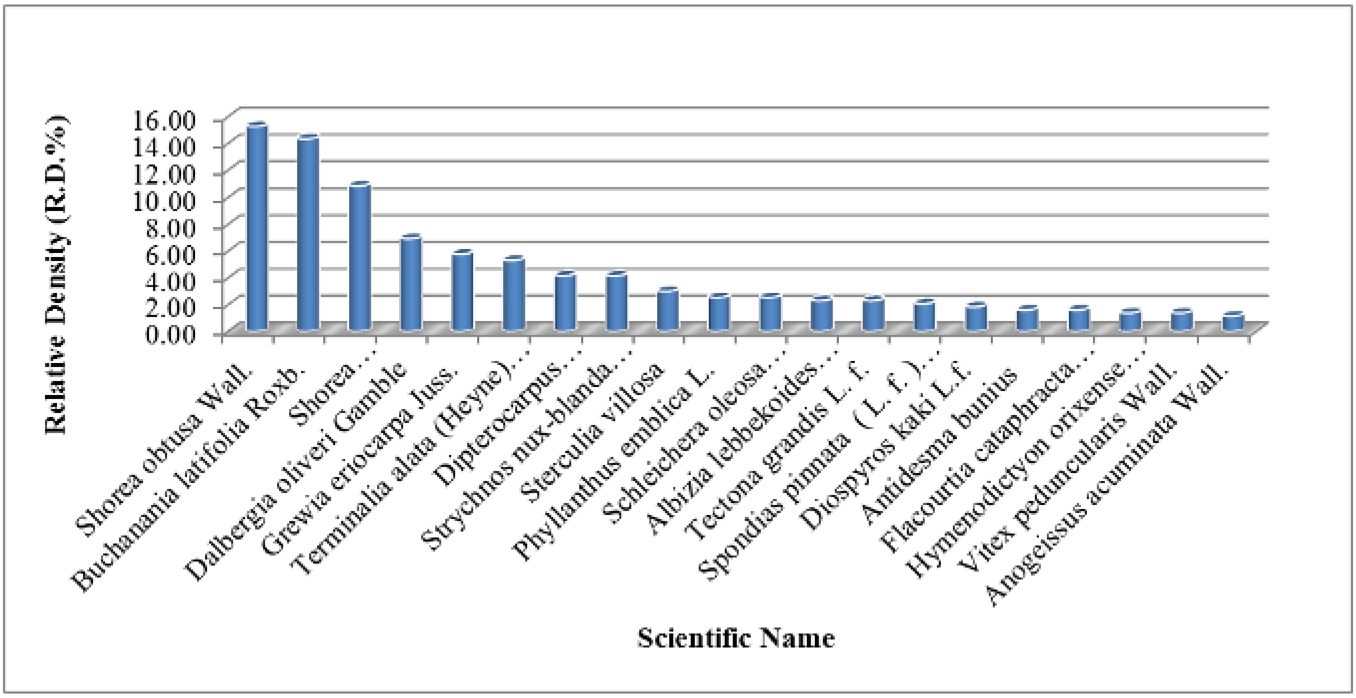
Among the sample plots, species density per hectare is varied and the species with the highest densities are *Shorea obtusa* Wall., *Buchanania latifolia* Roxb., *Shorea siamensis*(Kurz)Miq., followed by *Dalbergia oliveri* Gamble, *Grewia eriocarpa Juss.*, and *Terminalia alata* (Heyne) Roth. This shows that these six species are abundant in this area.

Table 26: Tree Species Relative Density

No.	**Scientific Name**	**Density (D)**	**Relative Density (R.D.%)**

1	*Shorea obtusa* Wall.	5.50	15.28
2	*Buchanania latifolia* Roxb.	5.17	14.35
3	*Shorea siamensis*(Kurz)Miq.	3.92	10.88
4	*Dalbergia oliveri* Gamble	2.50	6.94
5	*Grewia eriocarpa Juss.*	2.08	5.79
6	*Terminalia alata* (Heyne) Roth	1.92	5.32
7	*Dipterocarpus tuberculatus* Roxb.	1.50	4.17
8	*Strychnos nux-blanda* A.W.Hill	1.50	4.17
9	*Sterculia villosa*	1.08	3.01
10	*Phyllanthus emblica* L.	0.92	2.55
11	*Schleichera oleosa* (Lour.) Oken	0.92	2.55
12	*Albizia lebbekoides* (DC.) Benth.	0.83	2.31
13	*Tectona grandis* L. f.	0.83	2.31
14	*Spondias pinnata* (L. f.) Kurz.	0.75	2.08
15	*Diospyros kaki* L.f.	0.67	1.85
16	*Antidesma bunius*	0.58	1.62
17	*Flacourtia cataphracta* Roxb.	0.58	1.62
18	*Hymenodictyon orixense* (Roxb.) Mabb.	0.50	1.39
19	*Vitex peduncularis* Wall.	0.50	1.39
20	*Anogeissus acuminata* Wall.	0.42	1.16
21	*Bridelia retusa* (L.) A. Juss.	0.42	1.16
22	*Syzygium grande* (Wight) Walp	0.42	1.16
23	*Emblica officinalis* Gaertn.	0.33	0.93
24	*Croton joufra* Roxb.	0.25	0.69
25	*Careya arborea* Roxb.	0.17	0.46
26	*Croton oblongifolius* Roxb.	0.17	0.46
27	*Dalbergia cultrata* Grah.	0.17	0.46
28	*Gardenia turgida* Roxb.	0.17	0.46
29	*Lagerstroemia macrocarpa* Kurz	0.17	0.46
30	*Terminalia chebula* Retz.	0.17	0.46
31	*Wendlandia tinctoria* DC.	0.17	0.46
32	*Albizia procera* (Roxb.) Benth.	0.08	0.23
33	*Aporusa dioica* (Roxb.) Mull.Arg.	0.08	0.23
34	*Bombax ceiba* L.	0.08	0.23
35	*Chukrasia velutina* Roem.	0.08	0.23
36	*Dillenia parviflora* Griff.	0.08	0.23
37	*Ficus semicordata*	0.08	0.23
38	*Oroxylum indicum* (L.)Kurz	0.08	0.23
39	*Quercus mespilifolia* Wall.	0.08	0.23
40	*Stereospermum suaveolens* (Roxb.) DC.	0.08	0.23

Chart 6: Tree Species Relative Density



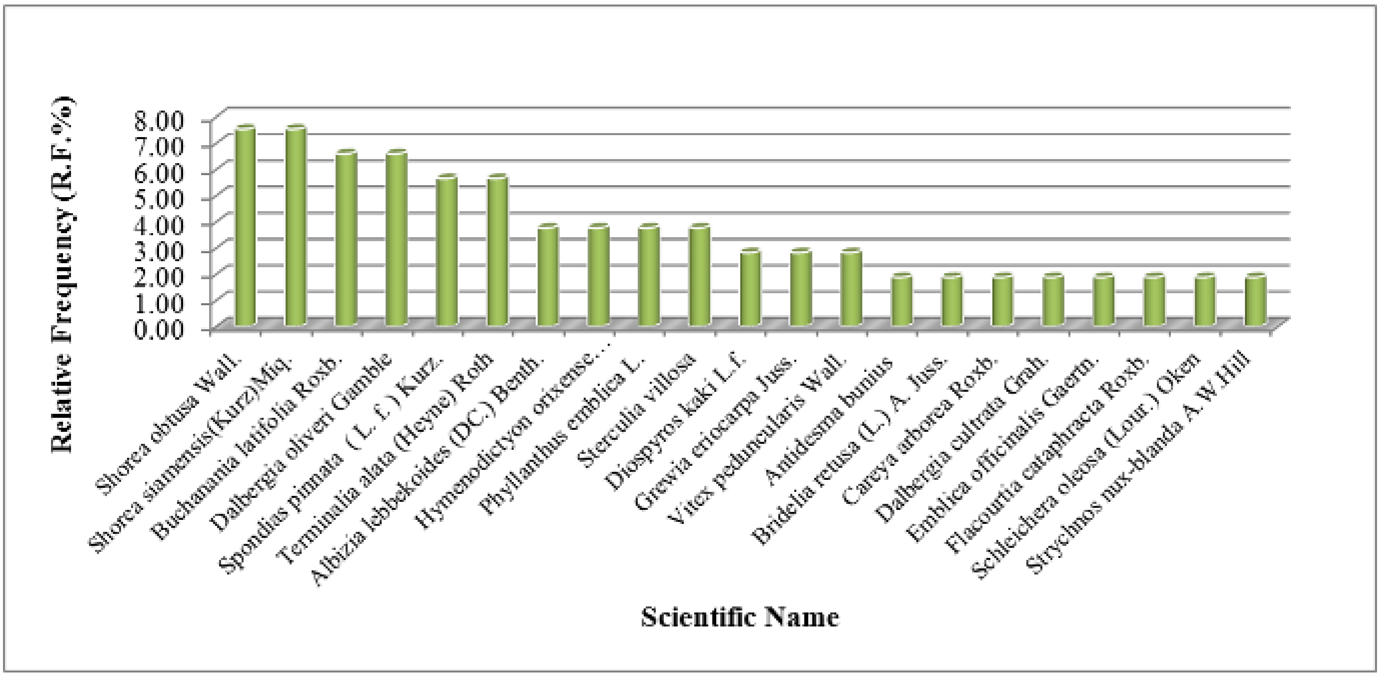
Relative frequency is the frequency of one species compared to the total frequency of all the species. According to the results**,** *Shorea obtusa* Wall., and *Shorea siamensis* (Kurz) Miq., are high relative frequency value (8%) followed by *Buchanania latifolia* Roxb., and *Dalbergia oliveri* Gamble (7%). Therefore, these species are fairly common in the area while those with lower frequencies such as *Albizia procera* (Roxb.) Benth., *Dillenia parviflora* Griff., and *Stereospermum suaveolens* (Roxb.) DC., can be considered rare species in the area.

Table 27: Tree Species Relative Frequency

No.	Scientific Name	Frequency (F)	Relative Frequency (R.F.%)
1	*Shorea obtusa* Wall.	0.67	7.55
2	*Shorea siamensis*(Kurz)Miq.	0.67	7.55
3	*Buchanania latifolia* Roxb.	0.58	6.60
4	*Dalbergia oliveri* Gamble	0.58	6.60
5	*Spondias pinnata* (L. f.) Kurz.	0.50	5.66
6	*Terminalia alata* (Heyne) Roth	0.50	5.66
7	*Albizia lebbekoides* (DC.) Benth.	0.33	3.77
8	*Hymenodictyon orixense* (Roxb.) Mabb.	0.33	3.77
9	*Phyllanthus emblica* L.	0.33	3.77
10	*Sterculia villosa*	0.33	3.77
11	*Diospyros kaki* L.f.	0.25	2.83
12	*Grewia eriocarpa Juss.*	0.25	2.83
13	*Vitex peduncularis* Wall.	0.25	2.83
14	*Antidesma bunius*	0.17	1.89

15	*Bridelia retusa* (L.) A. Juss.	0.17	1.89
16	*Careya arborea* Roxb.	0.17	1.89
17	*Dalbergia cultrata* Grah.	0.17	1.89
18	*Emblica officinalis* Gaertn.	0.17	1.89
19	*Flacourtia cataphracta* Roxb.	0.17	1.89
20	*Schleichera oleosa* (Lour.) Oken	0.17	1.89
21	*Strychnos nux-blanda* A.W.Hill	0.17	1.89
22	*Syzygium grande* (Wight) Walp	0.17	1.89
23	*Tectona grandis* L. f.	0.17	1.89
24	*Terminalia chebula* Retz.	0.17	1.89
25	*Wendlandia tinctoria* DC.	0.17	1.89
26	*Albizia procera* (Roxb.) Benth.	0.08	0.94
27	*Anogeissus acuminata* Wall.	0.08	0.94
28	*Aporusa dioica* (Roxb.) Mull.Arg.	0.08	0.94
29	*Bombax ceiba* L.	0.08	0.94
30	*Chukrasia velutina* Roem.	0.08	0.94
31	*Croton joufra* Roxb.	0.08	0.94
32	*Croton oblongifolius* Roxb.	0.08	0.94
33	*Dillenia parviflora* Griff.	0.08	0.94
34	*Dipterocarpus tuberculatus* Roxb.	0.08	0.94
35	*Ficus semicordata*	0.08	0.94
36	*Gardenia turgida* Roxb.	0.08	0.94
37	*Lagerstroemia macrocarpa* Kurz	0.08	0.94
38	*Oroxylum indicum* (L.)Kurz	0.08	0.94
39	*Quercus mespilifolia* Wall.	0.08	0.94
40	*Stereospermum suaveolens* (Roxb.) DC.	0.08	0.94

Chart 7: Tree Species Relative Frequency



3.3.4. Orchid Species

Brachycorythis helferi (Rchb.f.) Summerh.

Brachycorythis galeandra (Rchb.f.) Summerh.

Table 28: Orchid Species

No	Scientific Name	Common Name	Family Name
1	*Appendicula* sp.	Not known	Orchidaceae
2	*Brachycorythis galeandra* (Rchb.f.) Summerh.	Not known	Orchidaceae
3	*Brachycorythis helferi* (Rchb.f.) Summerh.	Not known	Orchidaceae
4	*Bulbophyllum* sp.	Not known	Orchidaceae
5	*Cleisostoma williamsonii* (Rchb.f.)Garay.	Not known	Orchidaceae
6	*Cymbidium aloifolium* (L.)Sw.	Thit-tet-lin-nae	Orchidaceae
7	*Dendrobium* sp.	Not known	Orchidaceae
8	*Gastrochilus* sp.	Not known	Orchidaceae
9	*Habenaria procera*	Not known	Orchidaceae
10	*Nervilia plicata*	Ta-bin-taing-shwe-hti	Orchidaceae

3.3.5. Mushroom Species

Psalliota silvatica (Schaeff.) Quel.

Marasmius foetidum Fr.

Table 29: Mushroom Species

No	Scientific Name	Common Name	Family Name
1	*Auricularia auricula-judae* (Bull.) J.Schröt.	Kywet-na-ywet-hmo	Auriculariaceae
2	*Calvatia gigantean* (Batsch.)Fr.	Not known	Agaricaceae
3	*Ganoderma australe*	Not known	Ganodermataceae
4	*Lactarius volemus* Fr.	Not known	Russulaceae
5	*Lepiota morgani* Pk.	Not known	Agraricaceae
6	*Lycoperdon pyriforme*	Not known	Agaricaceae
7	*Marasmius foetidum* Fr.	Not known	Marasmiaceae
8	*Microporus xanthopus* (Fr.) Kuntze	Not known	Polyporaceae
9	*Pholiota flammas* Pk	Hmo	Strophariaceae
10	*Psalliota placomyces* (Pk.) Kauffm.	Not known	Agaricaceae
11	*Psalliota silvatica* (Schaeff.) Quel.	Not known	Agaricaceae
12	*Pycnoporus cinnabarinus*	Not known	Polyporaceae
13	*Schizophyllum commune*	Not known	Schizophyllaceae

3.3.6. Bamboo Species

(Bamboo Forest Right Bank) *(Bamboo Forest Left Bank)*

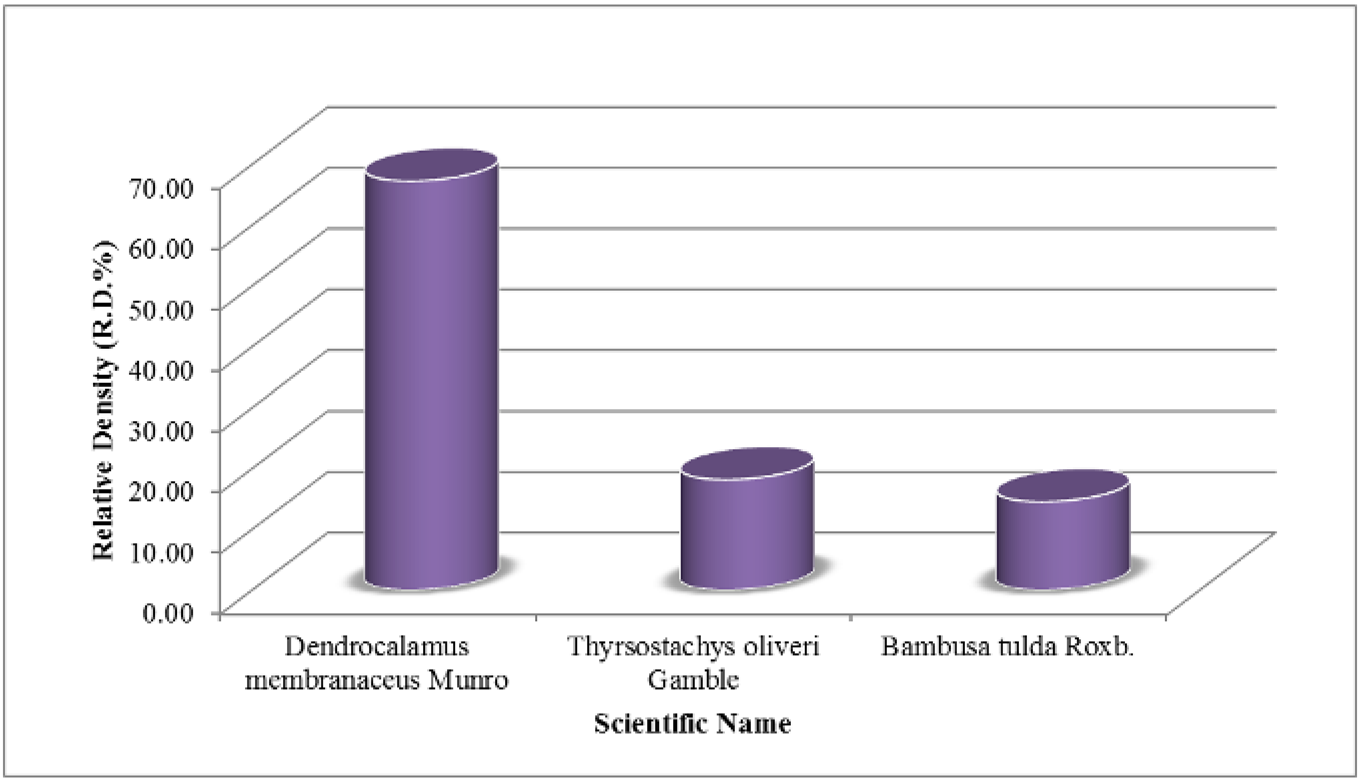
Table 30: Bamboo Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Bambusa tulda* Roxb.	8	22.22	14.55
2	*Dendrocalamus membranaceus* Munro	37	102.78	67.27
3	*Thyrsostachys oliveri* Gamble	10	27.78	18.18
	Total	**55**	**152.78**	**100.00**

Table 31: Bamboo Species Relative Density

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Dendrocalamus membranaceus* Munro	9.25	67.27
2	*Thyrsostachys oliveri* Gamble	2.5	18.18
3	*Bambusa tulda* Roxb.	2	14.55

Chart 8: Bamboo Species Relative Density



3.3.7. Flora IUCN Status

Of the flora species identified in research area three on the left bank, nine species are on the IUCN Red List. They are listed below. Most notably, *Dalbergia oliveri* Gamble is classified as EN A1cd and *Dalbergia cultrata* Grah.is classified as NT. The other seven species are classified as species of least concern or low risk/least concern.

Table 32: Flora on Threatened Species List

No	Scientific Name	Common Name	Family Name	IUCN Status
1	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae	LC
2	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	NT
3	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	EN A1cd
4	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	LC
5	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	LC
6	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	LC
7	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	LC
8	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	LR/Lc
9	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/Lc
EN=Endangered, LC=Least Concern, LR/Lc=Lower Risk/Least concern, NT=Near Threatened				

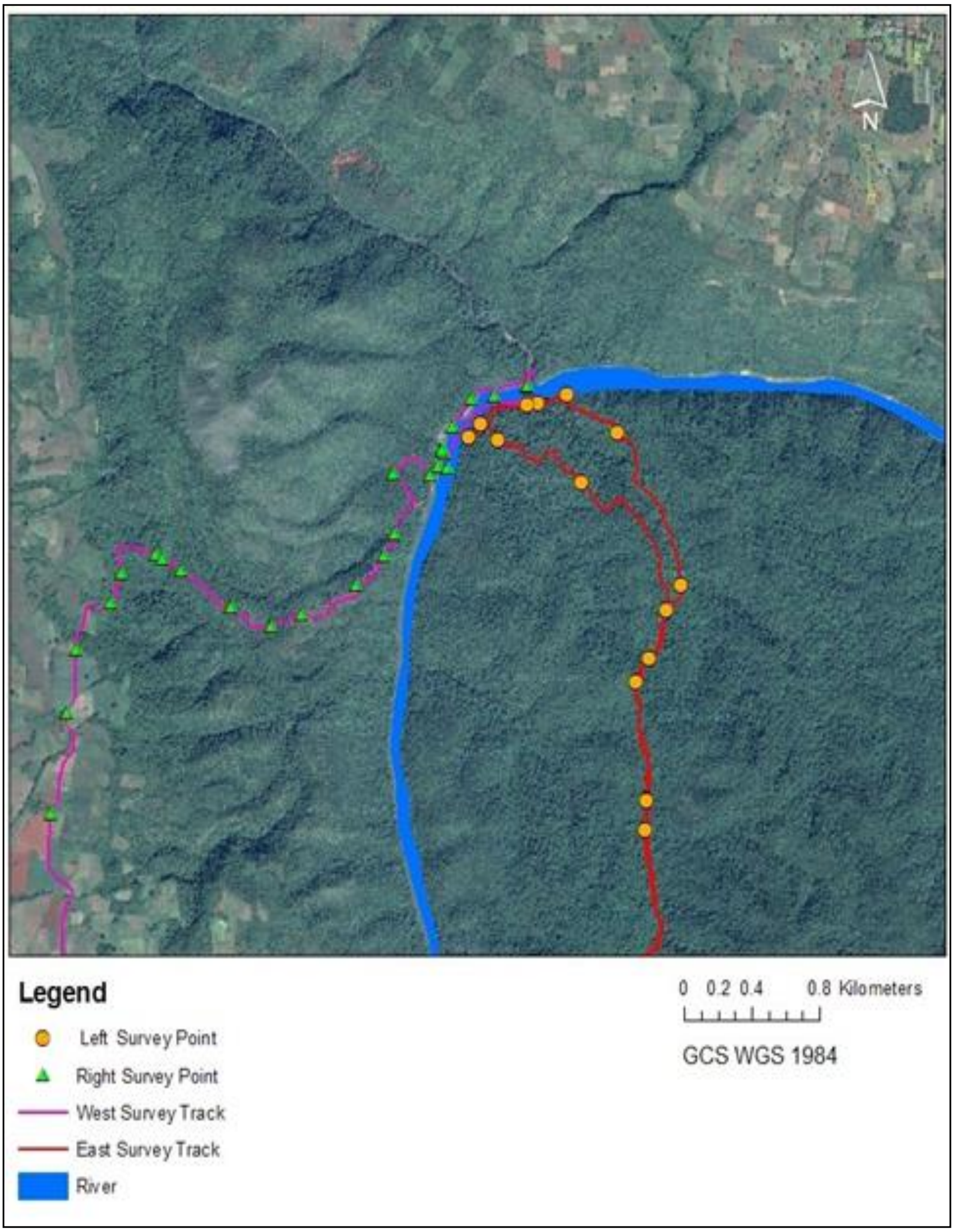
Dalbergia cultrata Grah.

Mimosa pudica L.

Shorea obtusa Wall. *Dalbergia oliveri* Gamble

3.4. Research Area Four

Map 8: Research Area Four



Map 9: Reservoir Elevation Line

Right Bank Forest **Left Bank Forest**

3.4.1. Quadrant Location and Vegetation Type

A total of 14 sample plots were taken in the left bank research area four. Vegetation in each of the plots consisted of deciduous teak forest. Relevant data is summarized in the table below.

Table 33: Research Area Four Sample Plots

No.	Sample Quadrant	Vegetation type	Latitude/Longitude	Altitude(m)	Dominant species
1	KGQ XXVI	Deciduous Teak & Bamboo Forest	N22 13 53.2 E96 57 11.0	614	*Tectona grandis* L. f.,*Terminalia alata* (Heyne) Roth, *Schleichera oleosa* (Lour.) Oken, *Shorea obtusa* Wall., *Dalbergia oliveri* Gamble, *Duabanga grandiflora, Shorea siamensis*(Kurz)Miq., *Lagerstroemia speciosa* (L.)
2	KGQ XXVII	Deciduous Teak & Bamboo Forest	N22 14 02.9 E96 57 04.3	565	
3	KGQ XXVIII	Deciduous Teak & Bamboo Forest	N22 13 26.2 E96 57 37.3	720	
4	KGQ XXIX	Deciduous Teak & Bamboo Forest	N22 14 28.6 E96 57 07.8	590	
5	KGQ XXX	Deciduous Teak & Bamboo Forest	N22 15 36.9 E96 57 20.4	461	
6	KGQ XXXI	Deciduous Teak & Bamboo Forest	N22 16 03.1 E96 57 08.3	390	
7	KGQ XXXII	Deciduous Teak & Bamboo Forest	N22 16 08.3 E96 56 52.9	319	
8	KGQ XXXIII	Deciduous Teak & Bamboo Forest	N22 16 01.9 E96 56 45.5	360	

9	KGQ XXXIV	Deciduous Teak Forest	N22 13 59.4 E97 02 12.3	669	Pers.,*Albizia lebbekoides* (DC.) Benth., *Vitex peduncularis* Wall., *Aporusa dioica* (Roxb.) Mull.Arg.
10	KGQ XXXV	Deciduous Teak & Bamboo Forest	N22 14 02.0 E97 02 11.8	640	
11	KGQ XXXVI	Deciduous Teak & Bamboo Forest	N22 14 10.3 E97 02 06.1	518	
12	KGQ XXXVII	Deciduous Teak & Bamboo Forest	N22 14 14.7 E97 02 03.4	459	
13	KGQ XXXVIII	Deciduous Teak & Bamboo Forest	N22 14 19.8 E97 02 00.3	394	
14	KGQ XXXIX	Deciduous Teak Forest	N22 14 22.6 E97 01 58.1	376	

3.4.2. Flora Species on Left and Right Banks

A total of 160 flora species were identified in research area four on the left bank, compared to 142 on the right bank. There were 111 flora species found only on the left bank and 93 flora species found only on the right bank. 49 species were present on both banks. This yields a total of 253 flora species present on left, right or both banks.

Table 34: Flora Species in Left Bank Research Area Four

No.	Scientific Name	Common Name	Family Name	Habit
1	*Acacia intsia* Willd.	Su-bok	Mimosaceae	CL
2	*Acacia pennata* (L.)Willd.	Su-yit	Mimosaceae	CL
3	*Adiantum latifolium*	Not known	Pteridaceae	F
4	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae	H
5	*Alangium chinense* (Lour.) Harms	Taw-po-sa	Alangiaceae	T
6	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae	T
7	*Alocasia macrorrhizos*	Pein-gyi	Araceae	H
8	*Amalocalyx microlobus*	Not known	Apocynaceae	CL
9	*Amaranthus gracilis* Desf.	Hnin-nu-nwee-ying	Amaranthaceae	H
10	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Wa-u	Araceae	H
11	*Anthocephalus morindaefolius* Korth.	Ma-u-let-tan-shae	Rubiaceae	T
12	*Antidesma bunius*	Kin-ba-lin	Euphorbiaceae	S
13	*Aporusa dioica* (Roxb.) Mull.Arg.	Thit-khauk	Euphorbiaceae	ST
14	*Arenga pinnata*(Wurmb)Merr.	Taw-ohn	Arecaceae	T
15	*Artemisia vulgaris*	Not known	Asteraceae	H
16	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae	ST
17	*Auricularia auricula-judae* (Bull.) J.Schröt.	Kywet-na-ywet-hmo	Auriculariaceae	Mu
18	*Bauhinia racemosa* Lam.	Pha-lan/Hta-la	Caesalpiniaceae	ST
19	*Begonia semperflorens*	Kyauk-chin-pan	Begoniaceae	H
20	*Bliospermum axillare* Blume	Hnut-cho	Euphorbiaceae	S
21	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae	H
22	*Bombax ceiba* L.	Let-pan	Bombacaceae	T
23	*Bridelia retusa* (L.) A. Juss.	Myauk-zi/Seik-chi	Euphorbiaceae	T
24	*Butea parviflora* L.	Pauk-home	Fabaceae	CL
25	*Butea superba* Roxb.	Pauk-nwee	Fabaceae	CL
26	*Caesalpinia sappan* L.	Tein-nyet	Caesalpiniaceae	ST
27	*Callicarpa formosana*	Kyun-na-lin	Verbenaceae	ST

No.	Scientific Name	Common Name	Family Name	Habit
28	*Calocera viscosa*	Not known	Dacrymycetaceae	Mu
29	*Cassia fistula* L.	Ngu	Caesalpiniaceae	T
30	*Chromolaena odorata* (L.) R.M. King & H Robinson	Bi-zet	Asteraceae	S
31	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae	ST
32	*Cinnamomum parthenoxylon* Meissner	Ka-ra-way-yaing	Lauraceae	T
33	*Clausena excavata* var.*villosa* Hook. f.	Taw-pyin-daw-thein	Rutaceae	ST
34	*Clerodendrum paniculatum* L.	Pan-pa-day-tha	Verbenaceae	S
35	*Clerodendrum serratum* L.	Yin-bya-net	Verbenaceae	S
36	*Codonopsis lanceolata*	Ba-la-cheik	Campanulaceae	CL
37	*Colocasia esculenta*	Pein-yaing	Araceae	H
38	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae	ST
39	*Commelina communis*	Myet-kyut	Commelinaceae	H
40	*Commelina persicariaefolia* Wright.	Myet-kyut	Commelinaceae	H
41	*Costus specious* Sm.	Pha-lan-taung-hmwe	Costaceae	H
42	*Crassocephalum crepidioides*	Pan-zauk-htoe	Asteraceae	H
43	*Crateva magna* (Lour.) DC.	Ka-det	Capparaceae	ST
44	*Cratoxylum neriifolium* Kurz	Bae-bya	Hypericaceae	ST
45	*Cratoxylum polyanthum*Korth.	Bae-bya	Hypericaceae	ST
46	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae	ST
47	*Curcuma alismatifolia*	Ma-lar	Zingiberaceae	H
48	*Curcuma longa*	Ma-lar	Zingiberaceae	H
49	*Curcuma petiolata* Roxb.	Ma-lar	Zingiberaceae	H
50	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae	G
51	*Cyperus malaccensis* var. *brevifolius*	Not known	Cyperaceae	H
52	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	T
53	*Datura metel* L.	Pa-daing	Solanaceae	S
54	*Dendrocalamus latiflorus* Munro	Wa-bo	Poaceae	B
55	*Desmodium heterocarpon*	Myay-pe-htwe	Fabaceae	S
56	*Desmodium umbellatum* DC.	Kyee-hmi-apho	Fabaceae	S
57	*Dillenia parviflora* Griff.	Zin-byun	Dilleniaceae	ST
58	*Dioscorea alata*	Myauk-u	Dioscoreaceae	CL
59	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae	CL
60	*Dioscorea cylindrica* Burm.	Kyway-thon-ywet	Dioscoreaceae	CL
61	*Dioscorea pentaphylla* L.	Kyway-ngar-ywet	Dioscoreaceae	CL
62	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae	F
63	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae	T
64	*Equisetum hyemale*	Not known	Equisetaceae	H
65	*Eugenia balsama* Wight	Ye-tha-bye	Myrtaceae	T
66	*Euphorbia heterophylla*	Sae-pa-le	Euphorbiaceae	H
67	*Euphorbia hypericifolia* L.	Kywe-kyaung-hmin-se	Euphorbiaceae	H
68	*Ficus auriculata*	Sin-tha-phan	Moraceae	T

No.	Scientific Name	Common Name	Family Name	Habit
69	*Ficus bengalensis* L.	Pyin-nyaung	Moraceae	T
70	*Ficus hispida* L.	Kha-aung	Moraceae	ST
71	*Ficus lanceolata* Buch.-Ham.	Ye-tha-phan	Moraceae	T
72	*Ficus pumila* L.	Kyauk-kat-nyaung	Moraceae	CL
73	*Ficus semicordata*	Ka-dut	Moraceae	T
74	*Ficus variegata*	Kon-tha-phan	Moraceae	T
75	*Flemingia stricta* Roxb.	Kyee-hmi	Fabaceae	S
76	*Ganoderma lucidum*	Not known	Ganodermataceae	Mu
77	*Gardenia coronaria* Buch-Ham.	Yin-khat-gyi	Rubiaceae	ST
78	*Garuga pinnata* Roxb.	Chin-yoke	Burseraceae	T
79	*Globba patens*	Pa-dein-ngo	Zingiberaceae	H
80	*Globba pendula*	Pa-dein-ngo-thay	Zingiberaceae	H
81	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae	T
82	*Gochnatia decora*	Not known	Asteraceae	ST
83	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae	ST
84	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae	S
85	*Heteropanax fragrans* (Roxb. ex DC.) Seem.	Kyaung-dauk/La-ka-du	Araliaceae	ST
86	*Heterophragma sulfureum* Kurz	Phet-than	Bignoniaceae	T
87	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	S
88	*Hymenodictyon orixense* (Roxb.) Mabb.	Khu-than	Rubiaceae	T
89	*Hypholoma incertum* Pk.	Not known	Microthyriaceae	Mu
90	*Jasminum multiflorum*	Taw-sa-bei	Oleaceae	S
91	*Lactarius glaucescens* Pk.	Not known	Russulaceae	Mu
92	*Lactarius volemus* Fr.	Not known	Russulaceae	Mu
93	*Lagerstroemia speciosa* (L.) Pers.	Pyin-ma-ywet-thay	Lythraceae	T
94	*Lagerstroemia villosa* Wall.ex Kurz	Let-khwe	Lythraceae	T
95	*Lasia aculeata* Lour.	Za-yit	Araceae	H
96	*Leea hirta* Banks	Naga-mauk-phyu/Hta-min-yae	Leeaceae	S
97	*Leea macrophylla* Roxb.	Na-ga-mauk-gyi	Leeaceae	S
98	*Leea rubra*	Naga-mauk-ni/Hta-min-yae	Leeaceae	S
99	*Leucaena leucocephala* (Lam.) De.Wit	Baw-sa-gaing	Mimosaceae	ST
100	*Lygodium japonicum*(Thunb.)Sw.	Not known	Lygodiaceae	F
101	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae	T
102	*Marasmium oreades*	Not known	Marasmiaceae	Mu
103	*Markhamia stipulata* (Wall.) Seem. Ex K.Schum.	Ma-hlwa	Bignoniaceae	T
104	*Mesua ferrea* L.	Taw-gan-gaw	Hypericaceae	T
105	*Microporus xanthopus* (Fr.) Kuntze	Not known	Polyporaceae	Mu
106	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae	CL
107	*Millettia extensa* Benth.	Win-u	Fabaceae	CL
108	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	H
109	*Mitragyna rotundifolia* (Roxb.) Kuntze	Bin-ga	Rubiaceae	T

No.	Scientific Name	Common Name	Family Name	Habit
110	*Musa balbisiana*	Nget-pyaw	Musaceae	H
111	*Musa* sp.	Nga-pyaw-yaing	Musaceae	H
112	*Mussaenda calycina* Wall. ex Kurz	Pwint-tu-ywet-tu	Rubiaceae	ST
113	*Nauclea orientalis* L.	Ma-u-let-tan-to	Rubiaceae	T
114	*Nervilia plicata*	Ta-bin-taing-shwe-hti	Orchidaceae	H
115	*Oroxylum indicum* (L.)Kurz	Kyaung-sha	Bignoniaceae	ST
116	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae	B
117	*Pennisetum purpureum*	Yone-zar-myet	Poaceae	G
118	*Phellinus tremulae*	Not known	Hymenochaetaceae	Mu
119	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	ST
120	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae	H
121	*Pleurotus cornucopiae*	Not known	Pleurotaceae	Mu
122	*Polygonum barbatum*	Kywe-hna-khaung-gyate	Polygonaceae	H
123	*Pouzolzia zeylanica* (L.) Benn.	Not known	Urticaceae	H
124	*Premna amplectens* Wall	Yin-bya-phyu	Verbenaceae	S
125	*Pseuderanthemum polyanthum*	Not known	Acanthaceae	H
126	*Pterospermum acerifolium* (L.) Willd.	Taung-phet-wun	Sterculiaceae	T
127	*Quercus mespilifolia* Wall.	Yin-gu	Fagaceae	T
128	*Randia uliginosa* DC.	Hman-ni	Rubiaceae	ST
129	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	T
130	*Selaginella willdenowii*	Not known	Selaginellaceae	F
131	*Senna hirsuta* (L.) Irwin & Barneby	Ka-thaw-hmwe-htu	Caesalpiniaceae	S
132	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	T
133	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	T
134	*Sida acuta* Burm f.	Ta-byet-si-ywet-shae	Malvaceae	S
135	*Sida rhombifolia* L.	Ta-byet-se-ywet-waing	Malvaceae	S
136	*Sinomenium acutum* (Thunb.)Rehd.et Wils.	Nwee-war/Say-war	Menispermaceae	CL
137	*Smilax aspericaulis* Wall ex A. D.C.	Sein-na-baw-thay	Smilacaceae	CL
138	*Smilax macrophylla* Roxb.	Sein-na-baw-gyi	Smilacaceae	CL
139	*Solanum torvum* Swartz	Kha-yan-ka-zawt	Solanaceae	S
140	*Solanum verbascifolium*	Not known	Solanaceae	ST
141	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae	T
142	*Sterculia villosa*	Shaw	Sterculiaceae	T
143	*Strychnos nux-blanda* A.W.Hill	Kha-baung	Loganiaceae	ST
144	*Syzygium grande* (Wight) Walp	Tha-bye	Myrtaceae	T
145	*Tamarindus indica* L.	Ma-gyi	Caesalpiniaceae	T
146	*Tectona grandis* L. f.	Kyun	Verbenaceae	T
147	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae	T
148	*Terminalia bellerica* Roxb.	Thit-seint	Combretaceae	T
149	*Terminalia chebula* Retz.	Phan-kha	Combretaceae	T
150	*Tetrameles nudiflora* R.Br.	Thit-pok	Datiscaceae	T

No.	Scientific Name	Common Name	Family Name	Habit
151	*Thespesia lampas* Dalzell & A.Gibson	Taw-wa	Malvaceae	S
152	*Thunbergia fragrans* Roxb.	Pan-ye-sut	Acanthaceae	CL
153	*Thyrsostachys oliveri* Gamble	Tha-net-wa	Poaceae	B
154	*Tithonia diversifolia* A. Gray	Nay-kyar-yaing	Asteraceae	S
155	*Triumfetta bartramia* L.	Kat-se-nae-thay	Tiliaceae	S
156	*Uraria crinita* (L.)Desv.ex DC.	Not known	Fabaceae	S
157	*Urena sinuata*	Kat-se nae-gyi	Malvaceae	S
158	*Vangueria spinosa* Roxb.	Ma-gyi-bauk	Rubiaceae	ST
159	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae	T
160	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae	ST
161	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	ST
B=Bamboo,CL=Climber,F=Fern, G=Grass,H=Herbs,Mu=Mushroom,S=Shrubs,ST=Small Tree, T=Tree				

Table 35: Right and Left Bank Species

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
1	*Abelmoschus moschatus*	Taw-yon-pa-de	Malvaceae	√	
2	*Acacia intsia* Willd.	Su-bok	Mimosaceae		√
3	*Acacia pennata* (L.)Willd.	Su-yit	Mimosaceae		√
4	*Adenanthera pavonina* L.	Ywe-gyi	Mimosaceae	√	
5	*Adenostemma viscosum*	Not known	Asteraceae	√	
6	*Adiantum latifolium*	Not known	Pteridaceae		√
7	*Adiantum peruvianum*	Adiantum	Pteridaceae	√	
8	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae	√	√
9	*Albizia chinensis* (Osbeck)Merr.	Bom-me-za	Mimosaceae	√	√
10	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae	√	√
11	*Alocasia macrorrhizos*	Pein-gyi	Araceae		√
12	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	√	
13	*Amalocalyx microlobus*	Not known	Apocynaceae		√
14	*Amaranthus gracilis* Desf.	Hnin-nu-nwee-ying	Amaranthaceae	√	√
15	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae	√	
16	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Wa-u	Araceae		√
17	*Anisomeles indica*	Not known	Lamiaceae	√	
18	*Anthocephalus morindaefolius* Korth.	Ma-u-let-tan-shae	Rubiaceae		√
19	*Antidesma bunius*	Kin-ba-lin	Euphorbiaceae	√	√
20	*Aporusa dioica* (Roxb.) Mull.Arg.	Thit-khauk	Euphorbiaceae		√
21	*Ardisia* sp.	Kyet-ma-ok	Myrsinaceae	√	
22	*Arenga pinnata*(Wurmb)Merr.	Taw-ohn	Arecaceae		√
23	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae	√	
24	*Argyreia nervosa* (Burm.f.)Bojer	Kazun-gyi	Convolvulaceae	√	
25	*Aristolochia acuminata*	Eik-tha-ya-mu-li	Aristolochiaceae	√	

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
26	*Artemisia vulgaris*	Not known	Asteraceae		√
27	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae	√	√
28	*Auricularia auricula-judae* (Bull.) J.Schröt.	Kywet-na-ywet-hmo	Auriculariaceae		√
29	*Bambusa bambos*(L.)Voss.	Kya-khat-wa	Poaceae	√	
30	*Barleria strigosa* Willd.	Not known	Acanthaceae	√	
31	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae	√	
32	*Bauhinia racemosa* Lam.	Pha-lan/Hta-la	Caesalpiniaceae		√
33	*Bauhinia* sp.	Swe-daw	Caesalpiniaceae	√	
34	*Begonia semperflorens*	Kyauk-chin-pan	Begoniaceae		√
35	*Bidens pilosa*	Hmwe-sok	Asteraceae	√	
36	*Bischofia javanica*	Not known	Euphorbiaceae	√	
37	*Bliospermum axillare* Blume	Hnut-cho	Euphorbiaceae	√	√
38	*Blumea balsamifera*	Not known	Asteraceae	√	
39	*Boerhavia diffusa* L.	Pa-yan-na-wa	Nyctaginaceae	√	
40	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae		√
41	*Bombax ceiba* L.	Let-pan	Bombacaceae	√	√
42	*Bombax insigne* Wall.	De-du	Bombacaceae	√	
43	*Bridelia retusa* (L.) A. Juss.	Myauk-zi/Seik-chi	Euphorbiaceae		√
44	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae	√	
45	*Butea parviflora* L.	Pauk-home	Fabaceae		√
46	*Butea superba* Roxb.	Pauk-nwee	Fabaceae		√
47	*Caesalpinia sappan* L.	Tein-nyet	Caesalpiniaceae		√
48	*Callicarpa formosana*	Kyun-na-lin	Verbenaceae		√
49	*Calocera viscosa*	Not known	Dacrymycetaceae		√
50	*Calycopteris floribunda* Lam.	Kyun-khaung-nwee	Combretaceae	√	
51	*Canavalia cathartica*	Not known	Fabaceae	√	
52	*Canscora diffusa* (Vahl) R.Br.	Kyauk-pan	Gentianaceae	√	
53	*Carduus pycnocephalus*	Not known	Asteraceae	√	
54	*Careya arborea* Roxb.	Ban-bwe	Lecythidaceae	√	
55	*Cassia fistula* L.	Ngu	Caesalpiniaceae	√	√
56	*Centratherum punctatum*	Not known	Asteraceae	√	
57	*Chromolaena odorata* (L.) R.M. King & H Robinson	Bi-zet	Asteraceae		√
58	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae		√
59	*Cinnamomum parthenoxylon* Meissner	Ka-ra-way-yaing	Lauraceae		√
60	*Cissus hastata* Miq.	Sa-pyit-yaing	Vitaceae	√	
61	*Clausena excavata* var.*villosa* Hook. f.	Taw-pyin-daw-thein	Rutaceae		√
62	*Clerodendrum paniculatum* L.	Pan-pa-day-tha	Verbenaceae		√
63	*Clerodendrum serratum* L.	Yin-bya-net	Verbenaceae	√	√
64	*Codonopsis lanceolata*	Not known	Campanulaceae	√	√
65	*Colocasia esculenta*	Pein-yaing	Araceae		√
66	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae		√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
67	*Commelina communis*	Myet-kyut	Commelinaceae		√
68	*Commelina persicariaefolia* Wright.	Myet-kyut	Commelinaceae	√	√
69	*Costus specious* Sm.	Pha-lan-taung-hmwe	Costaceae	√	√
70	*Crassocephalum crepidioides*	Pan-zauk-htoe	Asteraceae		√
71	*Crateva magna* (Lour.) DC.	Ka-det	Capparaceae		√
72	*Cratoxylum neriifolium* Kurz	Bae-bya	Hypericaceae		√
73	*Cratoxylum polyanthum*Korth.	Bae-bya	Hypericaceae		√
74	*Crotalaria alata* Buch.-Ham. ex G.Don	Not known	Fabaceae	√	
75	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae		√
76	*Curcuma alismatifolia*	Ma-lar	Zingiberaceae		√
77	*Curcuma longa*	Ma-lar	Zingiberaceae		√
78	*Curcuma petiolata* Roxb.	Ma-lar	Zingiberaceae	√	√
79	*Curcuma* sp.	Mar-la	Zingiberaceae	√	
80	*Cymbidium aloifolium* (L.)Sw.	Thit-tet-lin-nae	Orchidaceae	√	
81	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae		√
82	*Cyperus malaccensis* var. *brevifolius*	Not known	Cyperaceae		√
83	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	√	
84	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae	√	
85	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	√	√
86	*Datura metel* L.	Pa-daing	Solanaceae		√
87	*Dendrocalamus latiflorus* Munro	Wa-bo	Poaceae		√
88	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	√	
89	*Dendrophthoe pentandra* (L.) Miq.	Kyi-paung	Loranthaceae	√	
90	*Desmodium gangeticum* L.	Not known	Fabaceae	√	
91	*Desmodium heterocarpon*	Myay-pe-htwe	Fabaceae		√
92	*Desmodium pulchellum* Benth.	Taung-damin	Fabaceae	√	
93	*Desmodium triangulare* (Retz.) Merr.	Not known	Fabaceae	√	
94	*Desmodium umbellatum* DC.	Kyee-hmi-apho	Fabaceae		√
95	*Dichanthium caricosum* (L.)A.Camus	Pa-daw-myet	Poaceae	√	
96	*Dillenia parviflora* Griff.	Zin-byun	Dilleniaceae	√	√
97	*Dioscorea alata*	Myauk-u	Dioscoreaceae		√
98	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae	√	√
99	*Dioscorea cylindrica* Burm.	KYwary-thon-ywet	Dioscoreaceae	√	√
100	*Dioscorea pentaphylla* L.	KYwary-ngar-ywet	Dioscoreaceae	√	√
101	*Dioscorea sativa* L.	Kyauk-yin-nwee	Dioscoreaceae	√	
102	*Diospyros kaki* L.f.	Tae	Ebenaceae	√	
103	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae	√	√
104	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae	√	√
105	*Ehretia acuminata* R.Br	Taung-poe-lu-lin	Boraginaceae	√	
106	*Elaeocarpus hainanensis* Oliv.	Kywe-pan-pin	Elaeocarpaceae	√	
107	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae	√	

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
108	*Emblica officinalis* Gaertn.	Sha-phyu	Euphorbiaceae	√	
109	*Engelhardtia spicata*	Pan-swe-le	Juglandaceae	√	
110	*Equisetum hyemale*	Not known	Equisetaceae		√
111	*Erythrina stricta* Roxb.	Ka-thit	Fabaceae	√	
112	*Eugenia balsama* Wight	Ye-tha-bye	Myrtaceae		√
113	*Eugenia densiflora* DC.	Kyauk-tha-bye	Myrtaceae	√	
114	*Euphorbia antiquorum* L.	Tazaung-gyi	Euphorbiaceae	√	
115	*Euphorbia heterophylla*	Sae-pa-le	Euphorbiaceae		√
116	*Euphorbia hypericifolia* L.	Kywe-kyaung-hmin-se	Euphorbiaceae		√
117	*Ficus auriculata*	Sin-tha-phan	Moraceae		√
118	*Ficus bengalensis* L.	Pyin-nyaung	Moraceae	√	√
119	*Ficus hispida* L.	Kha-aung	Moraceae	√	√
120	*Ficus lanceolata* Buch.-Ham.	Ye-tha-phan	Moraceae		√
121	*Ficus pumila* L.	Kyauk-kat-nyaung	Moraceae	√	√
122	*Ficus racemosa*	Tha-phan	Moraceae	√	
123	*Ficus semicordata*	Ka-dut	Moraceae		√
124	*Ficus variegata*	Kon-tha-phan	Moraceae	√	√
125	*Flemingia stricta* Roxb.	Kyee-hmi	Fabaceae		√
126	*Flueggea leucopyrus* Willd	Ye-chin-ya	Euphorbiaceae	√	
127	*Gagea reticulata* (Pall.) Schult.	Not known	Liliaceae	√	
128	*Ganoderma lucidum*	Not known	Ganodermataceae		√
129	*Gardenia coronaria* Buch-Ham.	Yin-khat-gyi	Rubiaceae		√
130	*Garuga pinnata* Roxb.	Chin-yoke	Burseraceae		√
131	*Globba patens*	Pa-dein-ngo	Zingiberaceae	√	√
132	*Globba pendula*	Pa-dein-ngo-thay	Zingiberaceae		√
133	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae	√	√
134	*Gochnatia decora*	Not known	Asteraceae		√
135	*Gonostegia hirta*	Not known	Rubiaceae	√	
136	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae		√
137	*Grewia laevigata* Vahl	Ta-yaw	Tiliaceae	√	
138	*Habenaria chlorina* Par. & Rchb.f.	Not known	Orchidaceae	√	
139	*Habenaria hosseusii* Schltr.	Not known	Orchidaceae	√	
140	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae	√	√
141	*Hedyotis diffusa*	Not known	Rubiaceae	√	
142	*Helicteres angustifolia L.*	Not known	Sterculiaceae	√	
143	*Heteropanax fragrans* (Roxb. ex DC.) Seem.	Kyaung-dauk/La-ka-du	Araliaceae		√
144	*Heterophragma sulfureum* Kurz	Phet-than	Bignoniaceae		√
145	*Hiptage benghalensis* (L.) Kurz	Sar-say/Bein-nwee	Malpighiaceae	√	
146	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	√	
147	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	√	√
148	*Hymenodictyon orixense* (Roxb.) Mabb.	Khu-than	Rubiaceae		√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
149	*Hypholoma incertum* Pk.	Not known	Microthyriaceae		√
150	*Indigofera tinctoria*	Me-yaing	Fabaceae	√	
151	*Isachne albens* Trin.	Myet	Poaceae	√	
152	*Jasminum multiflorum*	Taw-sa-bei	Oleaceae		√
153	*Justicia procumbens*	Not known	Acanthaceae	√	
154	*Lactarius glaucescens* Pk.	Not known	Russulaceae		√
155	*Lactarius volemus* Fr.	Not known	Russulaceae		√
156	*Lagerstroemia speciosa* (L.) Pers.	Pyin-ma-ywet-thay	Lythraceae		√
157	*Lagerstroemia villosa* Wall.ex Kurz	Let-khwe	Lythraceae		√
158	*Lannea coromandelica* (Houtt.) Merrr.	Na-be	Anacardiaceae	√	
159	*Lasia aculeata* Lour.	Za-yit	Araceae		√
160	*Leea hirta* Banks	Naga-mauk-phyu/Hta-min-yae	Leeaceae	√	√
161	*Leea macrophylla* Roxb.	Na-ga-mauk-gyi	Leeaceae	√	√
162	*Leea rubra*	Na-ga-mauk-ni	Leeaceae	√	√
163	*Leucaena leucocephala* (Lam.) De.Wit	Baw-sa-gaing	Mimosaceae		√
164	*Lygodium circinnatum*	Not known	Lygodiaceae	√	
165	*Lygodium japonicum*(Thunb.)Sw.	Not known	Lygodiaceae		√
166	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae		√
167	*Marasmium oreades*	Not known	Marasmiaceae		√
168	*Markhamia stipulata* (Wall.) Seem. Ex K.Schum.	Ma-hlwa	Bignoniaceae		√
169	*Melanorrhoea usitata* Wall.	Thit-si	Anacardiaceae	√	
170	*Mesua ferrea* L.	Taw-gan-gaw	Hypericaceae		√
171	*Micromelum minutum* (G. Forst.) Wight & Arn.	Pa-le-pan/Pauk-chaung	Rutaceae	√	
172	*Microporus xanthopus* (Fr.) Kuntze	Not known	Polyporaceae	√	√
173	*Mikania micrantha* H.B.K.	Bi-zet-new	Asteraceae	√	√
174	*Millettia extensa* Benth.	Win-u	Fabaceae		√
175	*Millettia ovalifolia* Kurz	Thin-win	Fabaceae	√	
176	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae		√
177	*Mitragyna rotundifolia* (Roxb.) Kuntze	Bin-ga	Rubiaceae		√
178	*Musa balbisiana*	Nget-pyaw	Musaceae		√
179	*Musa* sp.	Nga-pyaw-yaing	Musaceae		√
180	*Mussaenda calycina* Wall. ex Kurz	Pwint-tu-ywet-tu	Rubiaceae		√
181	*Myriopteron paniculatum* Griff	Ti-lay-na-tha	Asclepiadaceae	√	
182	*Nauclea orientalis* L.	Ma-u-let-tan-to	Rubiaceae		√
183	*Nervilia plicata*	Ta-bin-taing-shwe-hti	Orchidaceae		√
184	*Ochna integerrima*	Indaing-seni	Ochnaceae	√	
185	*Oldenlandia diffusa*	Not known	Rubiaceae	√	
186	*Oroxylum indicum* (L.)Kurz	Kyaung-sha	Bignoniaceae		√
187	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae	√	√
188	*Paederia foetida*	Pe-bok-nwee-thay	Rubiaceae	√	
189	*Paederia scandens* Lour.	Pe-bok-nwee-gyi	Rubiaceae	√	

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
190	*Pennisetum purpureum*	Yone-zar-myet	Poaceae		√
191	*Pericampylus glaucus* L.	Not known	Menispermaceae	√	
192	*Phellinus tremulae*	Not known	Hymenochaetaceae		√
193	*Phyllanthus amarus*	Myay-zi-phyu	Euphorbiaceae	√	
194	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	√	√
195	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae	√	√
196	*Pilea scripta* Langtang	Phet-ya	Urticaceae	√	
197	*Pleurotus cornucopiae*	Not known	Pleurotaceae		√
198	*Polygonum barbatum*	Kywe-hna-khaung-gyate	Polygonaceae		√
199	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	√	
200	*Pouzolzia zeylanica* (L.) Benn.	Not known	Urticaceae		√
201	*Premna amplectens* Wall	Yin-bya-phyu	Verbenaceae		√
202	*Pseuderanthemum polyanthum*	Not known	Acanthaceae		√
203	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	√	
204	*Pterospermum acerifolium* (L.) Willd.	Taung-phet-wun	Sterculiaceae		√
205	*Pycnoporus sanguineus*	Hmo	Polyporaceae	√	
206	*Quercus mespilifolia* Wall.	Yin-gu	Fagaceae		√
207	*Randia uliginosa* DC.	Hman-ni	Rubiaceae		√
208	*Schima wallichii* (DC.) Korth.	Lauk-ya	Theaceae	√	
209	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	√	√
210	*Selaginella willdenowii*	Not known	Selaginellaceae		√
211	*Senna hirsuta* (L.) Irwin & Barneby	Ka-thaw-hmwe-htu	Caesalpiniaceae		√
212	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	√	√
213	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	√	√
214	*Sida acuta* Burm f.	Ta-byet-si-ywet-shae	Malvaceae		√
215	*Sida rhombifolia* L.	Ta-byet-se-ywet-waing	Malvaceae		√
216	*Sinomenium acutum* (Thunb.)Rehd.et Wils.	Nwee-war/Say-war	Menispermaceae		√
217	*Smilax aspericaulis* Wall ex A. D.C.	Sein-na-baw-thay	Smilacaceae		√
218	*Smilax macrophylla* Roxb.	Sein-na-baw-gyi	Smilacaceae		√
219	*Smilax*sp.	Sein-na-baw	Smilacaceae	√	
220	*Solanum coagulans*	Kha-yan	Solanaceae	√	
221	*Solanum torvum* Swartz	Kha-yan-ka-zawt	Solanaceae		√
222	*Solanum verbascifolium*	Not known	Solanaceae		√
223	*Spirogyra* sp.	Algae	Zygnemataceae	√	
224	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae	√	√
225	*Stemona tuberosa*	Tha-mya	Stemonaceae	√	
226	*Sterculia foetida* L.	Shaw-phyu	Sterculiaceae	√	
227	*Sterculia villosa*	Shaw	Sterculiaceae	√	√
228	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae	√	
229	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae	√	
230	*Strychnos nux-blanda* A.W.Hill	Kha-baung	Loganiaceae	√	√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
231	*Syzygium grande* (Wight) Walp	Tha-bye	Myrtaceae	√	√
232	*Tamarindus indica* L.	Ma-gyi	Caesalpiniaceae		√
233	*Tectona grandis* L. f.	Kyun	Verbenaceae		√
234	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae	√	√
235	*Terminalia bellerica* Roxb.	Thit-seint	Combretaceae		√
236	*Terminalia chebula* Retz.	Phan-kha	Combretaceae		√
237	*Termitomyces albuminosa*	Taung-po-hmo	Agaricaceae	√	
238	*Tetrameles nudiflora* R.Br.	Thit-pok	Datiscaceae		√
239	*Thespesia lampas* Dalzell & A.Gibson	Taw-wa	Malvaceae		√
240	*Thunbergia fragrans* Roxb.	Pan-ye-sut	Acanthaceae		√
241	*Thunbergia grandiflora*	Kyi-hnok-thi-nwee	Acanthaceae	√	
242	*Thyrsostachys oliveri* Gamble	Tha-net-wa	Poaceae		√
243	*Tithonia diversifolia* A. Gray	Nay-kyar-yaing	Asteraceae	√	√
244	*Trichosanthes cordata* Roxb.	Kyi-ah	Cucurbitaceae	√	
245	*Triumfetta bartramia* L.	Kat-se-nae-thay	Tiliaceae		√
246	*Uraria crinita* (L.)Desv.ex DC.	Not known	Fabaceae	√	√
247	*Urena sinuata*	Kat-se nae-gyi	Malvaceae		√
248	*Uvaria cordata* Schum. & Thonn.	Tha-but-gyi	Annonaceae	√	
249	*Vanda coerulescens* Griff.	Mo-lon-hmying-apyar-lay	Orchidaceae	√	
250	*Vangueria spinosa* Roxb.	Ma-gyi-bauk	Rubiaceae		√
251	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae	√	√
252	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae	√	√
253	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	√	√

3.4.3. Tree Species

Out of the 14 sample plots in research area four on the left bank, 25 tree species belonging to 22 genera were identified. The dominant tree species in this area is *Tectona grandis* L. f. (Kyun) followed by *Terminalia alata* (Heyne) Roth (Htauk-kyant), *Schleichera oleosa* (Lour.) Oken (Gyo), and *Shorea obtusa* Wall., (Thit-ya).

Table 36: Tree Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Albizia lebbekoides* (DC.) Benth.	5	3.97	2.76
2	*Aporusa dioica* (Roxb.) Mull.Arg.	4	3.17	2.21
3	*Bridelia retusa* (L.) A. Juss.	2	1.59	1.10
4	*Croton oblongifolius* Roxb.	2	1.59	1.10
5	*Dalbergia oliveri* Gamble	8	6.35	4.42
6	*Dillenia parviflora* Griff.	1	0.79	0.55
7	*Duabanga grandiflora*	8	6.35	4.42

8	*Ficus bengalensis* L.	1	0.79	0.55
9	*Ficus lanceolata* Buch.-Ham.	4	3.17	2.21
10	*Heterophragma sulfureum* Kurz	1	0.79	0.55
11	*Lagerstroemia speciosa* (L.) Pers.	6	4.76	3.31
12	*Mangifera sylvatica* Roxb.	1	0.79	0.55
13	*Quercus mespilifolia* Wall.	1	0.79	0.55
14	*Schleichera oleosa* (Lour.) Oken	22	17.46	12.15
15	*Shorea obtusa* Wall.	10	7.94	5.52
16	*Shorea siamensis*(Kurz)Miq.	8	6.35	4.42
17	*Spondias pinnata* (L. f.) Kurz.	4	3.17	2.21
18	*Sterculia villosa*	1	0.79	0.55
19	*Tamarindus indica* L.	1	0.79	0.55
20	*Tectona grandis* L. f.	55	43.65	30.39
21	*Terminalia alata* (Heyne) Roth	25	19.84	13.81
22	*Terminalia chebula* Retz.	1	0.79	0.55
23	*Tetrameles nudiflora* R.Br.	4	3.17	2.21
24	*Vitex peduncularis* Wall.	5	3.97	2.76
25	*Wendlandia tinctoria* DC.	1	0.79	0.55
	Total	**181**	**143.65**	**100.00**

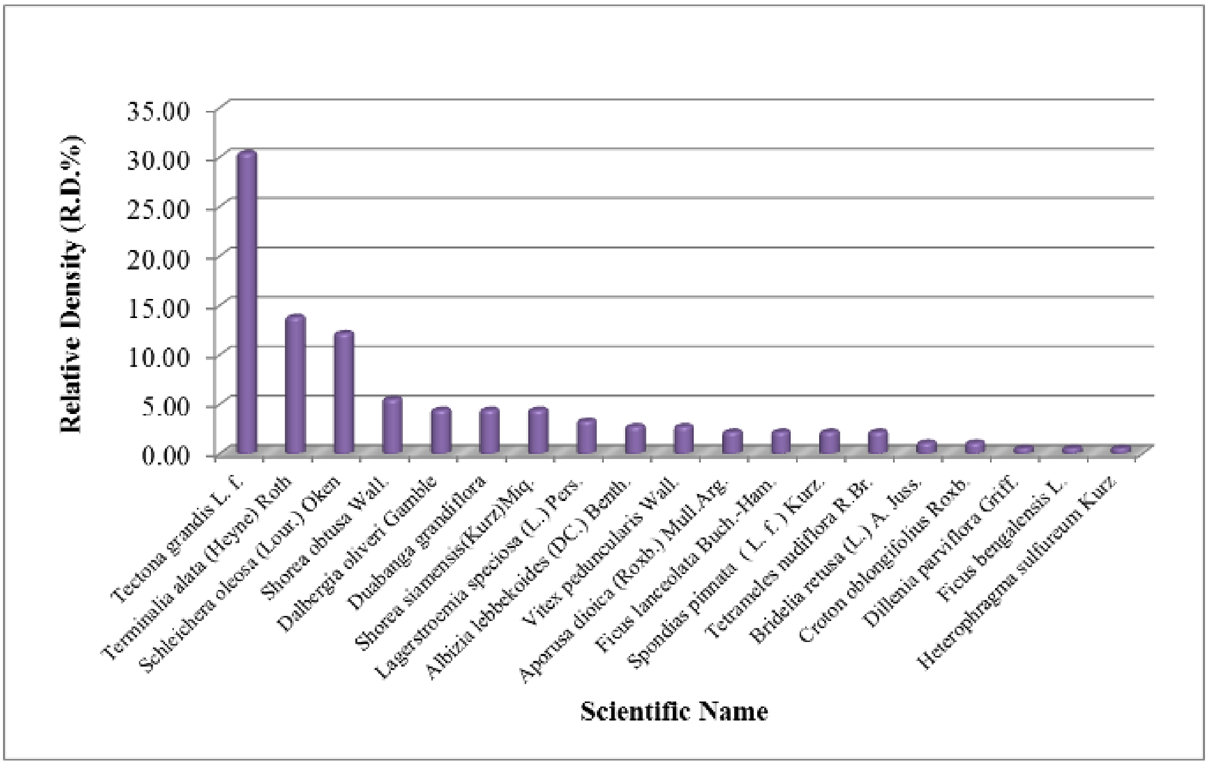
Among the sample plots, species density per hectare varied. The most densely populated species include; *Tectona grandis* L. f., *Terminalia alata* (Heyne) Roth, *Schleichera oleosa* (Lour.) Oken, followed by *Shorea obtusa* Wall., *Dalbergia oliveri* Gamble, *Duabanga grandiflora* and *Shorea siamensis* (Kurz) Miq.. These seven species can be considered abundant in this area.

Table 37: Tree Species Relative Density

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Tectona grandis* L. f.	3.93	30.39
2	*Terminalia alata* (Heyne) Roth	1.79	13.81
3	*Schleichera oleosa* (Lour.) Oken	1.57	12.15
4	*Shorea obtusa* Wall.	0.71	5.52
5	*Dalbergia oliveri* Gamble	0.57	4.42
6	*Duabanga grandiflora*	0.57	4.42
7	*Shorea siamensis*(Kurz)Miq.	0.57	4.42
8	*Lagerstroemia speciosa* (L.) Pers.	0.43	3.31
9	*Albizia lebbekoides* (DC.) Benth.	0.36	2.76
10	*Vitex peduncularis* Wall.	0.36	2.76
11	*Aporusa dioica* (Roxb.) Mull.Arg.	0.29	2.21
12	*Ficus lanceolata* Buch.-Ham.	0.29	2.21
13	*Spondias pinnata* (L. f.) Kurz.	0.29	2.21
14	*Tetrameles nudiflora* R.Br.	0.29	2.21

15	*Bridelia retusa* (L.) A. Juss.	0.14	1.10
16	*Croton oblongifolius* Roxb.	0.14	1.10
17	*Dillenia parviflora* Griff.	0.07	0.55
18	*Ficus bengalensis* L.	0.07	0.55
19	*Heterophragma sulfureum* Kurz	0.07	0.55
20	*Mangifera sylvatica* Roxb.	0.07	0.55
21	*Quercus mespilifolia* Wall.	0.07	0.55
22	*Sterculia villosa*	0.07	0.55
23	*Tamarindus indica* L.	0.07	0.55
24	*Terminalia chebula* Retz.	0.07	0.55
25	*Wendlandia tinctoria* DC.	0.07	0.55

Chart 9: Tree Species Relative Density

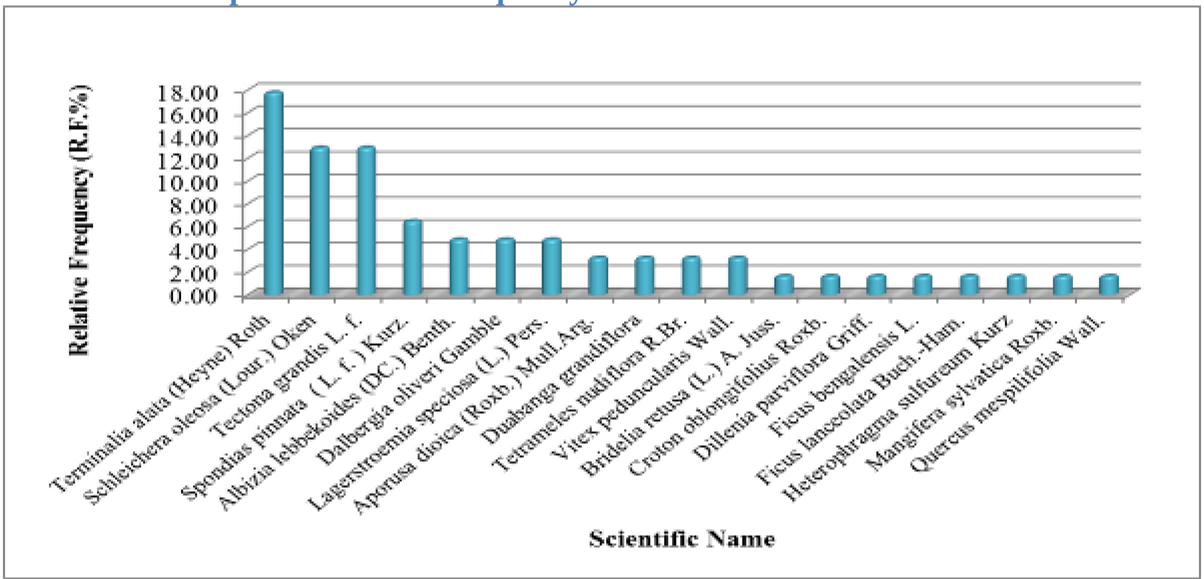


Relative frequency is the frequency of one species compared to the total frequency of all the species. According to the results**,** *Terminalia alata* (Heyne) Roth are high relative frequency value (18%) and followed by *Schleichera oleosa* (Lour.) Oken, and *Tectona grandis* L. f., (13%) are equal *Spondias pinnata* (L. f.) Kurz., (6%) respectively. Therefore, these species occur everywhere in the study area. The lower frequency of some species is such as *Bridelia retusa* (L.) A. Juss., *Quercus mespilifolia* Wall., and *Wendlandia tinctoria* DC. are demarcated as rare species in the area.

Table 38: Tree Species Relative Frequency

No.	Scientific Name	Frequency (F)	Relative Frequency (R.F.%)
1	*Terminalia alata* (Heyne) Roth	0.79	17.74
2	*Schleichera oleosa* (Lour.) Oken	0.57	12.90
3	*Tectona grandis* L. f.	0.57	12.90
4	*Spondias pinnata* (L. f.) Kurz.	0.29	6.45
5	*Albizia lebbekoides* (DC.) Benth.	0.21	4.84
6	*Dalbergia oliveri* Gamble	0.21	4.84
7	*Lagerstroemia speciosa* (L.) Pers.	0.21	4.84
8	*Aporusa dioica* (Roxb.) Mull.Arg.	0.14	3.23
9	*Duabanga grandiflora*	0.14	3.23
10	*Tetrameles nudiflora* R.Br.	0.14	3.23
11	*Vitex peduncularis* Wall.	0.14	3.23
12	*Bridelia retusa* (L.) A. Juss.	0.07	1.61
13	*Croton oblongifolius* Roxb.	0.07	1.61
14	*Dillenia parviflora* Griff.	0.07	1.61
15	*Ficus bengalensis* L.	0.07	1.61
16	*Ficus lanceolata* Buch.-Ham.	0.07	1.61
17	*Heterophragma sulfureum* Kurz	0.07	1.61
18	*Mangifera sylvatica* Roxb.	0.07	1.61
19	*Quercus mespilifolia* Wall.	0.07	1.61
20	*Shorea obtusa* Wall.	0.07	1.61
21	*Shorea siamensis*(Kurz)Miq.	0.07	1.61
22	*Sterculia villosa*	0.07	1.61
23	*Tamarindus indica* L.	0.07	1.61
24	*Terminalia chebula* Retz.	0.07	1.61
25	*Wendlandia tinctoria* DC.	0.07	1.61

Chart 10: Tree Species Relative Frequency



3.4.4. Orchid Species


Nervilia plicata

Table 39: Orchid Species

No.	Scientific Name	Common Name	Family Name
1	*Nervilia plicata*	Ta-bin-taing-shwe-hti	Orchidaceae

3.4.5. Mushroom Species

Calocera viscosa

Auricularia auricula-judae (Bull.) J.Schröt.

Table 40: Mushroom Species

No.	Scientific Name	Common Name	Family Name
1	*Auricularia auricula-judae* (Bull.) J.Schröt.	Kywet-na-ywet-hmo	Auriculariaceae
2	*Calocera viscose*	Not known	Dacrymycetaceae
3	*Ganoderma lucidum*	Not known	Ganodermataceae
4	*Hypholoma incertum* Pk.	Not known	Microthyriaceae
5	*Lactarius glaucescens* Pk.	Not known	Russulaceae
6	*Lactarius volemus* Fr.	Not known	Russulaceae
7	*Marasmium oreades*	Not known	Marasmiaceae
8	*Microporus xanthopus* (Fr.) Kuntze	Not known	Polyporaceae
9	*Phellinus tremulae*	Not known	Hymenochaetaceae
10	*Pleurotus cornucopiae*	Not known	Pleurotaceae

3.4.6. Bamboo Species

(Bamboo Forest Right Bank)

(Bamboo Forest Left Bank)

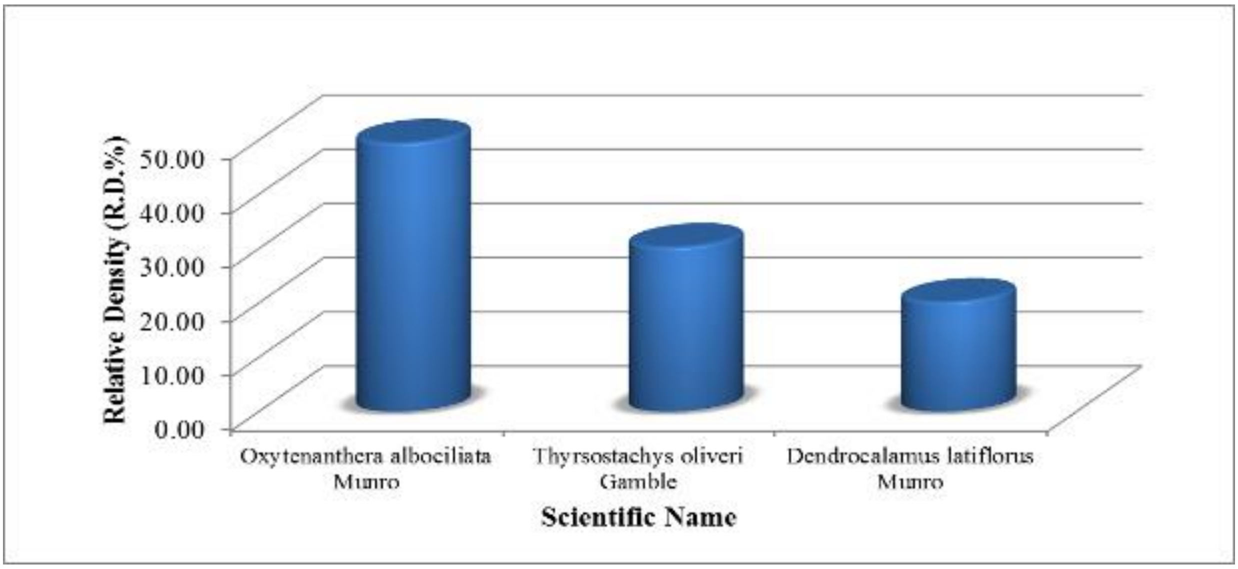
Table 41: Bamboo Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Dendrocalamus latiflorus* Munro	40	37.04	20.20
2	*Oxytenanthera albociliata* Munro	98	90.74	49.49
3	*Thyrsostachys oliveri* Gamble	60	55.56	30.30
	Total	**198**	**183.33**	**100.00**

Table 42: Bamboo Species Relative Density

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Oxytenanthera albociliata* Munro	8.17	49.49
2	*Thyrsostachys oliveri* Gamble	5.00	30.30
3	*Dendrocalamus latiflorus* Munro	3.33	20.20

Chart 11: Bamboo Species Relative Density



3.4.7. Flora IUCN Status

A total of 10 flora species in research area four on the left bank are on the IUCN Red List. Most notably, *Curcuma alismatifolia* is classified as NT and *Dalbergia oliveri* Gamble is classified as EN A1cd. The other eight species are classified as least concern or low risk/least concern.

No.	Scientific Name	Common Name	Family Name	IUCN Status
1	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae	LC
2	*Caesalpinia sappan* L.	Tein-nyet	Caesalpiniaceae	LR/Lc
3	*Colocasia esculenta*	Pein-yaing	Araceae	LC
4	*Curcuma alismatifolia*	Ma-lar	Zingiberaceae	NT
5	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	EN A1cd
6	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	LC
7	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae	LR/Lc
8	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	LC
9	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	LR/Lc
10	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/Lc
EN=Endangered, LC=Least Concern, LR/Lc=Lower Risk/Least concern, NT=Near Threatened				

Caesalpinia sappan L.

Curcuma alismatifolia

Colocasia esculenta

Homonoia riparia

3.5 Combined Data for all Four Research Areas

A total of 462 species of flora were identified across the entire project area on both banks. Of these species, 289 can be found on the right bank and 383 can be found on the left bank. This means that the left bank has more diversity than the right bank with an additional 94 species (or 33% more species) than the right bank. 210 species of flora can be found on both banks, indicating a similar environment in terms of flora cover.

Table 43: Flora Species Across Entire Research Area

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
1	*Abelmoschus esculentus*	Not known	Malvaceae	√	
2	*Abelmoschus moschatus*	Taw-yon-pa-de	Malvaceae	√	√
3	*Abutilon indicum*	Bauk-khwe	Malvaceae	√	
4	*Acacia catechu* Willd.	Sha	Mimosaceae		√
5	*Acacia concinna* (Willd.) DC.	Ka-mon-chin	Mimosaceae	√	√
6	*Acacia intsia* Willd.	Su-bok	Mimosaceae	√	√
7	*Acacia pennata* (L.)Willd.	Su-yit	Mimosaceae		√
8	*Acer laurinum* Hassk.	Not known	Aceraceae	√	√
9	*Acer negunda*	Not known	Aceraceae	√	√
10	*Acmella calva* (DC.) R.K. Jansen	Pe-le-nyin	Asteraceae	√	√
11	*Adenanthera pavonina* L.	Ywe-gyi	Mimosaceae	√	
12	*Adenostemma viscosum*	Not known	Asteraceae	√	√
13	*Adiantum latifolium*	Not known	Pteridaceae	√	√
14	*Adiantum peruvianum*	Not known	Pteridaceae	√	
15	*Adiantum tenerum*	Not known	Pteridaceae	√	
16	*Aegiceras corniculatum* (L.) Blanco	Bu-ta-let	Myrsinaceae		√
17	*Aeginetia indica* L.	Kauk-hlaing-di	Orobanchaceae	√	
18	*Agaricus silvicola*	Not known	Agaricaceae		√
19	*Ageratum conyzoides* L.	Khwe-thay-pan	Asteraceae	√	√
20	*Albatrellus ovinus*	Not known	Albatrellaceae		√
21	*Albizia chinensis* (Osbeck)Merr.	Bom-me-za	Mimosaceae	√	√
22	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae	√	√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
23	*Albizia procera* (Roxb.) Benth.	Thit-phyu	Mimosaceae		√
24	*Alocasia macrorrhizos*	Pein-gyi	Araceae		√
25	*Alphonsea boniana*	Not known	Annonaceae		√
26	*Alstonia scholaris*(L.) R. Br.	Taung-ma-yoe	Apocynaceae	√	√
27	*Alternanthera nodiflora* R.Br.	Ka-na-phaw-yaing	Amaranthaceae	√	√
28	*Alternanthera sessilis* (L.) R.Br.	Pa-zun-sa-yaing	Amaranthaceae	√	√
29	*Alysicarpus vaginalis* (L.) Dc.	Than-ma-naing-kyauk-ma-naing	Fabaceae	√	
30	*Amalocalyx microlobus*	Not known	Apocynaceae		√
31	*Amaranthus gracilis* Desf.	Hin-nu-nwe-yaing	Amaranthaceae	√	√
32	*Amaranthus spinosus* L.	Hnin-nu-new-su-bauk	Amaranthaceae	√	√
33	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Wa-u	Araceae	√	√
34	*Ampelocissus barbata* Planch.	Not known	Vitaceae		√
35	*Anisomeles indica*	Not known	Lamiaceae	√	
36	*Anneslea fragrans* Wall.	Pan-ma	Theaceae		√
37	*Anogeissus acuminata* Wall.	Yon	Combretaceae	√	√
38	*Anthocephalus morindaefolius* Korth.	Ma-u-let-tan-shae	Rubiaceae		√
39	*Antidesma bunius*	Kin-ba-lin	Euphorbiaceae	√	√
40	*Aporusa dioica* (Roxb.) Mull.Arg.	Thit-khauk	Euphorbiaceae		√
41	*Appendicula* sp.	Not known	Orchidaceae		√
42	*Ardisia* sp.	Kyet-ma-ok	Myrsinaceae	√	√
43	*Arenga pinnata*(Wurmb)Merr.	Taw-ohn	Arecaceae		√
44	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae	√	
45	*Argyreia nervosa*	Ka-zun-nwee	Convolvulaceae	√	√
46	*Argyreia nervosa* (Burm.f.)Bojer	Kazun-gyi	Convolvulaceae	√	√
47	*Aristolochia acuminata*	Eik-tha-ya-mu-li	Aristolochiaceae	√	
48	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae	√	√
49	*Artemisia* sp.	Not known	Asteraceae	√	√
50	*Artemisia vulgaris*	Not known	Asteraceae	√	√
51	*Artocarpus lakoocha*	Taung-pein-ne	Moraceae		√
52	*Asparagus densiflorus*	Shint-ma-tet	Asparagaceae	√	√
53	*Asparagus filicinus* Buch.-Ham. ex D. Don	Ka-nyut	Asparagaceae	√	√
54	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae	√	√
55	*Auricularia auricula-judae* (Bull.) J.Schröt.	Kywet-na-ywet-hmo	Auriculariaceae		√
56	*Bambusa bambos*(L.)Voss.	Kya-khat-wa	Poaceae	√	
57	*Bambusa teres* Buch.-Ham. ex Wall.	Ta-bin-taing-wa	Poaceae		√
58	*Bambusa tulda* Roxb.	Theik-wa	Poaceae		√
59	*Barleria strigosa* Willd.	Not known	Acanthaceae	√	√
60	*Bauhinia corymbosa*	Swe-daw	Caesalpiniaceae	√	√
61	*Bauhinia ornata* Kurz	Myauk-hle-ga	Caesalpiniaceae		√
62	*Bauhinia racemosa* Lam.	Pha-lan/Hta-la	Caesalpiniaceae		√
63	*Bauhinia* sp.	Swe-daw-thay	Caesalpiniaceae	√	√
64	*Begonia semperflorens*	Kyauk-chin-pan	Begoniaceae	√	√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
65	*Berrya mollis*	Not known	Tiliaceae		√
66	*Bidens pilosa*	Hmwe-sok	Asteraceae	√	√
67	*Bischofia javanica*	Ye-pa-done	Euphorbiaceae	√	√
68	*Bliospermum axillare* Blume	Hnut-cho	Euphorbiaceae	√	√
69	*Blumea balsamifera*	Not known	Asteraceae	√	√
70	*Blumea balsamifera* (L.) DC.	Phon-ma-thein	Asteraceae	√	√
71	*Boerhavia chinensis* (L.) Asch. & Schw.	Not known	Nyctaginaceae	√	
72	*Boerhavia coccinea*	Pa-yan-na-war	Nyctaginaceae	√	
73	*Boerhavia diffusa* L.	Pa-yan-na-wa	Nyctaginaceae	√	√
74	*Boesenbergia rotunda* (L.) Mansf.	Seik-phu	Zingiberaceae		√
75	*Bombax ceiba* L.	Let-pan	Bombacaceae	√	√
76	*Bombax insigne* Wall.	De-du	Bombacaceae	√	
77	*Brachycorythis galeandra* (Rchb.f.) Summerh.	Not known	Orchidaceae		√
78	*Brachycorythis helferi* (Rchb.f.) Summerh.	Not known	Orchidaceae		√
79	*Bridelia retusa* (L.) A. Juss.	Myauk-zi/Seik-chi	Euphorbiaceae		√
80	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae	√	√
81	*Buddleja asiatica* Lour	Not known	Buddlejaceae	√	√
82	*Bulbophyllum* sp.	Not known	Orchidaceae		√
83	*Butea parviflora* L.	Pauk-home	Fabaceae		√
84	*Butea superba* Roxb.	Pauk-nwee	Fabaceae		√
85	*Caesalpinia sappan* L.	Tein-nyet	Caesalpiniaceae		√
86	*Callicarpa formosana*	Kyun-na-lin	Verbenaceae		√
87	*Calocera viscosa*	Not known	Dacrymycetaceae		√
88	*Calotropis gigantea* (L.) Dryand. ex W.T. Aiton	Ma-yoe-gyi	Asclepiadaceae	√	
89	*Calvatia gigantean* (Batsch.)Fr.	Not known	Agaricaceae		√
90	*Calycopteris floribunda* Lam.	Kyun-khaung-nwee	Combretaceae	√	
91	*Cananga latifolia*	Not known	Annonaceae	√	√
92	*Canavalia cathartica*	Not known	Fabaceae	√	√
93	*Canscora diffusa* (Vahl) R.Br.	Kyauk-pan	Gentianaceae	√	
94	*Cantharellus aurantiacus* (Wulf.)Fr.	Not known	Cantharelleae		√
95	*Canthium parvifolium* Roxb.	Say-than-baya	Rubiaceae		√
96	*Carduus pycnocephalus*	Not known	Asteraceae	√	
97	*Carex brizoides* L.	Taw-kyet-le-hlee	Cyperaceae		√
98	*Careya arborea* Roxb.	Ban-bwe	Lecythidaceae	√	√
99	*Carissa spinarum* A. DC.	Taw-khan-pin	Apocynaceae	√	
100	*Cassia fistula* L.	Ngu	Caesalpiniaceae	√	√
101	*Castanopsis diversifolia* King	Pa-phyu/Castanopsis	Fagaceae		√
102	*Celastrus monospermus* Roxb.	Not known	Celastracae		√
103	*Celosia argentea* L.	Taw-kyet-mauk	Amaranthaceae	√	√
104	*Centratherum punctatum*	Not known	Asteraceae	√	
105	*Chamaesyce hypericifolia*	Not known	Euphorbiaceae	√	
106	*Chamaesyce thymifolia*	Not known	Euphorbiaceae		√
107	*Chenopodium acuminatum* subsp. virgatum	Not known	Chenopodiaceae	√	√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
108	*Chromolaena odorata* (L.) R.M. King & H Robinson	Bi-zet	Asteraceae	√	√
109	*Chukrasia velutina* Roem.	Yin-ma	Meliaceae	√	√
110	*Cibotium barometz* (Linn.) J. Sm.	Da-yin-kauk	Dicksoniaceae	√	
111	*Cinnamomum parthenoxylon* Meissner	Ka-ra-way-yaing	Lauraceae		√
112	*Cissus discolor* Blume	Wa-yaung-chin	Vitaceae	√	√
113	*Cissus hastata* Miq.	Sa-pyit-yaing	Vitaceae	√	√
114	*Claoxylon indicum* Hassk.	Not known	Euphorbiaceae	√	√
115	*Clausena excavata* var.*villosa* Hook. f.	Taw-pyin-daw-thein	Rutaceae	√	√
116	*Cleisostoma williamsonii* (Rchb.f.)Garay.	Not known	Orchidaceae		√
117	*Clerodendrum paniculatum* L.	Pan-pa-day-tha	Verbenaceae		√
118	*Clerodendrum serratum* L.	Yin-bya-net	Verbenaceae	√	√
119	*Clerodendrum villosum* Blume	Phet-kha	Verbenaceae	√	√
120	*Clitocybe caespitosa* Pk.	Wa-yin-hmo	Tricholomataceae	√	√
121	*Codonopsis lanceolata*	Not known	Campanulaceae	√	√
122	*Collybia cirrhata*	Not known	Tricholomataceae		√
123	*Colocasia esculenta*	Pein-yaing	Araceae	√	√
124	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae	√	√
125	*Combretum alfredii* Hance	Not known	Combretaceae	√	
126	*Commelina communis*	Myet-kyut	Commelinaceae		√
127	*Commelina diffusa* Burm.f.	Myet-kyut	Commelinaceae		√
128	*Commelina persicariaefolia* Wright.	Myet-kyut	Commelinaceae	√	√
129	*Convolvulus parviflorus* Vahl	Not known	Convolvulaceae	√	
130	*Coprinus disseminatus*	Not known	Psathyrellaceae		√
131	*Coprinus plicatilis* (Curt.) Fr.	Not known	Psathyrellaceae		√
132	*Corchorus olitorius* L.	Pi-law-yaing	Tiliaceae	√	
133	*Costus specious* Sm.	Pha-lan-taung-hmwe	Costaceae	√	√
134	*Crassocephalum crepidioides*	Pan-zauk-htoe	Asteraceae		√
135	*Crateva magna* (Lour.) DC.	Ka-det	Capparaceae	√	√
136	*Cratoxylum neriifolium* Kurz	Bae-bya	Hypericaceae		√
137	*Cratoxylum polyanthum*Korth.	Bae-bya	Hypericaceae		√
138	*Crotalaria alata* Buch.-Ham. ex G.Don	Not known	Fabaceae	√	
139	*Crotalaria multiflora* L.	Taw-paik-san	Fabaceae	√	√
140	*Crotalaria sericea* Retz	Taw-paik-san	Fabaceae	√	
141	*Croton joufra* Roxb.	Tha-yin-ka-doe	Euphorbiaceae		√
142	*Croton oblongifolius* Roxb.	Tha-yin-gyi	Euphorbiaceae	√	√
143	*Curculigo orchioides* Gaertn.	Kywet-ma-lut-ohn	Hypoxidaceae		√
144	*Curcuma alismatifolia*	Ma-lar	Zingiberaceae		√
145	*Curcuma aromatica*	Mar-la	Zingiberaceae		√
146	*Curcuma longa*	Ma-lar	Zingiberaceae		√
147	*Curcuma longa* L.	Na-nwin	Zingiberaceae		√
148	*Curcuma petiolata* Roxb.	Ma-lar	Zingiberaceae	√	√
149	*Curcuma* sp.	Mar-la	Zingiberaceae	√	
150	*Cycas siamensis* Miq.	Mon-daing	Cycadaceae		√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
151	*Cymbidium aloifolium* (L.)Sw.	Thit-tet-lin-nae	Orchidaceae	√	√
152	*Cynodon dactylon* (L.) Pers.	Myay-sa	Poaceae	√	√
153	*Cyperus malaccensis* var. *brevifolius*	Not known	Cyperaceae		√
154	*Dactyloctenium aegyptium* (L.) Willd.	Myet-lay-gwa	Poaceae	√	
155	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	√	√
156	*Dalbergia fusca* Pierre	Taw-yingu	Fabaceae	√	√
157	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	√	√
158	*Datura metel* L.	Pa-daing	Solanaceae		√
159	*Dendrobium* sp.	Not known	Orchidaceae		√
160	*Dendrocalamus latiflorus* Munro	Wa-bo	Poaceae		√
161	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	√	√
162	*Dendrophthoe pentandra* (L.) Miq.	Kyi-paung	Loranthaceae	√	
163	*Desmodium gangeticum* L.	Not known	Fabaceae	√	
164	*Desmodium heterocarpon*	Myay-pe-htwe	Fabaceae		√
165	*Desmodium pulchellum* Benth.	Taung-damin	Fabaceae	√	
166	*Desmodium rufihirsutum* Craib	Not known	Fabaceae	√	√
167	*Desmodium triangulare* (Retz.) Merr.	Not known	Fabaceae	√	√
168	*Desmodium triflorum*	Not known	Fabaceae	√	
169	*Desmodium umbellatum* DC.	Kyee-hmi-apho	Fabaceae	√	√
170	*Dichanthium caricosum* (L.)A.Camus	Pa-daw-myet	Poaceae	√	√
171	*Dichrocephala integrifolia (*L.f.)Kuntze	Not known	Asteraceae	√	√
172	*Dicliptera neesii* Trimen.	Not known	Acanthaceae	√	√
173	*Dillenia indica* L.	Tha-byu	Dilleniaceae		√
174	*Dillenia parviflora* Griff.	Zin-byun	Dilleniaceae	√	√
175	*Dioscorea alata*	Myauk-u	Dioscoreaceae	√	√
176	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae	√	√
177	*Dioscorea cylindrica* Burm.	Kywary-thon-ywet	Dioscoreaceae	√	√
178	*Dioscorea pentaphylla* L.	Kyway-ngar-ywet	Dioscoreaceae	√	√
179	*Dioscorea sativa* L.	Kyauk-yin-nwee	Dioscoreaceae	√	√
180	*Diospyros kaki* L.f.	Tae	Ebenaceae	√	√
181	*Dipterocarpus tuberculatus* Roxb.	In	Dipterocarpaceae		√
182	*Dracaena sanderiana*	Zaw-sein	Asparagaceae		√
183	*Drynaria quercifolia*	Birdnet-fern	Polypodiaceae	√	√
184	*Duabanga grandiflora*	Myauk-ngo/Phet-pauk	Lythraceae	√	√
185	*Dunbaria punctata*	Not known	Fabaceae	√	√
186	*Dysolobium grande* Prain	Khwe-la-byut	Fabaceae		√
187	*Eclipta alba* (L.) Hassk.	Kyeik-hman	Asteraceae		√
188	*Ehretia acuminata* R.Br	Taung-poe-lu-lin	Boraginaceae	√	√
189	*Elaeocarpus hainanensis* Oliv.	Kywe-pan-pin	Elaeocarpaceae	√	√
190	*Elatostema reticulatum*	Wet-sa	Urticaceae	√	√
191	*Eleusine indica* Gaertn.	Sin-ngo-myet	Poaceae	√	√
192	*Emblica officinalis* Gaertn.	Sha-phyu	Euphorbiaceae	√	√
193	*Engelhardtia spicata*	Pan-swe-le	Juglandaceae	√	√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
194	*Entada scandens* Benth.	Doe-nwee	Mimosaceae	√	√
195	*Equisetum hyemale*	Not known	Equisetaceae	√	√
196	*Eragrostis tef* (Zucc.)Trotter	Myet	Poaceae	√	
197	*Erythrina stricta* Roxb.	Ka-di\Ka-thit	Fabaceae	√	√
198	*Eugenia balsama* Wight	Ye-tha-bye	Myrtaceae		√
199	*Eugenia densiflora* DC.	Kyauk-tha-bye	Myrtaceae	√	√
200	*Euphorbia antiquorum* L.	Tazaung-gyi	Euphorbiaceae	√	√
201	*Euphorbia heterophylla*	Sae-pa-le	Euphorbiaceae	√	√
202	*Euphorbia hypericifolia* L.	Kywe-kyaung-hmin-se	Euphorbiaceae	√	√
203	*Ficus auriculata*	Sin-tha-phan	Moraceae		√
204	*Ficus bengalensis* L.	Pyin-nyaung	Moraceae	√	√
205	*Ficus glomerata* Roxb.	Ye-tha-phan	Moraceae		√
206	*Ficus hispida* L.	Kha-aung	Moraceae	√	√
207	*Ficus lanceolata* Buch.-Ham.	Ye-tha-phan	Moraceae		√
208	*Ficus pumila* L.	Creeping fig.	Moraceae	√	√
209	*Ficus racemosa*	Tha-phan	Moraceae	√	√
210	*Ficus religiosa* L.	Baw-di-nyaung	Moraceae		√
211	*Ficus semicordata*	Ka-dut	Moraceae		√
212	*Ficus variegata*	Kon-tha-phan	Moraceae	√	√
213	*Fimbristylis sieboldii*	Not known	Cyperaceae		√
214	*Flacourtia cataphracta* Roxb.	Na-ywe	Flacourtiaceae		√
215	*Flemingia stricta* Roxb.	Kyee-hmi	Fabaceae		√
216	*Flueggea leucopyrus* Willd	Ye-chin-ya	Euphorbiaceae	√	√
217	*Fomes fomentarius*	Not known	Polyporaceae		√
218	*Gagea reticulata* (Pall.) Schult.	Not known	Liliaceae	√	
219	*Ganoderma australe*	Not known	Ganodermataceae		√
220	*Ganoderma lucidum*	Not known	Ganodermataceae		√
221	*Garcinia cowa* Roxb.	Taung-tha-lae	Hypericaceae		√
222	*Gardenia coronaria* Buch-Ham.	Yin-khat-gyi	Rubiaceae	√	√
223	*Gardenia turgida* Roxb.	Hman-phyu/ Hnan-khaung-chauk	Rubiaceae		√
224	*Garuga pinnata* Roxb.	Chin-yoke	Burseraceae		√
225	*Gastrochilus* sp.	Not known	Orchidaceae		√
226	*Getonia floribunda* Roxb.	Kywet-nwee	Combretaceae	√	
227	*Getonia floribunda* Roxb.	Kywet-nwee	Combretaceae	√	
228	*Globba patens*	Pa-dein-ngo	Zingiberaceae	√	√
229	*Globba pendula*	Pa-dein-ngo-thay	Zingiberaceae	√	√
230	*Glochidion* sp.	Hta-min-sok	Euphorbiaceae		√
231	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae	√	√
232	*Gochnatia decora*	Not known	Asteraceae	√	√
233	*Gonostegia hirta*	Not known	Rubiaceae	√	√
234	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae	√	√
235	*Grewia laevigata*	Not known	Tiliaceae		√
236	*Grewia laevigata* Vahl	Ta-yaw	Tiliaceae	√	

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
237	*Habenaria chlorina* Par. & Rchb.f.	Not known	Orchidaceae	√	
238	*Habenaria hosseusii* Schltr.	Not known	Orchidaceae	√	
239	*Habenaria procera*	Not known	Orchidaceae		√
240	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae	√	√
241	*Hedyotis auricularia*	Not known	Rubiaceae		√
242	*Hedyotis diffusa*	Not known	Rubiaceae	√	
243	*Helicia erratica* Hook. f.	Dauk-yat	Proteaceae		√
244	*Helicteres angustifolia* L.	Not known	Sterculiaceae	√	√
245	*Heliotropium indicum* L.	Sin-hna-maung	Boraginaceae	√	√
246	*Hemigraphis repanda*	Not known	Acanthaceae	√	
247	*Heteropanax fragrans* (Roxb. ex DC.) Seem.	Kyaung-dauk/La-ka-du	Araliaceae		√
248	*Heterophragma adenophylla* (Wall.) Seem. ex Benth. & Hook.	Phet-than	Bignoniaceae		√
249	*Heterophragma sulfureum* Kurz	Phet-than	Bignoniaceae		√
250	*Hibiscus ficulneus* L.	Taw-yon-pade	Malvaceae	√	√
251	*Hiptage benghalensis* (L.) Kurz	Sar-say/Bein-nwee	Malpighiaceae	√	√
252	*Holarrhena pubescens* Wall. ex G. Don	Let-htok-gyi	Apocynaceae	√	√
253	*Homonoia riparia*	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	√	√
254	*Hydrocotyle sibthorpioides* Thunb	Myin-khwa	Apiaceae	√	√
255	*Hygrophorus limacinus*	Not known	Hygrophoraceae		√
256	*Hymenodictyon orixense* (Roxb.) Mabb.	Khu-than	Rubiaceae		√
257	*Hypericum japonicum* Thunb. ex Murray	Not known	Hypericaceae	√	√
258	*Hypholoma incertum* Pk.	Not known	Microthyriaceae		√
259	*Impatiens chinensis* L.	Dan-pan	Balsaminaceae		√
260	*Imperata cylindrica* (L.) P. Beauv.	Thet-kae	Poaceae		√
261	*Indigofera tinctoria*	Me-yaing	Fabaceae	√	
262	*Indigofera tinctoria* L.	Taw-hne	Fabaceae	√	√
263	*Inonotus hispidus*	Not known	Hymenochaetaceae		√
264	*Ipomoea cairica*	Ka-zun	Convolvulaceae	√	
265	*Ipomoea cordatotriloba*	Ka-zun	Convolvulaceae	√	
266	*Isachne albens* Trin.	Myet	Poaceae	√	
267	*Ischaemum ciliare*	Not known	Poaceae	√	
268	*Ischnoderma benzoinum*	Hmo	Fomitopsidaceae	√	
269	*Jasminum multiflorum*	Taw-sa-bei	Oleaceae		√
270	*Justicia procumbens*	Not known	Acanthaceae	√	
271	*Kyllinga brevifolia*	Not known	Cyperaceae		√
272	*Lactarius glaucescens* Pk.	Not known	Russulaceae		√
273	*Lactarius volemus* Fr.	Not known	Russulaceae		√
274	*Lagerstroemia macrocarpa* Kurz	Pyin-ma-ywet-gyi	Lythraceae		√
275	*Lagerstroemia speciosa* (L.) Pers.	Pyin-ma-ywet-thay	Lythraceae	√	√
276	*Lagerstroemia villosa* Wall. ex Kurz	Zaung-palae	Lythraceae		√
277	*Lagerstroemia villosa* Wall.ex Kurz	Let-khwe	Lythraceae		√
278	*Lannea coromandelica* (Houtt.) Merrr.	Na-be	Anacardiaceae	√	√

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279	*Lantana camara* L.	Sein-na-pan	Verbenaceae	√	√
280	*Lasia aculeata* Lour.	Za-yit	Araceae		√
281	*Leea hirta* Banks	Naga-mauk-phyu/Hta-min-yae	Leeaceae	√	√
282	*Leea macrophylla* Roxb.	Na-ga-mauk-gyi	Leeaceae	√	√
283	*Leea rubra*	Na-ga-mauk-ni	Leeaceae	√	√
284	*Lentinus squarrosulus*	Not known	Polyporaceae		√
285	*Lenzites betulina*	Not known	Polyporaceae		√
286	*Lepiota cristata*	Not known	Agaricaceae		√
287	*Lepiota morgani* Pk.	Not known	Agraricaceae		√
288	*Leptadenia reticulata* Wight & Arn.	Gon-kha	Asclepiadaceae		√
289	*Leucaena leucocephala* (Lam.) De.Wit	Baw-sa-gaing	Mimosaceae	√	√
290	*Leucas cephalotes* Spreng.	Pin-gu-hteik-peik	Lamiaceae		√
291	*Lithocarpus craibianus* Barnett	Thit-ae	Fagaceae	√	
292	*Litsea glutinosa*	On-don	Lauraceae		√
293	*Ludwigia hyssopifolia*	Lay-nyin-thay	Onagraceae	√	√
294	*Ludwigia octovalvis*	Lay-nyin-gyi	Onagraceae	√	
295	*Luffa aegyptiaca* Mill.	Tha-but	Cucurbitaceae		√
296	*Lycoperdon pyriforme*	Not known	Agaricaceae		√
297	*Lygodium circinnatum*	Not known	Lygodiaceae	√	
298	*Lygodium japonicum*(Thunb.)Sw.	Not known	Lygodiaceae		√
299	*Mallotus philippensis*	Taw-thi-din	Euphorbiaceae		√
300	*Mangifera sylvatica* Roxb.	Taw-tha-yet	Anacardiaceae	√	√
301	*Marasmium oreades*	Not known	Marasmiaceae		√
302	*Marasmius foetidum* Fr.	Not known	Marasmiaceae		√
303	*Markhamia stipulata* (Wall.) Seem. Ex K.Schum.	Ma-hlwa	Bignoniaceae		√
304	*Melanorrhoea usitata* Wall.	Thit-si	Anacardiaceae	√	√
305	*Merremia vitifolia* (Burm.f.) Hallier. f.	Kyet-hinga-lae-new	Convolvulaceae	√	
306	*Mesua ferrea* L.	Taw-gan-gaw	Hypericaceae	√	√
307	*Michelia baillonii* (Pierr)Finet & Gagnep.	Sa-ga-phyu	Magnoliaceae		√
308	*Micromelum minutum* (G. Forst.) Wight & Arn.	Pa-le-pan/Pauk-chaung	Rutaceae	√	
309	*Microporus xanthopus* (Fr.) Kuntze	Hmo	Polyporaceae	√	√
310	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae	√	√
311	*Millettia extensa* Benth.	Win-u	Fabaceae	√	√
312	*Millettia ovalifolia* Kurz	Thin-win-pho	Fabaceae	√	√
313	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	√	√
314	*Mitragyna rotundifolia* (Roxb.) Kuntze	Bin-ga	Rubiaceae		√
315	*Morus indica* L.	Po-sa	Moraceae	√	√
316	*Mucuna pruriens* (L.)DC.	Khwe-la-ya	Fabaceae	√	√
317	*Murdannia bracteata*	Not known	Commelinaceae	√	√
318	*Musa balbisiana*	Nget-pyaw	Musaceae		√
319	*Musa* sp.	Nga-pyaw-yaing	Musaceae		√
320	*Mussaenda calycina* Wall. ex Kurz	Pwint-tu-ywet-tu	Rubiaceae		√

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321	*Myriopteron paniculatum* Griff	Ti-lay-na-tha	Asclepiadaceae	√	√
322	*Nauclea orientalis* L.	Ma-u-let-tan-to	Rubiaceae		√
323	*Nervilia plicata*	Tabin-ting-shwe-hti	Orchidaceae	√	√
324	*Ochna integerrima*	Indaing-seni	Ochnaceae	√	
325	*Oldenlandia diffusa*	Not known	Rubiaceae	√	
326	*Operculina turpethum* (L.) Silva Mansa	Kyar-hin-nwee	Convolvulaceae	√	√
327	*Ophioglossum nudicaule*	Addler's Tongue Fern	Ophioglossaceae		√
328	*Oroxylum indicum* (L.)Kurz	Kyaung-sha	Bignoniaceae	√	√
329	*Oxalis corniculata* L.	Hmo-chin	Oxalidaceae	√	√
330	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae	√	√
331	*Paederia foetida*	Pe-bok-nwee-thay	Rubiaceae	√	
332	*Paederia scandens* Lour.	Pe-bok-nwee-gyi	Rubiaceae	√	
333	*Pandanus odoratissimus* L.f.	Sat-tha-phu	Pandanaceae	√	√
334	*Panus tigrinus*	Not known	Polyporaceae		√
335	*Passiflora foetida* L.	Taw-su-ka	Passifloraceae	√	√
336	*Paxillus involutus* (Batsch.)Fr.	Hmo	Paxillaceae	√	
337	*Pennisetum purpureum*	Yon-sa-myet	Poaceae	√	√
338	*Peperomia pellucida*	Thit-ye-kyi	Piperaceae	√	
339	*Pericampylus glaucus* L.	Not known	Menispermaceae	√	
340	*Peristrophe roxburghiana*	Not known	Acanthaceae	√	
341	*Peristylus affinis* (D.Don)Seidenf.	Not known	Orchidaceae		√
342	*Peristylus goodyeroides* (D.Don)Lindl.	Simidauk	Orchidaceae		√
343	*Persicaria odorata*	Kywe-hna-khaung-gyate	Polygonaceae	√	√
344	*Phaseolus* sp.	Not known	Fabaceae	√	
345	*Phaseolus velutina* Grah.	Pauk-net	Fabaceae	√	√
346	*Phellinus tremulae*	Not known	Hymenochaetaceae		√
347	*Phoenix loureiri* Kunth	Thin-baung	Arecaceae		√
348	*Pholiota flammas* Pk.	Hmo	Strophariaceae	√	√
349	*Phyllanthus amarus*	Myay-zi-phyu	Euphorbiaceae	√	√
350	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	√	√
351	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae	√	√
352	*Physalis minima* L.	Bauk-thi	Solanaceae	√	√
353	*Pilea scripta* Langtang	Phet-ya	Urticaceae	√	√
354	*Piper cubebe* L. f.	Peik-chin	Piperaceae		√
355	*Pleurotus cornucopiae*	Not known	Pleurotaceae		√
356	*Ploiarium alternifolium*	Not known	Theaceae	√	√
357	*Poa sylvestris*	Myet	Poaceae	√	
358	*Pogostemon auricularius*	Not known	Lamiaceae	√	√
359	*Polyalthia viridis*	Not known	Annonaceae		√
360	*Polygonum barbatum*	Kywe-hna-khaung-gyate	Polygonaceae		√
361	*Polygonum plebeium*	Not known	Polygonaceae	√	√
362	*Polyporus ovinus* (Schaeff.)Fr.	Not known	Polyporaceae		√
363	*Portulaca grandiflora* Hook.	Shan-hnin-si	Portulacaceae		√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
364	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	√	
365	*Pouzolzia zeylanica*	Not known	Urticaceae	√	√
366	*Pouzolzia zeylanica* (L.) Benn.	Not known	Urticaceae		√
367	*Premna amplectens* Wall	Yin-bya-phyu	Verbenaceae		√
368	*Psalliota placomyces* (Pk.) Kauffm.	Not known	Agaricaceae		√
369	*Psalliota silvatica* (Schaeff.) Quel.	Not known	Agaricaceae		√
370	*Pseuderanthemum polyanthum*	Not known	Acanthaceae	√	√
371	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	√	√
372	*Pterospermum acerifolium*	Not known	Sterculiaceae	√	
373	*Pterospermum acerifolium* (L.) Willd.	Taung-phet-wun	Sterculiaceae		√
374	*Pterospermum diversifolium*	Not known	Sterculiaceae	√	√
375	*Pycnoporus cinnabarinus*	Not known	Polyporaceae		√
376	*Pycnoporus sanguineus*	Hmo	Polyporaceae	√	
377	*Quercus mespilifolia* Wall.	Yin-gu	Fagaceae		√
378	*Randia uliginosa* DC.	Hman-ni	Rubiaceae	√	√
379	*Rumex crispus* L.	Not known	Polygonaceae	√	√
380	*Rumex trisetiferus* Stokes	Not known	Polygonaceae	√	√
381	*Saccharum spontaneum* L.	Kaing	Poaceae	√	√
382	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae	√	√
383	*Sapium baccata*	Aw-le	Euphorbiaceae		√
384	*Schima wallichii* (DC.) Korth.	Lauk-ya	Theaceae	√	√
385	*Schizophyllum commune*	Not known	Schizophyllaceae	√	√
386	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	√	√
387	*Schrebera swietenioides* Roxb.	Thit-swe-le	Oleaceae	√	√
388	*Scindapsus officinalis* (Roxb.) Schott	Sin-peik-chin	Araceae	√	
389	*Scoparia dulcis* L.	Dana-thu-kha	Scrophulariaceae	√	√
390	*Scurrula parasitica* L.	Kyi-paung	Loranthaceae	√	
391	*Selaginella willdenowii*	Not known	Selaginellaceae	√	√
392	*Senna hirsuta* (L.) Irwin & Barneby	Ka-thaw-hmwe-htu	Caesalpiniaceae	√	√
393	*Senna tora* (L.) Roxb	Dan-gwe	Caesalpiniaceae	√	√
394	*Sesbania* sp.	Nyan	Fabaceae		√
395	*Setaria palmifolia* Stapf.	Myet	Poaceae	√	
396	*Shorea obtusa* Wall.	Thit-ya	Dipterocarpaceae	√	√
397	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	√	√
398	*Sida acuta* Burm f.	Ta-byet-si-ywet-shae	Malvaceae		√
399	*Sida rhombifolia* L.	Ta-byet-se-ywet-waing	Malvaceae		√
400	*Sinomenium acutum* (Thunb.)Rehd.et Wils.	Nwee-war/Say-war	Menispermaceae		√
401	*Smilax aspericaulis* Wall ex A. D.C.	Sein-na-baw-thay	Smilacaceae		√
402	*Smilax china* L.	Not known	Smilacaceae		√
403	*Smilax macrophylla* Roxb.	Sein-na-baw-gyi	Smilacaceae		√
404	*Smilax*sp.	Sein-na-baw	Smilacaceae	√	
405	*Solanum aculeatissimum* Jacq.	Not known	Solanaceae	√	√
406	*Solanum coagulans*	Kha-yan	Solanaceae	√	

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
407	*Solanum indicum* L.	Ka-zaw-kha	Solanaceae	√	√
408	*Solanum nigrum* L.	Baung-laung-nyo	Solanaceae		√
409	*Solanum torvum* Swartz	Kha-yan-ka-zawt	Solanaceae	√	√
410	*Solanum verbascifolium*	Not known	Solanaceae		√
411	*Spermacoce remota*	Not known	Rubiaceae	√	
412	*Spirogyra* sp.	Algae	Zygnemataceae	√	
413	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae	√	√
414	*Stemona burkillii* Prain	Tha-mya	Stemonaceae		√
415	*Stemona tuberosa*	Tha-mya	Stemonaceae	√	√
416	*Sterculia foetida* L.	Shaw-phyu	Sterculiaceae	√	√
417	*Sterculia villosa*	Shaw	Sterculiaceae	√	√
418	*Stereospermum suaveolens* (Roxb.) DC.	Kywe-ma-gyo-lein	Bignoniaceae	√	√
419	*Streptocaulon tomentosum* Wight & Arn.	Myin-sa-gon-ni	Asclepiadaceae	√	√
420	*Strobilanthes isophyllus*	Not known	Acanthaceae		√
421	*Strophanthus wallichii* A.DC.	Na-sha-gyi	Apocynaceae		√
422	*Strychnos nux-blanda* A.W.Hill	Kha-baung	Loganiaceae	√	√
423	*Syzygium grande* (Wight) Walp	Tha-bye	Myrtaceae	√	√
424	*Tamarindus indica* L.	Ma-gyi	Caesalpiniaceae		√
425	*Tanacetum tibeticum* Hook.f. & Thomson	Not known	Asteraceae	√	√
426	*Taraxacum officinale*	Not known	Asteraceae	√	√
427	*Tectona grandis* L. f.	Kyun	Verbenaceae	√	√
428	*Terminalia alata* (Heyne) Roth	Htauk-kyant	Combretaceae	√	√
429	*Terminalia bellerica* Roxb.	Thit-seint	Combretaceae		√
430	*Terminalia chebula* Retz.	Phan-kha	Combretaceae		√
431	*Terminalia oliveri* Brandis	Than	Combretaceae	√	√
432	*Terminalia tripteroides* Craib	Than-bae	Combretaceae		√
433	*Termitomyces albuminosa*	Taung-po-hmo	Agaricaceae	√	√
434	*Tetrameles nudiflora* R.Br.	Thit-pok	Datiscaceae	√	√
435	*Tetrastigma leucostaphylum*	Not known	Vitaceae	√	√
436	*Thespesia lampas* Dalzell & A.Gibson	Taw-wa	Malvaceae	√	√
437	*Thunbergia fragrans* Roxb.	Pan-ye-sut	Acanthaceae		√
438	*Thunbergia grandiflora*	Kyi-hnok-thi-nwee	Acanthaceae	√	
439	*Thyrsostachys oliveri* Gamble	Tha-net-wa	Poaceae		√
440	*Tithonia diversifolia* A. Gray	Nay-kyar-yaing	Asteraceae	√	√
441	*Trametes versicolor*	Taung-po-hmo	Polyporaceae	√	√
442	*Trema orientalis* (L.) Blume	Khwe-sha	Ulmaceae		√
443	*Trichosanthes cordata* Roxb.	Kyi-ah	Cucurbitaceae	√	
444	*Tristaniopsis burmanica* (griff.)P.G.Wilson & J.T. Waterh.	Dauk-yat	Myrtaceae		√
445	*Triumfetta bartramia* L.	Kat-se-nae-thay	Tiliaceae		√
446	*Tylophora indica*	Not known	Apocynaceae	√	√
447	*Uraria crinita* (L.)Desv.ex DC.	Not known	Fabaceae	√	√
448	*Uraria lagopodioides* (L.)Desv.ex DC.	Not known	Fabaceae		√
449	*Urena sinuata*	Kat-se nae-gyi	Malvaceae		√

No.	Scientific Name	Common Name	Family Name	Right Bank	Left Bank
450	*Utricularia caerulea*	Ye-bu-baung	Lentibulariaceae	√	
451	*Uvaria cordata* Schum. & Thonn.	Tha-but-gyi	Annonaceae	√	
452	*Vanda coerulescens* Griff.	Mo-lon-hmying-apyar-lay	Orchidaceae	√	
453	*Vangueria spinosa* Roxb.	Ma-gyi-bauk	Rubiaceae	√	√
454	*Verpa cornica*	Not known	Morchellaceae		√
455	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae	√	√
456	*Vitex vestita* Wall.	Tauk-sha	Verbenaceae	√	√
457	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae	√	√
458	*Wrightia arborea* (Dennst.) Mabb.	Let-htok-thein	Apocynaceae		√
459	*Xylia xylocarpa* (Roxb.) Taub.	Pyin-ka-doe	Mimosaceae		√
460	*Zephyranthes carinata* Herb.	Hnin-pan	Amaryllidaceae		√
461	*Zingibr zerumbet*	Linne-gyi	Zingiberaceae		√
462	*Ziziphus jujuba* Lam.	Zi	Rhamnaceae	√	√

A total of 20 flora species on the IUCN Red List can be found on the left bank. Most notably, *Curcuma alismatifolia* is classified as NT, *Dalbergia cultrata* Grah.is classified as NT, *Cycas siamensis* Miq. is classified as VU A2 cd, and *Dalbergia oliveri* Gamble is classified as EN A1cd. The other 16 species on the list are classified as either least concern or low risk/least concern.

Table 44: Flora IUCN Status (Entire Left Bank)

Scientific Name	Common Name	Family Name	IUCN Status
Bauhinia ornata Kurz	Myauk-hle-ga	Caesalpiniaceae	LC
Boesenbergia rotunda (L.) Mansf.	Seik-phu	Zingiberaceae	LC
Caesalpinia sappan L.	Tein-nyet	Caesalpiniaceae	LR/Lc
Colocasia esculenta	Pein-yaing	Araceae	LC
Curcuma alismatifolia	Ma-lar	Zingiberaceae	NT
Cycas siamensis Miq.	Mon-daing	Cycadaceae	VU A2cd
Dalbergia cultrata Grah.	Yin-daik	Fabaceae	NT
Dalbergia oliveri Gamble	Ta-ma-lan	Fabaceae	EN A1cd
Dendrocalamus membranaceus Munro	Hmyin-wa	Poaceae	LC
Dipterocarpus tuberculatus Roxb.	In	Dipterocarpaceae	LR/Lc
Engelhardtia spicata	Pan-swe-le	Juglandaceae	LR/Lc
Equisetum hyemale	Not known	Equisetaceae	LC
Holarrhena pubescens Wall. ex G. Don	Let-htok-gyi	Apocynaceae	LC
Homonoia riparia	Ye-mo-ma-kha/Ye-ma-nae	Euphorbiaceae	LC
Ludwigia hyssopifolia	Lay-nyin-thay	Onagraceae	LC
Mangifera sylvatica Roxb.	Taw-tha-yet	Anacardiaceae	LR/Lc
Mimosa pudica L.	Hti-ka-yone	Mimosaceae	LC
Saccharum spontaneum L.	Kaing	Poaceae	LC

Shorea obtusa Wall.	Thit-ya	Dipterocarpaceae	LR/Lc
Shorea siamensis(Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/Lc

4. FAUNA

4.1 Insects and Other Invertebrate Species

A total of 86 insects and other invertebrate species were identified on the left bank. This includes 38 butterfly species, 15 beetle species, 11 dragonfly/damselfly species, 7 grasshopper species, 3 locust species, 5 true bug species, 5 spider species, 1 scorpion species and 1 praying mantis species. A total of 138 insect and invertebrate species were found on both the left and right banks combined. Of this total, 86 species of insects and other invertebrates where identified on the left bank as opposed to 74 found on the right bank. 22 species were found on both banks while 52 species were found on the right bank only and 65 species were found on the left bank only.

Table 45: Insect and Other Invertebrate Species on Left Bank

No.	Order	Family	Scientific Name	Common Name	Local Name
1	Lepidoptera	Papilionidae	*Papilio polytes Romulus*	Butterfly	Leik-pyar
2	Lepidoptera	Papilionidae	*Papilio hipponous pitmani*	Butterfly	Leik-pyar
3	Lepidoptera	Papilionidae	*Papilio memnon agenor*	Butterfly	Leik-pyar
4	Lepidoptera	Papilionidae	*Lamproptera curis curis*	Butterfly	Leik-pyar
5	Lepidoptera	Papilionidae	*Lamproptera merge*	Butterfly	Leik-pyar
6	Lepidoptera	Papilionidae	*Graphium nomius*	Butterfly	Leik-pyar
7	Lepidoptera	Nymphalidae	*Junonia lemonias lemonias*	Butterfly	Leik-pyar
8	Lepidoptera	Nymphalidae	*Junonia hierta*	Butterfly	Leik-pyar
9	Lepidoptera	Nymphalidae	*Phalanta phalanta*	Butterfly	Leik-pyar
10	Lepidoptera	Nymphalidae	*Phalanta alcipee*	Butterfly	Leik-pyar
11	Lepidoptera	Nymphalidae	*Neptis leucopharus*	Butterfly	Leik-pyar
12	Lepidoptera	Nymphalidae	*Kallima limborgii*	Butterfly	Leik-pyar
13	Lepidoptera	Nymphalidae	*Chersonesia rahriodes*	Butterfly	Leik-pyar
14	Lepidoptera	Nymphalidae	*Hypolimanas misippus*	Butterfly	Leik-pyar
15	Lepidoptera	Nymphalidae	*Cupha erymanthis lotis*	Butterfly	Leik-pyar
16	Lepidoptera	Nymphalidae	*Lexias pardalis dirteana*	Butterfly	Leik-pyar
17	Lepidoptera	Nymphalidae	*Argyreus hyperbius hyperbius*	Butterfly	Leik-pyar
18	Lepidoptera	Nymphalidae	*Tanaecia munda manata*	Butterfly	Leik-pyar
19	Lepidoptera	Nymphalidae	*Cethosia cyane auanthes*	Butterfly	Leik-pyar

20	Lepidoptera	Nymphalidae	*Charaxes solon sulphureu*	Butterfly	Leik-pyar
21	Lepidoptera	Pieridae	*Delias hyparete metarete*	Butterfly	Leik-pyar
22	Lepidoptera	Danaidae	*Danaus affinis*	Butterfly	Leik-pyar
23	Lepidoptera	Danaidae	*Euploea mulcibermulciber*	Butterfly	Leik-pyar
24	Lepidoptera	Satyridae	*Orsotriena medus medus*	Butterfly	Leik-pyar
25	Lepidoptera	Satyridae	*Mycalesis mineus mineus*	Butterfly	Leik-pyar
26	Lepidoptera	Satyridae	*Erites argentina delia*	Butterfly	Leik-pyar
27	Lepidoptera	Lycaenidae	*Byasa dasarada*	Butterfly	Leik-pyar
28	Lepidoptera	Lycaenidae	*Orsotriaena medus*	Butterfly	Leik-pyar
29	Lepidoptera	Lycaenidae	*Ypthima baldus*	Butterfly	Leik-pyar
30	Lepidoptera	Lycaenidae	*Laringa casteinaui*	Butterfly	Leik-pyar
31	Lepidoptera	Lycaenidae	*Discolampa ethion*	Butterfly	Leik-pyar
32	Lepidoptera	Lycaenidae	*Caleta elna*	Butterfly	Leik-pyar
33	Lepidoptera	Lycaenidae	*Caleta decidia decidia*	Butterfly	Leik-pyar
34	Lepidoptera	Lycaenidae	*Lorura arynnaus*	Butterfly	Leik-pyar
35	Lepidoptera	Lycaenidae	*Moduza procris*	Butterfly	Leik-pyar
36	Lepidoptera	Lycaenidae	*Zeltus amasa amasa*	Butterfly	Leik-pyar
37	Lepidoptera	Lycaenidae	*Rapala pheretima*	Butterfly	Leik-pyar
38	Lepidoptera	Lycaenidae	*Heliophorus brahma*	Butterfly	Leik-pyar
39	Coleoptera	Chrysomelidae	*Aulacophora foveicollis*	Beetle	Poe-taung-mar
40	Coleoptera	Chrysomelidae	*Aulacophora lewisii*	Beetle	Poe-taung-mar
41	Coleoptera	Chrysomelidae	*Aspidomorpha miliaris*	Beetle	Poe-taung-mar
42	Coleoptera	Chrysomelidae	*Cassida circumdata*	Beetle	Poe-taung-mar
43	Coleoptera	Chrysomelidae	*Agetocera filicorhis*	Beetle	Poe-taung-mar
44	Coleoptera	Scarabaeidae	*Catharsius mollossus*	Beetle	Poe-taung-mar
45	Coleoptera	Scarabaeidae	*Enoplotrupes sharpi*	Beetle	Poe-taung-mar
46	Coleoptera	Scarabaeidae	*Anomala grandis*	Beetle	Poe-taung-mar
47	Coleoptera	Meloidae	*Mylabris cichorii*	Beetle	Poe-taung-mar
48	Coleoptera	Meloidae	*Mylabris phalerata*	Beetle	Poe-taung-mar
49	Coleoptera	Cerambycidae	*Zonopterus flavitarsis*	Beetle	Poe-taung-mar

50	Coleoptera	Eumolpidae	*Platycorynus peregrinus*	Beetle	Poe-taung-mar
51	Coleoptera	Cicindelidae	*Tricodyla annulicornis*	Beetle	Poe-taung-mar
52	Coleoptera	Cocinellidae	*Coccinella transversalis*	Beetle	Poe-taung-mar
53	Coleoptera	Carabidae	*Dischissus mirandus*	Beetle	Poe-taung-mar
54	Odonata	Libellulidae	*Neurothemis fulvia*	Dragonfly	Ba-zine
55	Odonata	Libellulidae	*Neurothemis tullia tullia*	Dragonfly	Ba-zine
56	Odonata	Libellulidae	*Neurothemis inquirendae*	Dragonfly	Ba-zine
57	Odonata	Libellulidae	*Neurothemis atlanta*	Dragonfly	Ba-zine
58	Odonata	Libellulidae	*Neurothemis intermedia Atlanta*	Dragonfly	Ba-zine
59	Odonata	Libellulidae	*Rhyothemis plutonia*	Dragonfly	Ba-zine
60	Odonata	Libellulidae	*Rhodothemis rufa*	Dragonfly	Ba-zine
61	Odonata	Libellulidae	*Brachythemis contaminate*	Dragonfly	Ba-zine
62	Odonata	Libellulidae	*Trithemis aurora*	Dragonfly	Ba-zine
63	Odonata	Lestidae	*Coeliccia cyanomelas*	Damselfly	Ba-zine
64	Odonata	Lestidae	*Platycnemis foliaces*	Damselfly	Ba-zine
65	Orthoptera	Pyrgomorphidae	*Sp.1*	Grasshopper	Hnan-kaung
66	Orthoptera	Locustidae	*Sp. 1*	Grasshopper	Hnan-kaung
67	Orthoptera	Locustidae	*Sp. 2*	Grasshopper	Hnan-kaung
68	Orthoptera	Cantantopidae	*Sp. 1*	Grasshopper	Hnan-kaung
69	Orthoptera	Cantantopidae	*Sp. 2*	Grasshopper	Hnan-kaung
70	Orthoptera	Arcypteridae	*Sp. 1*	Grasshopper	Hnan-kaung
71	Orthoptera	Arcypteridae	*Sp. 2*	Grasshopper	Hnan-kaung
72	Orthoptera	Tettigidae	*Sp. 1*	Locusts	Kyaing-kaung
73	Orthoptera	Tettigidae	*Sp. 2*	Locusts	Kyaing-kaung
74	Mantodea	Mantidae	*Sp. 1*	Praying Mantes	Shit-khoe-kaung
75	Hemiptera	Reduviidae	*Platymeris sp.*	True bug	Gya-boe
76	Hemiptera	Tessaratomidae	*Eurostus validus*	True bug	Gya-boe
77	Hemiptera	Cercopidae	*Cosmoscarta sp.*	True bug	Gya-boe
78	Hemiptera	Cercopidae	*Pyrrhocoridae sp.*	True bug	Gya-boe
79	Hemiptera	Corixidae	*Sphedanolestes impressicollis*	True bug	Gya-boe

80	Homoptera	Cicadidae	*Sp. 1*	Locusts	Kyaing-kaung
81	Araneida	Ctenidae	*Anahita sp.*	Spider	Pint-ku
82	Araneida	Salticidae	*Telamonia festiva*	Spider	Pint-ku
83	Araneida	Araneidae	*Nephila antipodiana*	Spider	Pint-ku
84	Araneida	Araneidae	*Nephila maculate*	Spider	Pint-ku
85	Araneida	Araneidae	*Crytophora beccarii*	Spider	Pint-ku
86	Scorpiones	Scorpiones	*Sp. 1*	Scorpion	Kin-myee-kauk

Table 46: Habitat Preference of Butterfly Species on Left Bank

No.	Scientific Name	Habitat Type				No. of Observations
		Near Water	Forest	Flowering Plant	Bushes	
1	*Papilio polytes romulus*	√	√	√		1
2	*Papilio hipponous pitmani*			√		*1*
3	*Papilio memnon agenor*	√		√		*2*
4	*Lamproptera curis curis*	√		√		*1*
5	*Lamproptera merge*			√		*5*
6	*Graphium nomius*	√			√	*2*
7	*Junonia lemonias lemonias*	√		√	√	*10*
8	*Junonia hierta*	√		√	√	*10*
9	*Phalanta phalanta*		√	√		*2*
10	*Phalanta alcipee*		√	√		*2*
11	*Neptis leucopharus*	√	√	√		5
12	*Kallima limborgii*		√			*1*
13	*Chersonesia rahriodes*			√		*1*
14	*Hypolimanas misippus*			√		*2*
15	*Cupha erymanthis lotis*	√			√	*2*
16	*Lexias pardalis dirteana*			√	√	*1*
17	*Argyreus hyperbius hyperbius*			√		*1*

18	*Tanaecia munda manata*		√			*1*
19	*Cethosia cyane auanthes*			√	√	*1*
20	*Charaxes solon sulphureu*	√				2
21	Delias hyparete metarete	√		√	√	5
22	*Danaus affinis*		√	√		5
23	*Euploea mulcibermulciber*		√	√		3
24	*Orsotriena medus medus*	√			√	1
25	*Mycalesis mineus mineus*	√	√	√		3
26	*Erites argentina delia*	√		√		2
27	*Byasa dasarada*	√		√	√	2
28	*Orsotriaena medus*			√		3
29	*Ypthima baldus*	√		√		5
30	*Laringa casteinaui*	√		√	√	2
31	*Discolampa ethion*	√		√		5
32	*Caleta elna*	√		√		5
33	*Caleta decidia decidia*	√			√	2
34	*Lorura arynnaus*	√		√	√	3
35	*Moduza procris*			√		2
36	*Zeltus amasa amasa*	√			√	1
37	*Rapala pheretima*		√			2
38	*Heliophorus brahma*	√		√		1
	TOTAL	**26**	**11**	**31**	**15**	**127**

Table 47: Habitat Preference of Beetle and Dragonfly Species on Left Bank

No.	Scientific Name	Habitat Types				No. of Observations
		Tree Leaves	Ground	Tree Trunk	Near Water	
1	*Aulacophora foveicollis*	√				5
2	*Aulacophora lewisii*	√				*5*
3	*Aspidomorpha miliaris*	√				*3*

4	*Cassida circumdata*	√				*2*
5	*Agetocera filicorhis*	√				*5*
6	*Catharsius mollossus*		√			*2*
7	*Enoplotrupes sharpi*		√			*2*
8	*Anomala grandis*		√			*2*
9	*Mylabris cichorii*	√				*2*
10	*Mylabris phalerata*	√				*5*
11	*Zonopterus flavitarsis*			√		*2*
12	*Platycorynus peregrinus*	√				*1*
13	*Tricodyla annulicornis*				√	*2*
14	*Coccinella transversalis*	√				*2*
15	*Dischissus mirandus*		√	√		*1*
16	*Neurothemis fulvia*				√	*10*
17	Neurothemis tullia tullia				√	*5*
18	Neurothemis inquirendae				√	*10*
19	Neurothemis atlanta				√	*5*
20	Neurothemis intermedia atlanta				√	*10*
21	Rhyothemis plutonia				√	*3*
22	Rhodothemis rufa				√	*3*
23	Brachythemis contaminate				√	*5*
24	Trithemis aurora				√	*5*
25	*Coeliccia cyanomelas*				√	*5*
26	*Platycnemis foliaces*				√	*3*
	TOTAL	**9**	**4**	**2**	**12**	**105**

Table 48: Habitat Preference of Grasshoppers, Locusts, True bug, and Spiders Species on Left Bank

Scientific Name					Habitat Types			
					near the stream	in foorest	grassland	bushes
1	Orthoptera	Pyrgomorphidae	*Sp.1*	Grasshopper		√	√	√
2	Orthoptera	Locustidae	*Sp. 1*	Grasshopper		√	√	
3	Orthoptera	Locustidae	*Sp. 2*	Grasshopper		√	√	
4	Orthoptera	Cantantopidae	*Sp. 1*	Grasshopper		√	√	
5	Orthoptera	Cantantopidae	*Sp. 2*	Grasshopper		√	√	
6	Orthoptera	Arcypteridae	*Sp. 1*	Grasshopper		√	√	
7	Orthoptera	Arcypteridae	*Sp. 2*	Grasshopper		√	√	
8	Orthoptera	Tettigidae	*Sp. 1*	Locusts			√	√
9	Orthoptera	Tettigidae	*Sp. 2*	Locusts			√	√
10	Mantodea	Mantidae	*Sp. 1*	Praying Mantes			√	√
11	Hemiptera	Reduviidae	*Platymeris sp.*	True bug		√	√	√
12	Hemiptera	Tessaratomidae	*Eurostus validus*	True bug		√	√	√
13	Hemiptera	Cercopidae	*Cosmoscarta sp.*	True bug		√	√	√
14	Hemiptera	Cercopidae	*Pyrrhocoridae sp.*	True bug		√	√	√
15	Hemiptera	Corixidae	*Sphedanolestes impressicollis*	True bug		√	√	√
16	Homoptera	Cicadidae	*Sp. 1*	Locusts			√	
17	Araneida	Ctenidae	*Anahita sp.*	Spider	√	√		√
18	Araneida	Salticidae	*Telamonia festiva*	Spider	√	√		√
19	Araneida	Araneidae	*Nephila antipodiana*	Spider	√			√
20	Araneida	Araneidae	*Nephila maculate*	Spider	√			√
21	Araneida	Araneidae	*Crytophora beccarii*	Spider	√			√
22	Scorpiones	Scorpiones	*Sp. 1*	Scorpion				√

Table 49: Insect and Invertebrate Species on Right and Left Banks

No.	Scientific Name	Right Bank	Left Bank
1	*Pachlioptaaristolochiaegoniopeltis*	√	
2	*Papiliopolytes Romulus*	√	√
3	*Papiliohipponouspitmani*		√
4	*Chilasclytiaclytia*	√	
5	*Lampropteracuriscuris*	√	√
6	*Lamproptera merge*	√	√
7	*Papilioiswaraiswara*	√	
8	*Papiliomemnonagenor*	√	√
9	*Graphiumnomius*	√	√
10	*Junonialemoniaslemonias*	√	√
11	*Junoniahierta*		√
12	*Neptishylaskamarupa*	√	
13	*Chersonesiarisarisa*	√	
14	*Chersonesiarahriodes*		√
15	*Hypolimanasbolinajacintha*	√	
16	*Hypolimanasmisippus*		√
17	*Ariadne ariadnepallidor*	√	
18	*Junoniaiphitaocyale*	√	
19	*Cuphaerymanthislotis*	√	√
20	*Pantoporiahordoniahordonia*	√	
21	*Neptisleucoporosleucoporos*	√	
22	*Neptisleucopharus*	√	√
23	*Phalantaphalanta*	√	√
24	*Phalantaalcipee*		√
25	*Junoniaalmanaalmana*	√	
26	*Lassipavirajaviraja*	√	
27	*Chersonesiaperaka*	√	

28	*Lexiaspardalisdirteana*	√	√
29	*Kallimalimborgii*	√	√
30	*Argyreushyperbiushyperbius*		√
31	*Tanaeciamundamanata*		√
32	*Cethosiacyaneauanthes*		√
33	*Charaxes solon sulphureu*		√
34	*Pieriscanidiaindica*	√	
35	*Euremahecabecontubernails*	√	
36	*Deliaspasithoepasithoe*	√	
37	*AppiasLalassislalassis*	√	
38	*Artogenianaganumnagunum*	√	
39	*Deliasdescombidescombi*	√	
40	*Deliashyparetemetarete*	√	√
41	*Danausgenutiagenutia*	√	
42	*Danausaffinis*	√	√
43	*Euploeacamaralzemancamaralzeman*	√	
44	*Euploeasylvesterharisii*	√	
45	*Euploeamulcibermulciber*		√
46	*Danauslimniacelimniace*	√	
47	*Danauschrysippus*	√	
48	*Danausmelanippus*	√	
49	*Melanitisziteniusauletes*	√	
50	*Orsotrienamedusmedus*		√
51	*Mycalesismineusmineus*		√
52	*Eritesargentinadelia*		√
53	*Byasadasarada*	√	√
54	*Orsotriaenamedus*	√	√
55	*Ypthimabaldus*	√	√
56	*Laringacasteinaui*	√	√
57	*Discolampaethion*	√	√

58	*Caletaelna*	√	√
59	*Caletadecidiadecidia*		√
60	*Loruraarynnaus*	√	√
61	*Moduzaprocris*	√	√
62	*Prosotasnoranora*	√	
63	*Arphpalavarro*	√	
64	*Acraeaviolae*	√	
65	*Zeltusamasaamasa*		√
66	*Rapalapheretima*		√
67	*Heliophorus brahma*		√
68	*Hydrophilusaccuminatus*	√	
69	*Athemusvitellinus*	√	
70	*Prothemusciusianus*	√	
71	*Driloniusosawai*	√	
72	*Aulacophorafoveicollis*		√
73	*Aulacophoralewisii*		√
74	*Aspidomorphamiliaris*		√
75	*Cassidacircumdata*		√
76	*Agetocerafilicorhis*		√
77	*Catharsiusmollossus*		√
78	*Enoplotrupessharpi*		√
79	*Anomalagrandis*		√
80	*Mylabriscichorii*		√
81	*Mylabrisphalerata*		√
82	*Phymatodesmaaki*	√	
83	*Zonopterusflavitarsis*		√
84	*Platycorynusperegrinus*		√
85	*Tricodylaannulicornis*		√
86	*Coccinellatransversalis*		√
87	*Dischissusmirandus*		√

88	*Neurothemisfulvia*	√	√
89	Neurothemistulliatullia		√
90	Neurothemisinquirendae		√
91	Neurothemisfulvia		√
92	Neurothemisatlanta		√
93	Neurothemisintermediaatlanta		√
94	Rhyothemisplutonia		√
95	Rhodothemisrufa		√
96	Brachythemis contaminate		√
97	Trithemis aurora		√
98	*Pantalaflavescens*	√	
99	*Coelicciacyanomelas*	√	√
100	*Platycnemisfoliaces*		√
101	*Gryllus sp.*	√	
102	*Dissosteiralongipenis*	√	
103	*Brachystola magna.*	√	
104	*Dissosteiralongipennis*	√	
105	*Paratenodera sp.*	√	
106	Pyrgomorphidae Sp.1		√
107	Locustidae Sp. 1		√
108	Locustidae Sp. 2		√
109	Cantantopidae Sp. 1		√
110	Cantantopidae Sp. 2		√
111	Arcypteridae Sp. 1		√
112	Arcypteridae Sp. 2		√
113	Tettigidae Sp. 1		√
114	Tettigidae Sp. 2		√
115	Mantidae (Praying mantis) Sp. 1		√
116	*Paratenedera sp.*	√	
117	*Platymeris sp.*		√

118	*Gerris sp.*	√	
119	*Paratriozon*	√	
120	*Anasa sp.*	√	
121	*Eurostusvalidus*		√
122	*Cosmoscarta sp.*		√
123	*Pyrrhocoridae sp.*		√
124	Sphedanolestesimpressicollis		√
125	*Callibaetis sp.*	√	
126	*Forficulaauricularis*	√	
127	Homoptera: Cicadidae Sp. 1		√
128	*Lycosa sp.*	√	
129	*Anahita sp.*		
130	*Telamoniafestiva*		√
131	*Camponotus sp.*	√	
132	*Aphis mellifera*	√	
133	*Macrotermsspp:*	√	
134	*Domaliniaornis*	√	
135	Scorpions Sp. 1		√
136	*Nephilaantipodiana*		√
137	*Nephila maculate*		√
138	*Crytophorabeccarii*		√
	Total	**74**	**86**

4.1.1. Photographic Documentation of Insects and Other Invertebrate Species

(A)*Chersonesiarisarisa*

(B) *Lampropteracuriuscurius*

(C) *Cethosiacyaneauanthes*

(D) *Neurothemisfulvia*

(E) *Trithemis aurora*

(F) *Coelicciacyanomelas*

(G) *Zonopterusflavitarsis* (Beetle)

(H) *Nephilaantipodiana*(Spider)

(I) *Eurostusvalidus* (True Bug)

(J) Mantidae (Praying mantis)

(K) *Sphedanolestesimpressicollis*

(L) *Cosmoscarta* sp. (Frog hopper)

4.2 Fish and and Other Aquatic Species

Thirty-six fish species were identified during the left bank survey. Eighteen were identified by voucher specimens (i.e. caught by fishermen and presented to the fauna team for identification. An additional 18 species were identified by interviewing fishermen and asking them what types of fishes and aquatic species live in the Myitnge River. Of the fish species identified during the left bank survey, *Botiarostrata* is classified by the IUCN Red List as vulnerable, *Wallago attu* and *Anguilla bicolor* are both classified as near threatened and all other species are classified as least concern, data deficient or not evaluated.

Thirty-two fish and other aquatic species were identified during the right bank survey, and the two surveys combined yielded a total of 45 fish and other aquatic species. Naturally, a fair amount of overlap (23 species) exists between the two surveys, because both surveys covered the same body of water, the Myitnge River. The difference between the two surveys in terms of species identified is likely due to the different seasons in which the left and right bank surveys took place as well as variation in answers of interview respondents. Different people will likely remember and identify different fish and aquatic species.

Table 50: Fish and Other Aquatic Species Identified During Left Bank Survey

No.	Phyllum Class	Order	Family	Species	Common name	Local name
1	Actinopterygii	Cypriniformes	Cyprinidae	*Barbushexastichus*	Nga Kyaung	Nga kyaung
2	Actinopterygii	Cypriniformes	Cyprinidae	*Rohteecotio*	Carplet	nga-phan-ma
3	Actinopterygii	Cypriniformes	Cyprinidae	*Rohtebelangerii*	-	Nga phal aung
4	Actinopterygii	Cypriniformes	Cyprinidae	*Foliferbrevifilis*	Barbus brevifilis	Kyout ngalu
5	Actinopterygii	Cypriniformes	Cyprinidae	*Puntiusamphibious*	Pool barb	Nga khane ma
6	Actinopterygii	Cypriniformes	Cyprinidae	*Puntius oligolipis*	Checker barb	Nga khane ma wah
7	Actinopterygii	Cypriniformes	Cyprinidae	*Cirrhinamrigala*	Mrigal	Nga gyin
8	Actinopterygii	Cypriniformes	Cyprinidae	*Siloniasilondia*	Buttet catfish	Nga myin
9	Actinopterygii	Cypriniformes	Cyprinidae	*Puntius sp.*	Barb	Nga khone ma
10	Actinopterygii	Cypriniformes	Cyprinidae	*Danio aequipinnutus*	Giant danio	Yay pawe nga
11	Actinopterygii	Cypriniformes	Cyprinidae	*Crossochelius burmanicus*	Burmese latia	Nga din lone
12	Actinopterygii	Cypriniformes	Cyprinidae	*Bariliusguttatus*	-	Nga la war
13	Actinopterygii	Cypriniformes	Cyprinidae	*Barilius sp.*	-	Nga lettu
14	Actinopterygii	Cypriniformes	Cyprinidae	*Labeostoliczkae*	-	Nfa lu
15	Actinopterygii	Cypriniformes	Cyprinidae	*Burbusburmanicus*	Barb	Nga khone ma

16	Actinopterygii	Cypriniformes	Cyprinidae	*Nemacheilusbotia*	Loach	Nga thalae htoe
17	Actinopterygii	Cypriniformes	Cyprinidae	*Ophiocephalusstriatus*	Striped snake head	Nga yant
18	Actinopterygii	Cypriniformes	Cyprinidae	*Chela sladoni*	-	Nga mot twat
19	Actinopterygii	Cypriniformes	Cyprinidae	*Belonecancila*	Gar fish	Nga pha
20	Actinopterygii	Cypriniformes	Bagridae	*Mystusgulio*	Long whisker cat fish	Nga ywae
21	Actinopterygii	Perciformes	Cobitidae	*Lepidocephalusguntea*	Loach	Nga thale htoe
22	Actinopterygii	Perciformes	Cobitidae	*Botiarostrata*	Golden loach	Nga sin pyawt
23	Actinopterygii	Perciformes	Cobitidae	*Botiaberdmorei*	Loach	Nga sin pyawt kyar
24	Actinopterygii	Perciformes	Cobitidae	*Lepidocephalichthys Berdmori*	Loach	Nga thale htoe
25	Actinopterygii	Perciformes	Cobitidae	*Neonoemacheilus Labeosus*	Loach	Nga thale htoe
26	Actinopterygii	Perciformes	Channidae	*Channagachua*	Channa	Nga yant goung toe
27	Actinopterygii	Perciformes	Channidae	*Channaaurolineata*	Channa	Nga yant
28	Actinopterygii	Perciformes	Channidae	*Sillagodomina*	Whiting	Nga palwae
29	Actinopterygii	Siluriformes	Siluridae	Wallagoattu	Butter fish	Nga but
30	Actinopterygii	Siluriformes	Siluridae	*Clarirasbatrichus*	Walking catfish	Nga khue
31	Actinopterygii	Symbranchiformes	Symbranchidae	*Monopterus javanensis*	Eel	Nga shint
32	Actinopterygii	Anguilliformes	Anguillidae	*Anguilla bicolor*	Level finned fish	Nga myae
33	Malacostraco	Decapoda	Palaemonidae	*Cryphiops sp.*	Palaemon	Puzon
34	Malacostraco	Decapoda	Portunidae	*Chaybtissp.*	Crab	Gonan lone
35	Actinopterygii	Beloniformes	Belonidae	*Exocoetuspoecilopterus*	Flying fish	Nga pyan
36	Mollusca	Gastropoda	Bursidae	*Bufonaria sp.*	Frog shell	Khayu phin chan

Table 51: Habitat Type, Data Source, and IUCN Status

No.	Species	Habitat Type	# of Obv.	Data source	IUCN[5] Status
1	Barbushexastichus	Shallow water with sandy bottom		IS	
2	Rohteecotio	River and marshland		IS	LC
3	Rohtebelangerii	River and marshland		IS	LC
4	*Foliferbrevifilis*	clear water with rockt bottom riparian forest	1	VS	
5	*Puntiusamphibious*	sandy bottom & riparion	20	VS	DD
6	*Puntius oligolipis*	Riparian water plants	3	VS	
7	*Cirrhina mrigala*	Fast flowing stream and river with rocky bottom		IS	LC
8	*Siloniasilondia*	Shoals and freshwater		IS	LC
9	*Puntius sp.*	Sandy and riparian water	30	VS	LC
10	*Danio aequipinnutus*	Sandy and gravel beds in riparian	15	VS	LC
11	*Crossochelius burmanicus*	Fast flowing stream and river with rocky bottom	30	VS	LC
12	*Raiamas guttatus*	Fast flowing stream and river with rocky bottom		IS	LC
13	*Barilius sp.*	Fast flowing stream and river with rocky bottom	30	VS	
14	*Labeostoliczkae*	Large rivers and flatted plains	22	VS	
15	Burbusburmanicus	Shallow water and sandy bottom		IS	DD
16	Nemacheilusbotia	Sandy bottom and riparian water		IS	LC
17	*Ophiocephalus striatus*	Rivers and streams with riparian forest		IS	LC
18	*Chela sladoni*	Shallow water		IS	LC
19	*Belonecancila*	Shallow water		IS	
20	*Mystusgulio*	Large rivers	3	VS	LC
21	*Lepidocephalusguntea*	Main streams with rocky rapids		IS	LC

[5] Species without a IUCN classification have not yet been assessed by IUCN and are not in its database.

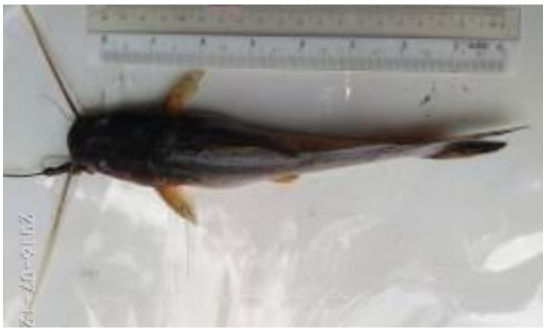
22	*Botiarostrata*	Main streams with rocky rapids	4	VS	VU
23	*Botiaberdmorei*	Rapid and hill stream	3	VS	NE
24	*Lepidocephalichthys Berdmori*	Stream with hill to low land	3	VS	LC
25	*Neonoemacheilus Labeosus*	Rocky rapid and hill stream	2	VS	LC
26	*Channa gachua*	Rivers and streams with riparian forest	40	VS	LC
27	*Channa aurolineata*	Rivers and streams with riparian forest		IS	
28	*Sillago domina*	Rivers and streams with riparian forests		IS	NE
29	Wallago attu	Rivers and streams with riparian forests		IS	NT
30	*Clariras batrichus*	Rivers and marshland	7	VS	LC
31	*Monopterus javanensis*	Streams , river and muddy		IS	
32	*Anguilla bicolor*	Adult inhabit upper rich & main stream		IS	NT
33	*Cryphiops sp.*	Clean water with sandy and rocky bottom	50	VS	
34	*Chaybtissp.*	Sandy and rocky bottom	10	VS	
35	*Exocoetus poecilopterus*	Streams and sandy bottom		IS	
36	*Bufonaria sp.*	Main rivers with sandy and rocky bottom	70	VS	

Table 52: Fish and Other Aquatic Species Identified During Right Bank and Left Bank Surveys

No.	Species	Right Bank	Left Bank
1	*Barbus hexastichus*	√	√
2	*Morulius calbasu*	√	
3	*Rohtee cotio*	√	√
4	*Rohtebe langerii*	√	√
5	*Crossochelius burmanicus*	√	
6	*Folifer brevifilis*	√	√
7	*Puntius amphibious*	√	√
8	*Puntius oligolipis*	√	√
9	*Cirrhina mrigala*		√
10	*Silonia silondia*		√
11	*Puntius sp.*	√	√
12	*Daniokaerri*	√	
13	*Danio aequipinnutus*	√	√
14	*Garra lamta*	√	
15	*Crossochelius burmanicus*	√	√
16	*Cabdiomoror*	√	
17	*Raiamas guttatus*		√
18	*Barilius sp.*	√	√
19	*Labeostoliczkae*	√	√
20	*Labeodyocheilus*	√	
21	*Amblypharyngodon mola*	√	
22	*Hemibagrus microphthalmus*	√	
23	*Glyptothorax trilineatus*	√	
24	*Burbus burmanicus*		√
25	*Nemacheilus botia*		√
26	*Ophiocephalus striatus*		√
27	*Chela sladoni*		√

28	*Belonecancila*		√
29	*Mystus gulio*	√	√
30	*Lepidocephalus guntea*		√
31	*Botia rostrata*	√	√
32	*Botia berdmorei*	√	√
33	*Lepidocephalichthys berdmori*	√	√
34	*Neonoemacheilus labeosus*	√	√
35	*Channa gachua*	√	√
36	*Channa aurolineata*	√	√
37	*Sillago domina*		√
38	*Wallago attu*	√	√
39	*Clariras batrichus*	√	√
40	*Monopterus javanensis*		√
41	*Anguilla bicolor*	√	√
42	*Cryphiops sp.*	√	√
43	*Chaybtissp.*	√	√
44	*Exocoetus poecilopterus*		√
45	*Bufonaria* sp.	√	√
		32	36

4.2.1. Photographic Documentation of Fish and Other Aquatic Species



A. *Mystus gulio* (Dorsal view)

B. *Mystus gulio* (Ventral view)

C .*Mystus gulio*

D. *Mystus gulio*

E. *Mystus gulio* (Dorsal fin)

F. *Mystus gulio* (Gill slit)

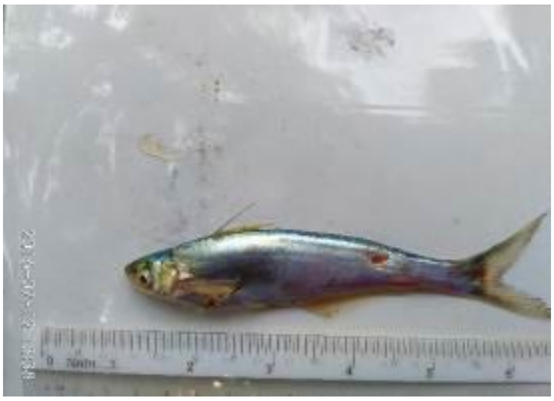
G. *Mystus seengala*

H. *Mystus seengala* (Front view)

I. *Mystus seengala* (Head)

J. *Mystus seengala*

K. *Barilius guttatus*



L. *Silonia silondia*

M. *Clarias batrachus*

N. *Clarias batrachus*

4.3 Herpet Species

Thirty-one herpet species were identified in the left bank survey. Of this total, 13 were identified via voucher specimen, 3 by visual observation, and the remaining 14 by interviews. According to the IUCN Red List, *Indotes tudoelongata* is endangered, *Melanoche lystrijuga* and *Python moluras* are both near threatened and the remaining 28 species are either least concern or not evaluated. It should be noted that the near threatened and endangered species were identified through interviews and not confirmed by direct visual observation.

A total of 45 herpet species were identified on both the left and right banks combined. Of this total thirty-one were identified on the left bank as opposed to 39 on the right bank. Twenty-five species were found on both banks while 14 species were found on the right bank only and 6 species were found on the left bank only.

Table 53: Herpet Species Left Bank

No.	Phylum Class	Order	Family	Scientific Name	Common name	Local name
1	Amphibia	Anura	Bufonidae	*Duttaphrynus melanostictus*	Common toad	Pher pyoke
2	Amphibia	Anura	Bufonidae	*Bufo sp.1*	Common toad	Pher pyoke
3	Amphibia	Anura	Ranidae	*Fejervaryalimnocharislimnocharis*	Paddy or swamp frog	Sar pher
4	Amphibia	Anura	Ranidae	*Kaloulapulchra*	Narrow mouth frog	Pher gone nyin
5	Amphibia	Anura	Ranidae	*Occido zygous*	Green paddle frog	Thae par
6	Amphibia	Anura	Rhachphoridae	*Polypedatesleucomystaxs*	Common free frog	Pher
7	Reptilia	Lacertilia	Agamidae	*Calotesversicolor*	Garden fence lizard	Pake thin nye
8	Reptilia	Lacertilia	Agamidae	*Calotesmystaceus*	Blue crested lizard	Pake thin nye
9	Reptilia	Lacertilia	Agamidae	*Calotesemmaattricristatus*	Emmagray's lizard	Pake thin nye
10	Reptilia	Lacertilia	Agamidae	*Calotesema*	Forest crested lizard	Pake thin nye
11	Reptilia	Lacertilia	Agamidae	*Branchocela cristatella*	Lizard	Te-too
12	Reptilia	Squmato	Gekkonidae	*Gekko gecko*	Tockay	Tack tae
13	Reptilia	Squmata	Gekkonidae	*Hemidactylusfrenatus*	Common house gecko	Eain myaung

14	Reptilia	Squmata	Varinidae	*Varanus bengalensis*	Bengal monitor	Bengal phut
15	Reptilia	Squmata	Varinidae	*Varanussalvator*	Asian water	Manitor phut
16	Reptilia	Squmata	Typhlopidae	*Typhlopsdiardi*	Diard' s blint snake	Khae mwe
17	Reptilia	Squmata	Colubridae	*Ptyaskorros*	Indo Chinese rat snake	Lin mwe
18	Reptilia	Squmata	Colubridae	*Ptyascarinatus*	Keeled rat snake	Lin mwe
20	Reptilia	Squmata	Colubridae	*Coelognathus radiata*	Snake	Hmwe
21	Reptilia	Squmata	Colubridae	*Dendrelaphisformosus*	Elegant branze snake	Snake
22	Reptilia	Squmata	Colubridae	*Elapheradiata*	Rodiated rat snake	Snake
23	Reptilia	Squmata	Colubridae	*Elapheprasina*	Rodiated rat snake	Snake
24	Reptilia	Squmata	Elapidae	*Ophiophagus hannah*.	King cobra	Taw-gyi-mwe-hauk
25	Reptilia	Squmata	Boidae	*Python moluras*	Burmese python	Saba ohn
26	Reptilia	Squmata	Geamydidae	*Melanochelystrijuga*	Myanmar black turtle	Lake chaepan
27	Reptilia	Squmata	Geamydidae	*Cyclemysoldhamii*	Oldham's leaf turtle	Late poat
28	Squmata	Testudines	Testudinidae	*Indotestudoelongata*	Yellow tortoise	Taung late
29	Squmata	Testudines	Scincidae	*Mabuyamultifasciata*	Many lined sun skink	Kin late chaw
30	Squmata	Testudines	Scincidae	*M. longicaudata*	Lang tailed sun skink	Kin late chaw
31	Squmata	Testudines	Scincidae	*Sphenomrphusmaculatus*	Stream side skink	Kin late chaw

Table 54: Habitat Type, Number of Observations, Data Source, and IUCN Status

No.	Species	Habitat Type	No. of Obv.	Data source	IUCN Status
1	*Duttaphrynusmelanostictus*	Under rock, near river	3	VO	LC
2	*Bufo sp.1*	Under rock, near river	2	VO	LC
3	*Fejervaryalimnocharislimnocharis*	In grass	4	VS	LC
4	*Kaloulapulchra*	Dwelling house	4	VS	LC
5	*Occido zygous*	Sandy land, near river	5	VS	LC
6	*Polypedatesleucomystaxs*	Under rock	3	VS	LC
7	*Calotesversicolor*	Tree hole	2	VS	LC
8	*Calotesmystaceus*	Tree	6	VS	LC
9	*Calotesemmaattricristatus*	Tree	5	VS	LC
10	*Calotesema*	Tree	4	VS	LC
11	*Branchocela cristatella*	Tree	3	VS	LC
12	*Gekko gecko*	Tree hole	1	VS	LC
13	*Hemidactylusfrenatus*	Dwelling house	2	VS	LC
14	*Varanus bengalensis*	Under stone		IS	LC
15	*Varanussalvator*	Ground		IS	LC
16	*Typhlopsdiardi*	Forest	1	IS	LC
17	*Ptyaskorros*	Agriculture land	1	IS	LC
18	*Ptyas carinatus*	Agriculture land	1	IS	LC
19	*Ptyas sp.*	Agriculture land	1	IS	LC
20	*Dendrelaphisformosus*	Forest	1	IS	LC
21	*Elaphe radiate*	Ground	1	IS	LC
22	*Elaphep rasina*	Forest	1	IS	LC

23	*Ophiophagus hannah*	Forest	1	IS	LC
24	*Python moluras*	Forest		IS	NT
25	*Melanoche lystrijuga*	Near river side		IS	NT
26	*Cyclemy soldhamii*	Near river side		IS	NE
27	*Indotes tudoelongata*	Ground	1	IS	EN
28	*Mabuya multifasciata*	Tree	1	VO	LC
29	*M. longicaudata*	Tree	1	VS	LC
30	*Sphenomrphusmaculatus*	Under log	1	VS	LC

Table 55: Herpet Species on Right and Left Banks

No.	Scientific Name	Right Bank	Left Bank
1	*Duttaphrynusmelanostictus*	√	√
2	*Bufo sp 1*		√
3	*Fejervaryalimnocharislimnocharis*	√	√
4	*Kaloulapulchra*	√	√
5	*Occido zygous*	√	√
6	*Polypedatesleucomystaxs*	√	√
7	*Calotesversicolor*	√	√
8	*Calotesmystaceus*	√	√
9	*Calotesemmaattricristatus*		√
10	*Pseudoclotesmicrolepis*	√	
11	*Branchocela cristatella*		√
12	*Calotesema*	√	√
13	*Gekko gecko*	√	√
14	*Hemidactylusfrenatus*	√	√
15	*Gehyramultilata*	√	
16	*Sphenomrphus maculatus*	√	√
17	*Eutropismultifaciata*	√	
18	*Varanus sp.*	√	

19	*Gecko moonarchus*	√	
20	*Varanus bengalensis*	√	√
21	*Varanussalvator*	√	√
22	*Typhlopsdiardi*	√	√
23	*Ophiophagus hannah*		√
24	*Ptyaskorros*	√	√
25	*Ptyascarinatus*	√	√
26	*Coelognathus radiata*	√	√
27	*Ahaetulla nasuta*	√	
28	*Chrysopelea ornata*	√	
29	*Dendrelaphis caudolineatus*	√	
30	*Dendrelaphis formosus*	√	√
31	*Rhabdophis subminiatus*	√	
32	*Xenochrophis piscator*	√	
33	*Elaphe taeiura*	√	
34	*Elaphe radiata*	√	√
35	*Elaphe prasina*	√	√
36	*Xenochrophis piscator*	√	
37	*Ophiophagus hannah*	√	√
38	*Amphiesmasp*	√	
39	*Python moluras*	√	√
40	*Melanochelys trijuga*	√	√
41	*Cyclemys oldhamii*	√	√
42	*Indotestudo elongata*	√	√
43	*Lissemys scutata*	√	
44	*Mabuyamult ifasciata*		√
45	*M. longicaudata*		√
	TOTAL	**39**	**31**

4.3.1. Photographic Documentation of Hepto Species

A. *Rana sp. 1*

B. Fejervarya limnocharis

C. *Bufo sp. 1*

D. *Ptyas korros*

E. *Coelognathus radiata*

F. *Calotes emma*

G. *Calotes vesicolor*

H. *Sphenomorphus maculatus*

I. *Calotes vesicular*

J. Calotes emma

K. *Ptyas korros*

L. *Coelognathus radiata*

4.4 Bird Species

Sixty-five bird species were identified in the left bank survey, all of which were identified by visual observation. According to the IUCN Red List, *Pavo muticus* is classified as endangered and *Psittacula eupatria, Psittacula finschii* and *Pisttacula krameri* are classified as near threatened. The rest are classified as least concern.

A total of 80 bird species were identified on both the left and right banks combined. Of this total sixty-five were identified on the left bank as opposed to 74 on the right bank. Naturally, there is a considerable amount of overlap between the two surveys with 59 species identified on both banks. This is likely due to the fact that, unlike flightless animals, the river does not constitute a significant barrier to the movement of birds across the research area.

Table 56: Bird Species on Left Bank

No.	Phylum Class	Order	Family	Scientific Name	Common name	Local name
1	Aves	Falconiformes	Falaconidae	*Microhieraxcaerulescens*	Collared falconet	Thein
2	Aves	Gallifornmes	Phasianidae	*Pavomuticus*	Green peafowl	Down
3	Aves	Pelecanifornes	Ardeidae	*Egrettacasmerodius*	Great egret	Byine
4	Aves	Pelecanifornes	Ardeidae	*Egrettagarzetta*	Little egret	Byine
5	Aves	Pelecanifornes	Ardeidae	*Bubulcus ibis*	Cattle egret	Kyawl kyaung byine
6	Aves	Accipitriformes	Accipitridae	*Milvusmigrans*	Black kite	Son
7	Aves	Columbiformes	Columbidae	*Streptopeliachinensis*	Spotted dove	Gyoe lae pyauk
8	Aves	Columbiformes	Columbidae	*Treronphoenicopterus*	Yellow- footed green pigeon	-
9	Aves	Columbiformes	Columbidae	*Columba liva*	Rock pigeon	Kho
10	Aves	Columbiformes	Columbidae	*Duculaaenea*	Green- imperial pigeon	Hnet nga nwar
11	Aves	Columbiformes	Columbidae	*Streptopeliaorientalis*	Oriental turtle dove	Gyoe ni pu
12	Aves	Cuculiformes	Cuculidae	*Clamatorcoromandus*	Chestnut- winged cuckoo	-
13	Aves	Cuculiformes	Cuculidae	*Centropussinensis*	Greater coucal	Bote
14	Aves	Camprimulgiformes	Apodiformes	*Cypsiurusbalasiensis*	Asian palm swift	Pyan hlwar

15	Aves	Coraciiformes	Coraciidae	*Coraciasbenghalensis*	Indian roller	Hnet khar
16	Aves	Coraciiformes	Coraciidae	*Eurystomusorientalis*	Dollar bird	Moe kaung
17	Aves	Piciformes	Megalaimidae	*Megalaimahaemacephala*	Coppersmith barbet	Hnet pa htein
18	Aves	Piciformes	Megalaimidae	*Megalaimalineata*	Lineated barbet	Phoe khaung
19	Aves	Piciformes	Megalaimidae	*Megalaimaasiatica*	White-throated barbet	Koat ka laung
20	Aves	Coraciiformes	Alcedinidae	*Halcyon smymensis*	White throated king fisher	Pain nyin yin phyu
21	Aves	Coraciiformes	Meropidae	*Meropsorientalis*	Green bee-eater	Pa zin htoe
22	Aves	Coraciiformes	Meropidae	*Meropsleschenaulti*	Chestnut-headed bee-eater	Pa zin htoe
23	Aves	Coraciiformes	Meropidae	*Meropsphilippinus*	Blue tailed bee-eater	Pa zin htoe
24	Aves	Piciformes	Picidae	*Dinopiumjavanense*	Common flameback	Thit toauk
25	Aves	Piciformes	Picidae	*Dinopiumraffesii*	Himalayan flameback	Thit toauk
26	Aves	Psittaciformes	Psittacidae	*Psittacula eupatria*	Alexandrine parakeet	Kyet tu ywe
27	Aves	Psittaciformes	Psittacidae	*Psittaculafinschii*	Grey-headed parakeet	Kyet tu ywe
28	Aves	Psittaciformes	Psittacidae	*Pisttaculakrameri*	Rose ring parakeet	Kyae kyote
29	Aves	Apodiformes	Apodidae	*Apuspacificus*	Forked tailed swift	Pyan hlwar
30	Aves	Apodiformes	Apodidae	*Apusaffinis*	House swift	Pyan hlwar
31	Aves	Passeriformes	Oriolodae	*Oriolus xanthomus*	Black-hooded oriole	Hnet war
32	Aves	Passeriformes	Dicruridae	*Dicrurusmacrocercus*	Black drongo	Hnet taw
33	Aves	Passeriformes	Dicruridae	*DicrurusIeucophaeus*	Ashy drongo	Hnet taw
34	Aves	Passeriformes	Corvidae	*Corvus splendens*	House crow	Kyee kan
35	Aves	Passeriformes	Corvidae	*Corvus macrorhynchos*	Large-billed crow	Taw kyee kan

36	Aves	Passeriformes	Oriolidae	*Oriolus tenuirostris*	Slender billed oriole	Hnet war
37	Aves	Passeriformes	Dicruridae	*Dicrurusaeneus*	Bronzed drongo	Hnet taw
38	Aves	Passeriformes	Motacillidae	*Motacilla alba*	White wagtail	Myee nyaunt kaung
39	Aves	Passeriformes	Estrildae	*Lonchurapunctulata*	Scaly breasted munia	Sar pa dee
40	Aves	Passeriformes	Estrildae	*Lonchuramalacca*	Black-headed munia	Sar pa dee
41	Aves	Passeriformes	Passeridae	*Passer domesticus*	House sparrow	Eain sar
42	Aves	Passeriformes	Passeridae	*Passer mmtanus*	Eurasian tree sparrow	Pa shue sar
43	Aves	Passeriformes	Muscicapidae	*Copsychussaularis*	Oriental magpie robin	Tha pate lwal
44	Aves	Passeriformes	Muscicapidae	*Saxicolacaprata*	Pied bushchat	Hnet kyar
45	Aves	Passeriformes	Sturnidae	*Acridotheresfuscus*	Jungle myna	Taw Zayet
46	Aves	Passeriformes	Sturnidae	*Acridotheresgrandis*	White vented myna	-
47	Aves	Passeriformes	Sturnidae	*Sturnusburmannicus*	Binous breaed starling	Zayet gaung phyu
48	Aves	Passeriformes	Sturnidae	*Gracularegiosa*	Common hill myna	Tha li kar
49	Aves	Passeriformes	Pycnonotidae	*Pycnonotusatriceps*	Black headed bulbul	-
50	Aves	Passeriformes	Pycnonotidae	*Pycnonotuscafer*	Red-vented bulbul	Bout phin ni
51	Aves	Passeriformes	Pycnonotidae	*Pycnonotusblanfordi*	Streak eared bulbul	Bout Chwal
52	Aves	Passeriformes	Pycnonotidae	*Pycnonotusjocosus*	Red-whichered bulbul	Bout Ka lon
53	Aves	Passeriformes	Pycnonotidae	*Pycnonotusmelanicterus*	Black-crested bulbul	-
54	Aves	Passeriformes	Hirundinidae	*Hirundorustica*	Barn swallow	Pyan hlwar gyi
55	Aves	Passeriformes	Nectarinidae	*Nectariniajugularis*	Olived- backed Sunbird	Pan Yi Sote

56	Aves	Passeriformes	Nectarinidae	*Nectariniaasiatica*	Purple sunbird	Pan Yi Sote
57	Aves	Passeriformes	Nectarinidae	*Aethopygasiparaja*	Cromson sunbird	Pan Yi Sote
58	Aves	Passeriformes	Cisticolidae	*Priniahodgsonii*	Grey breasted prinia	-
59	Aves	Passeriformes	Cisticolidae	*Priniarufescens*	Rufescent prinia	-
60	Aves	Passeriformes	Chloropseidae	*Chloropsisaurifrons*	Gonden fronted leafbird	Hnet sein
61	Aves	Passeriformes	Sturnidae	*Acridotherestristis*	Common myna	Zayet
62	Aves	Coraciiformes	Upupidae	*Upupaepops*	Common hoopoe	Taung pee sue
63	Aves	Passeriformes	Timaliidae	*Pellorenumruficeps*	Puff-throated babbler	-
64	Aves	Passeriformes	Campephagidae	*Pericrocotuscinnamomeus*	Small minived	-
65	Aves	Guriformes	Rallidae	*Gallinulachloropus*	Common moorhen	Yae Kyat

Table 57: Habitat Type, Number of Observations, Data Source, and IUCN Status

No.	Scientific Name	Habitat Type	No. of Obv.	Data Source	IUCN Status
1	*Microhierax caerulescens*	Top canopy	1	VO	LC
2	*Pavo muticus*	Near river bank	2	VO	EN
3	*Egretta casmerodius*	Near river site	4	VO	LC
4	*Egretta garzetta*	Near river site	3	VO	LC
5	*Bubulcus ibis*	Near river site/on sky	16	VO	LC
6	*Milvus migrans*	Top canopy/ on sky	1	VO	LC
7	*Streptopeli achinensis*	Cultivation/tree	18	VO	LC
8	*Treronphoeni copterus*	Top canopy	8	VO	LC
9	*Columba liva*	Building	22	VO	LC
10	*Ducula aenea*	Middle canopy	3	VO	LC
11	*Streptopeliaorientalis*	Cuitivation/middle canopy	20	VO	LC
12	*Clamatorcoro mandus*	Middle canopy	1	VO	LC

13	*Centropussinensis*	Shrub and bushes	5	VO	LC
14	*Cypsiurus balasiensis*	Tree/ on sky	30	VO	LC
15	*Coracias benghalensis*	Cultivation/middle canopy	4	VO	LC
16	*Eurystomus orientalis*	Top canopy	3	VO	LC
17	*Megalaima haemacephala*	Top canopy	12	VO	LC
18	*Megalai malineata*	Top canopy	15	VO	LC
19	*Megalaima asiatica*	Middle canopy	10	VO	LC
20	*Halcyon smymensis*	Tree/near river bank	6	VO	LC
21	*Merops orientalis*	Tree/ cultivation	10	VO	LC
22	*Merops leschenaulti*	Tree/ cultivation	18	VO	LC
23	*Merops philippinus*	Tree/ cultivation	5	VO	LC
24	*Dinopium javanense*	Middle canopy	2	VO	LC
25	*Dinopium raffesii*	Middle canopy	2	VO	LC
26	*Psittacula eupatria*	Tree	3	VO	NT
27	*Psittacula finschii*	Tree	12	VO	NT
28	*Pisttacula krameri*	Tree	2	VO	NT
29	*Apus pacificus*	On sky	35	VO	LC
30	*Apus affinis*	On sky	40	VO	LC
31	*Oriolus xanthomus*	Top canopy	2	VO	LC
32	*Dicrurus macrocercus*	Middle canopy	6	VO	LC
33	*Dicrurus Ieucophaeus*	Middle canopy	4	VO	LC
34	*Corvus splendens*	Tree/ cultivatuion	15	VO	LC
35	*Corvus macrorhynchos*	Cultivation	20	VO	LC
36	*Oriolus tenuirostris*	Top canopy	2	VO	LC
37	*Dicrurus aeneus*	Top canopy	5	VO	LC
38	*Motacilla alba*	Near river site/bank	4	VO	LC
39	*Lonchura punctulata*	Shrub and bushes/ Tree	15	VO	LC
40	*Lonchura malacca*	Shrub and bushes/ Tree	12	VO	LC
41	*Passer domesticus*	Tree	25	VO	LC
42	*Passer mmtanus*	Tree	25	VO	LC

43	*Copsychus saularis*	Shrub and bushes	5	VO	LC
44	*Saxicola caprata*	Cultivation/shrub and bushes	4	VO	LC
45	*Acridotheres fuscus*	Top canopy	20	VO	LC
46	*Acridotheres grandis*	Middle /top canopy	15	VO	LC
47	*Sturnus burmannicus*	Middle canopy/cultivation	10	VO	LC
48	*Gracula religiosa*	On sky	8	VO	LC
49	*Pycnonotusatriceps*	Top canopy/cultivation	2	VO	LC
50	*Pycnonotus cafer*	Top canopy/ shrub and bushes	3	VO	LC
51	*Pycnonotus blanfordi*	shrub and bushes	2	VO	LC
52	*Pycnonotus jocosus*	Top canopy/ shrub and bushes	2	VO	LC
53	*Pycnonotus melanicterus*	Middle /top canopy	3	VO	LC
54	*Hirundo rustica*	On sky	25	VO	LC
55	*Nectariniajugularis*	Top/ Middle canopy and bushes	6	VO	LC
56	*Nectariniaasiatica*	Top canopy and bushes	4	VO	LC
57	*Aethopygas iparaja*	Top canopy	2	VO	LC
58	*Priniahodgsonii*	shrub and bushes	2	VO	LC
59	*Priniarufescens*	shrub and bushes	4	VO	LC
60	*Chloropsisaurifrons*	Middle /top canopy	2	VO	LC
61	*Acridotherestristis*	Top canopy/ grassland	20	VO	LC
62	*Upupaepops*	Top canopy	2	VO	LC
63	*Pellorenumruficeps*	Shrub and bushes	6	VO	LC
64	*Pericrocotusc innamomeus*	Top canopy	2	VO	LC
65	*Gallinula chloropus*	Near water	3	VO	LC

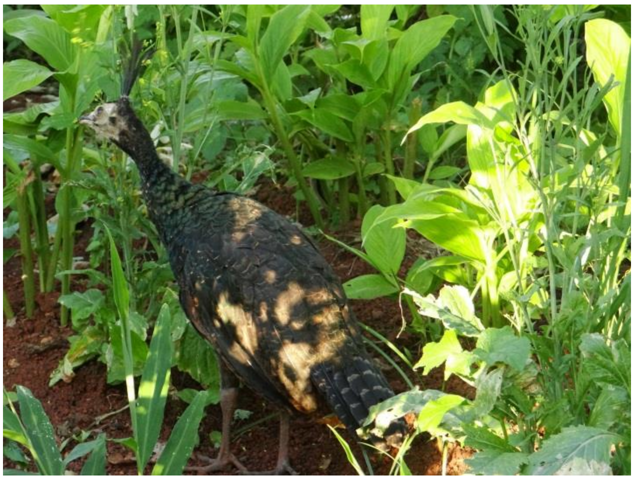
Table 58: Bird Species on Right and Left Bank

No.	Scientific Name	Right Bank	Left Bank
1	*Francolinuspintadeanus*	√	
2	*Microhieraxcaerulescens*		√
3	*Cotumixchinensis*	√	
4	*Pavomuticus*	√	√
5	*Gallus gallus*	√	
6	*Egrettacasmerodius*	√	√
7	*Egrettagarzetta*	√	√
8	*Bubulcus ibis*	√	√
9	*Milvusmigrans*	√	√
10	*Accipiter badius*	√	
11	*Streptopeliachinensis*	√	√
12	*Treronphoenicopterus*	√	√
13	*Columba liva*	√	√
14	*Duculaaenea*	√	√
15	*Streptopeliaorientalis*	√	√
16	*Treroncurvirostra*	√	
17	*Clamatorcoromandus*	√	√
18	*Eudynamysscolopaceus*	√	
19	*Centropussinensis*	√	√
20	*Cypsiurusbalasiensis*	√	√
21	*Coraciasbenghalensis*	√	√
22	*Eurystomusorientalis*		√
23	*Anthracocerosalbirostris*	√	
24	*Megalaimahaemacephala*	√	√
25	*Megalaimalineata*	√	√

26	*Megalaimaasiatica*	√	√
27	*Halcyon smymensis*	√	√
28	*Meropsorientalis*	√	√
29	*Meropsleschenaulti*	√	√
30	*Meropsphilippinus*	√	√
31	*Dinopiumjavanense*	√	√
32	*Dinopiumraffesii*		√
33	*Psittacula eupatria*	√	√
34	*Psittaculafinschii*	√	√
35	*Pisttaculakrameri*	√	√
36	*Apuspacificus*	√	√
37	*Apusaffinis*	√	√
38	*Oriolus xanthomus*	√	√
39	*Dicrurusmacrocercus*	√	√
40	*DicrurusIeucophaeus*	√	√
41	*Corvus splendens*		√
42	*Corvus macrorhynchos*	√	√
43	*Oriolus tenuirostris*	√	√
44	*Urocissa erythrorhyncha*	√	
45	*Dicrurusaeneus*	√	√
46	*Pericrocotusflammeus*	√	
47	*Motacilla alba*	√	√
48	*Ploceusphilippinus*	√	
49	*Lonchurapunctulata*	√	√
50	*Lonchuramalacca*	√	√
51	*Passer domesticus*	√	√
52	*Passer mmtanus*	√	√
53	*Copsychussaularis*	√	√
54	*Saxicolacaprata*	√	√
55	*Acridotheresfuscus*	√	√

56	*Acridotheresgrandis*	√	√
57	*Sturnusburmannicus*	√	√
58	*Gracularegligiosa*	√	√
59	*Pycnonotusatriceps*	√	√
60	*Pycnonotuscafer*	√	√
61	*Pycnonotusblanfordi*	√	√
62	*Pycnonotusjocosus*	√	√
63	*Pycnonotusmelanicterus*	√	√
64	*Hirundorustica*	√	√
65	*Vamellusindicus*	√	
66	*Nectariniajugularis*		√
67	*Nectariniaasiatica*		√
68	*Aethopygasiparaja*	√	√
69	*Priniahodgsonii*	√	√
70	*Priniarufescens*		√
71	*Chloropsisaurifrons*	√	√
72	*Chloropsiscochinchinensis*	√	
73	*Ketupazeylanensis*	√	
74	*Vanelluscinereus*	√	
75	*Turnixsuscitator*	√	
76	*Acridotherestristis*	√	√
77	*Upupaepops*	√	√
78	*Pellorenumruficeps*	√	√
79	*Pericrocotuscinnamomeus*	√	√
80	*Gallinulachloropus*	√	√
	TOTAL	**74**	**65**

4.3.1. Photographic Documentation of Bird Species



A. *Pavomuticus*

B. *Splaeornis spp.*

C. *Pellorneumruficeps*

D. *Gracularelig iosa*

F. *Merpsleschenaulti*

G. *Pycnonotuscafer*

H.*Corvusmacrorhynchos*

I. *Halcyon smyrnensis*

J. Oriolustenuirostris

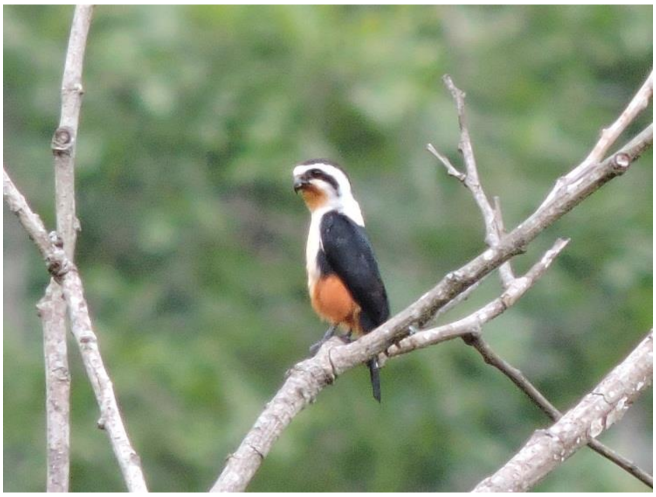
L. Lonchurapunctulata

M. *Pycnonotusjococsus*

N. Treronphenicopterus

P. *Dicrurusmacrocercus*

Q. *Streptopelia chinensis*



R. Microhierax caerulescens

4.5. Mammal Species

Twenty-five mammal species were identified in the left bank survey. Ten were identified by voucher specimen, four were identified by visual observation and the remaining eleven were identified by interviews. According to the IUCN Red List, five of the species identified in the left bank survey are classified as endangered; *Pantheratigris*, *Bosjavenensis Trochypithecusphayrei*, *Trochypithecuspileatus and Hylobateslor.* Three species are classified as near threatened; *Pantherapardus, Macacaassamensis, and Presbytisfemoraliz.* Eight species are classified as vulnerable; *Ursusthibetanus, Pardofelisnebulosa, Bosgourus, Cervusunicolon, Naemorhedus baileyi, Macaca sp., Macacafascularis* and *Macacanemenstrina.* The remaining nine species are classified as least concern. It should be noted that during the survey all species classified as endangered were identified via interviews and not confirmed via visual observation. The same is true for many of the species classified as near threatened or vulnerable. Given the lack of confirmation on key species, it is recommended that a camera trap survey be conducted in the area to determine the prevalence of these species.

A total of 35 mammal species were identified on both the left and right banks combined. Of this total 25 were identified on the left bank as opposed to 23 on the right bank. Thirteen species were identified on both banks.

Table 59: Mammal Species on Left Bank

No.	Phylum Class	Order	Family	Scientific Name	Common Name	Local Name
1	Mammalia	Carnivora	Ursidae	*Ursusthibetanus*	Asian black bear	Wat won
2	Mammalia	Carnivora	Felidae	*Pantheratigris*	Tiger	Kyar
3	Mammalia	Carnivora	Felidae	*Pantherapardus*	Leopard	Kyar thit
4	Mammalia	Carnivora	Felidae	*Felischaus*	Jungle cat	Taw kyaung
5	Mammalia	Carnivora	Felidae	*Pardofelisnebulosa*	Clouded leopard	Inn kyar
6	Mammalia	Artiodactyla	Bovidae	*Bosgourus*	Gaur	Pyaung
7	Mammalia	Artiodactyla	Bovidae	*Bosjavenensis*	Bantang	Saing
8	Mammalia	Artiodactyla	Suidae	*Susscrofa*	Eurasian wild pig	Taw wat
9	Mammalia	Artiodactyla	Cervidae	*Muntiacusmuntjak*	Red muntia	Chae
10	Mammalia	Artiodactyla	Cervidae	*Cervusunicolon*	Sambar	Sat
11	Mammalia	Artiodactyla	Bovidae	Naemorhedus baileyi	Red goral	Taung sateni
12	Mammalia	Primate	Cercopithecidae	*Macaca sp.*	Monkey	Myauk

13	Mammalia	Primate	Cercopithecidae	*Macacaassamensis*	Assamese macaque	Arsam myuk
14	Mammalia	Primate	Cercopithecidae	*Macacafascularis*	Long Tailed Macaque	Myauk tangar
15	Mammalia	Primate	Cercopithecidae	*Macaca nemenstrina*	Pig tailed macaque	Myauk putee
16	Mammalia	Primate	Cercopithecidae	*Macacamulatta*	Rhesus Macaque	Myauk sut
17	Mammalia	Primate	Cercopithecidae	*Trochypithecusphayrei*	Pharyre's langur	Myauk myat kwin pyar
18	Mammalia	Primate	Cercopithecidae	*Trochypithecuspileatus*	Cappet langur	Myauk nyo
19	Mammalia	Primate	Cercopithecidae	*Hylobateslor*	Whited handed gibbon	Myauk hlwe kyaw
20	Mammalia	Primate	Cercopithecidae	*Presbytisfemoralis*	Banded langur	Myauk mhee shae
21	Mammalia	Rodentia	Sciuridae	*Callosciurus erythraeus*	Pallas's squirrel	Shint nga paw
22	Mammalia	Rodentia	Hystricidae	*Hystrix brachyuran*	Malayan porcupine	Phyu
23	Mammalia	Chiroptera	Hipposideridae	*Hipposideros armiger*	Great round leaf bat	Lin noet
24	Mammalia	Chiroptera	Megadermatidae	*Megaderma sposma*	Lesser false vampire bat	Lin noet
25	Mammalia	Scandentia	Tupaiidae	*Tupaia belangeri*	Tree shrew	swae

Table 60: Habitat Type, Number of Observations, Data Source, and IUCN Status

No.	Scientific Name	Habitat Type	No. of Obv.	Data Source	IUCN Status
1	*Ursusthibetanus*	Forest		IS	VU
2	*Pantheratigris*	Forest		IS	EN
3	*Pantherapardus*	Forest		IS	NT
4	*Felischaus*	Forest	Foot print	VS	LC
5	*Pardofelisnebulosa*	Forest	Skin	VS	VU
6	*Bosgourus*	Forest		IS	VU
7	*Bosjavenensis*	Forest		IS	EN
8	*Susscrofa*	Forest	Foot print	VS	LC

9	*Muntiacusmuntjak*	Forest	Foot print	VS	LC
10	*Cervusunicolon*	Forest		IS	VU
11	*Naemorhedus baileyi*	Forest		IS	VU
12	*Macaca sp.*	Tree		VS	VU
13	*Macacaassamensis*	Tree		VO	NT
14	*Macacafascularis*	Tree	Foot print	VS	VU
15	*Macacanemenstrina*	Tree	Foot print	VS	VU
16	*Macacamulatta*	Tree	Foot print	VS	LC
17	*Trochypithecusphayrei*	Tree		IS	EN
18	*Trochypithecuspileatus*	Tree		IS	EN
19	*Hylobateslor*	Tree		IS	EN
20	*Presbytisfemoralis*	Tree		IS	NT
21	*Callosciurus erythraeus*	Teak tree	2+	VS	LC
22	*Hystrix brachyuran*	Cave	Quill	VS	LC
23	*Hipposideros armiger*	Cave	30	VO	LC
24	*Megaderma sposma*	Tree	3	VO	LC
25	*Tupaia belangeri*	Forest	2	VO	LC

Table 61: Mammal Species on Right and Left Banks

No.	Scientific Name	Right Bank	Left Bank
1	*Hylomyssuillus*	√	
2	*Talpa micrura*	√	
3	*Ursusthibetanus*	√	√
4	*Cuonalpinus*	√	
5	*Viverrazibetha*	√	
6	*Panthera tigris*		√
7	*Panthera pardus*		√
8	*Felis chaus*	√	√
9	*Pardofelisnebulosa*		√
10	*Bosgourus*	√	√

11	*Bosjavenensis*	√	√
12	*Susscrofa*	√	√
13	*Muntiacusmuntjak*	√	√
14	*Cervusunicolon*	√	√
15	*Naemorhedus baileyi*	√	√
16	*Macaca sp.*	√	√
17	*Macacaassamensis*	√	√
18	*Macacafascularis*		√
19	*Macacanemenstrina*		√
20	*Macacamulatta*		√
21	*Trochypithecusphayrei*		√
22	*Trochypithecuspileatus*		√
23	*Hylobateslor*		√
24	*Presbytisfemoralis*	√	√
25	*Mnanispentadactyla*	√	
26	*Lepuspeguensis*	√	
27	*Callosciurus erythraeus*	√	√
28	*Petauristasp*	√	
29	*Rhizomys sp.*	√	
30	*Hystrixbrachyura*	√	√
31	*Taphozouslongimanus*	√	
32	Copriconissumatraensis	√	
33	*Hipposideros armiger*		√
34	*Megaderma sposma*		√
35	*Tupaia belangeri*		√
	Total	**23**	**25**

4.5.1. Photographic Documentation of Mammal Species

(A) Foot print of *Macaca fascicularis*

(B) *Muntiacus muntjak*

(C)Foot print of *Macaca nemestrina*

(D) Foot print of *Sus*

(E) *Hipposideros armiger*

(F) *Tupaia belangeri*

(G) *Megaderma spasma*

(H) spine of *Hystrix brachyura*

(I) *Muntiacus muntjak*

(J) *Droppings of a large cat*

(K) *Macaca spp.*

(L) Foot print of *Macaca fascicularis*

(M) *Habitat of Tupaia belanger*

(N) Hair of *Hystrix brachyura*

(O) Cave of *Hipposideros armiger*

(P) *Hipposideros armiger*

(Q) *Megaderma spasma*

4.6. Fauna Totals for Entire Project Area

A total of 242 fauna species were identified on the left bank survey over a 20-day period. This is closely comparable with the right bank survey which identified 243 fauna species. A total of 343 fauna species were found on the left and right banks combined. The left bank also had a number of species present that exist on the IUCN Red List. Most notably, seven species are classified as endangered, nine as vulnerable and ten as near threatened.

Table 62: Total Fauna Left and Right Banks

No.	Fauna	Left Bank	Right Bank	Both Banks
1	Insects and other invertebrates species	86	74	138
2	Fish and other aquatic species	36	32	45
3	Herpeto species	31	39	45
4	Bird species	65	74	80
5	Mammal species	25	23	35
	TOTAL	243	242	343

Table 63: Left Bank Fauna IUCN Classification Totals

No.	Fauna	IUCN Red List categories						
		EN	VU	NT	LC	NE	DD	TOTAL
1	Insects and other invertebrates species	-	-	-	-	-	-	0
2	Fish and other aquatic species	-	1	2	16	2	2	23
3	Herpeto species	1	-	2	26	1	-	30
4	Bird species	1	-	3	61	-	-	65
5	Mammal species	5	8	3	9	-	-	25
	TOTAL	7	9	10	112	3	2	143

5. CONCLUSION AND RECOMMENDATIONS

5.1. Flora

The flora team conducted 38 sample plots and numerous transect walks on the left bank of the river to determine the flora species present as well as their density and common occurrence. The data were collected using the same methodology and team of researchers as the EIA for the right bank of the river. As such the data collected proves statistically robust and can offer an accurate representation of the flora species present on the left bank and how it compares in terms of biodiversity to the right bank.

At present the forest ecosystems on the left bank of the river are more substantial and diverse than those on the right. As noted earlier in the report, a total of 462 species of flora were identified across the entire project area on both banks. Of these species, 289 can be found on the right bank and 383 can be found on the left bank. This means that the left bank has more diversity than the right bank with an additional 94 species (or 33% more species) than the right bank. A total of 20 flora species on the IUCN Red List can be found on the left bank. Most notably, both *Curcuma alismatifolia* and *Dalbergia cultrata* Grah. are classified as near threatened (NT), *Cycas siamensis* Miq. is classified as Vulnerable (VU A2 cd) and *Dalbergia oliveri* Gamble is classified as endangered (EN A1cd). The other 16 species on the list are classified as either least concern or low risk/least concern.

Deforestation and forest fragmentation are more common on the right bank of the river. During fieldwork, no primary forests were found on the right bank; only the patches of secondary or degraded forest. Some patches of primary forest still exist on the left bank, but in general, left bank forests have also been degraded by small-scale logging operations of hardwoods as well as recent and substantial clearance of forests area for farmland. Due to these issues, bamboo forests with a low frequency of timber trees are beginning to replace the deciduous forests in the area; though, patches of deciduous Indine forest and deciduous teak forests still existing on the left bank to a limited extent. These remaining habitat blocks vary greatly in size, and it is foreseeable that many of them can continue to exist and expand if there is adequate protection and moderate restoration. Given these conditions the remaining patches could be enough to regenerate natural forests, given fifteen to twenty years. However, if the current process of small scale logging and land clearance for farmland continue without change, degradation of left bank forests will continue. In this scenario left bank flora cover will be degraded to the point where it is similar to that of the right bank within a few decades.

(small scale logging) (recently cleared forests for farm land)

5.2. Fauna

A total of 242 fauna species were identified on the left bank survey over a 20-day period. This is closely comparable with the right bank survey which identified 243 fauna species. A total of 343 fauna species were found on the left and right banks combined. The left bank also had a number of species present that exist on the IUCN Red List. Most notably, seven species are classified as endangered (EN), nine as vulnerable (VU) and ten as near threatened (NT). It should be noted that all of the species classified as endangered were identified via interviews with the local population and not confirmed via visual observation. The same is true for many of the species listed as vulnerable and near threatened. The majority of the twenty-six species which fall in these three categories are mammals (16 species). A camera trap survey is highly recommended. Such a survey should be able to provide an accurate understanding of the prevalence of many of these large mammal species.

5.3. External Impacts

The survey identified a number of factors impacting biodiversity on the left and right banks that are external to the project and will continue regardless of whether or not the Middle Yeywa HPP is implemented. Although not directly related to the project addressing them through selected interventions should be an integral part of SNPs measures to offset environmental damage caused by the project.

Loss of biodiversity and habitat

The catchment forest of the Myitnge River is facing deforestation due to the expansion of farm-land by nearby villages. Sugarcane and corn plantations are growing rapidly in Naung Cho Township on the right bank and cultivation of corn in Yat Sauk Township is happening on the left bank. Much of the forest cover on the right bank has already been removed and forest cover on the left bank is declining. The land use change is rapid and continued deforestation is inevitable. Small-scale logging is also taking place on the left bank of the river. Although these are mostly in reserve forests, it is unlikely to expect that the logging will cease. The deforestation of the area will have a negative impact on fauna, which rely on the forests as their natural habitat. As deforestation continues, fauna will compete over smaller areas of habitat and food sources, and many will be forced into more frequent contact with human populations as they look for alternative food sources. Fauna will also be more vulnerable to hunting.

Loss of fresh-water supply

The geology of the proposed Middle Yeywa reservoir consists of limestone bedrock covered by terra-rosa soil. The removal of surface vegetation due to forest clearance for farmland allows rain water to disappear quickly through the porous limestone, leaving the surface dry even after heavy rain. This may lead to the loss of the streams and springs and consequently, a shortage of freshwater supply in the area. This can have negative implications both for fauna and human populations in the area, particularly during the dry season.

Hunting by Local Populations

Wild game hunting is still practiced in the project area, particularly on the left bank. The present survey identified the presence of big cats, *Pantherapardus and Felischaus* and other mammals such as *Cervus unicolor, Muntiacus muntjak* and *Sus scrofa*. These species are facing extinction in the area due to the hunting practices of local populations.

5.4. Project Impacts

The survey provides enough evidence to predict that the Middle Yeywa HPP will have the following impacts on flora and fauna in the area.

Habitat loss

The reservoir will inundate all land located below 320 masl in the river valley. The steep slopes of the valley mean that much of the water volume will occupy vertical space and a relatively small surface area will be inundated. This area consists of riverine Indaine forests and is habitat for a variety of fauna species.

Changes in water quality and aquatic habitats

The project will transform a swift flowing section of the Myitnge River into a slow and stagnant reservoir. This could potentially have adverse effects on dissolved oxygen content (DOC) and consequently, affect the populations of various fish species living there. The inundated biomass can also have adverse effects on water quality, leading to eutrophication if proper preventative measures are not taken. Relatedly the project will also reduce sediment flow in the river. Much sediment will build up in the reservoir as opposed to being washed downstream. This can have adverse impacts on fish populations downstream which depend on the sediment load to fuel the base of their food chain.

Additional river fragmentation

The Lower Yeywa HPP has already fragmented the river and blocked potential migration routes for various fish species. Since this survey took place after the construction of the Lower Yeywa HPP, researchers were unable to determine the extent to which migration is already blocked. The addition of the Middle Yeywa HPP will lead to further river fragmentation, though impacts will be marginal relative to pre-existing fragmentation.

5.5. Recommendations

The EIA survey has identified several impacts on flora and fauna biodiversity in the project area. Some of these will be caused by the project while others will be the result of external factors. The following interventions are recommended to mitigate the effects of project impacts and external impacts, promote the sustainable use of natural resources in the project area and prevent the degradation of flora and fauna biodiversity. These interventions should be integrated parts of a wider Environmental Management Plan (EMP) to be financed and implemented by SN Power. The impacts, mentioned earlier in this section and the recommendations to follow are outlined in the 'Impact and Mitigation Matrix' (Section 6.6).

- Data collected from this survey can be used to calculate the habitat loss (both in terms of surface area and vegetation type) that the reservoir will inundate. SN Power should support community forest projects in the villages proximate to the river. Both reserve and productive forests should be created to offset habitat loss from the HPP and promote a more sustainable use of forest resources by the local population. To this end SNP should also help communities to establish a 'Conservation Fund'. This can be used to provide seed funding for the community forest projects as well as fund continued maintenance of community forests over the long-term.

- Biomass clearance should be conducted in the reservoir below the fill line of 320 masl. This will avoid oxygen deficiency and eutrophication and promote good water quality.

- Studies should be done to measure the cumulative impacts on water quality, sedimentation and dissolved oxygen content of the Middle Yeywa HPP and other current and planned HPP on the Myitnge River as a whole.

- The environmental survey carried out thus far on both the left and right banks of the river covered the direct impact zone of the project, especially the vegetation of the river valley and the river bank slope. The catchment forests are vital for the maintenance of sustainable water level in the dam. The present environmental survey points out the link between the catchment forests and river health but cannot identify the magnitude of impact. For the full environmental assessment, the indirect impact zone especially the catchment forest area of the river and the downstream ecosystem must be included.

- DOC should be closely monitored before, during and after the construction of the Middle Yeywa HPP. If approaches minimal acceptable levels, appropriate mitigation measures should be considered such as the construction of artificial waterfalls.

- An environmental audit should be conducted shortly after completion of the project. This will help to inform additional environmental protection measures where appropriate.

- Interviews with local villagers suggests the presence of several endangered fauna species. A camera trap survey should be conducted to confirm or disprove the existence of these species in the project area. Pending the findings of the camera trap survey, appropriate conservation efforts can then be determined and implemented.

5.6. Impacts and Mitigation Matrix

Project Impacts

Potential Impact to Biodiversity	Extent			Duration			Probability			Magnitude			Significance			Recommended Measures
	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	
1 Existing Indaing Forest and Teak forests in riverine area will be inundated.			√			√			√			√			√	The remaining Indaing forest above 320 masl should be protected from illegal logging and community forest projects should be conducted.
2 Eutrophication of water in dam reservoir due to biomass from inundated forests.		√			√			√			√			√		Biomass clearance should be conducted before reservoir is filled.
3 Decrease oxygen concentration in water due to the change of running water to stagnant water in reservoir.	√				√			√			√			√		To restore the DOC in the reservoir man-made falls and rapid should be constructed to get stable oxygen concentration in the inundated area along the river. DOC levels should be closely monitored before, during and after dam construction to determine if this measure is necessary or if DOC remains within acceptable levels without this intervention.
4 Food scarcity for aquatic fauna due to decrease nutrient transport from stagnant water in reservoir.		√			√			√			√			√		Reforestation of catchment forest so that the nutrition regime can be maintained

External Impacts

Potential Impact to Biodiversity	Extent			Duration			Probability			Magnitude			Significance			Recommended Measures
	L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	

1 Degradation of teak forests in catchment area due to small-scale logging and land clearance for farming.			√			√			√			√			√	Reforestation of teak plantation should be done.
2 Loss of nutrient regime from degraded catchment forest and transported from upstream to downstream			√		√			√		√				√		Reforestation of catchment forest should be carried out. A reforestation and conservation fund should be established and implemented.
3 Expansion of cultivated farm land into the forest area.		√				√			√			√			√	The remaining patches of forests should be conserved and regeneration of forest trees must be promoted in the deforested area. Further expansion of farm land in the forest area must be prevented.
4 Hunting of wild game is still practiced by local populations. Consequently, biodiversity of fauna is decreasing.			√			√			√			√			√	The enforcement of law and order should be strictly carried out and protection of wild animals, by forest ranger should also be promoted.

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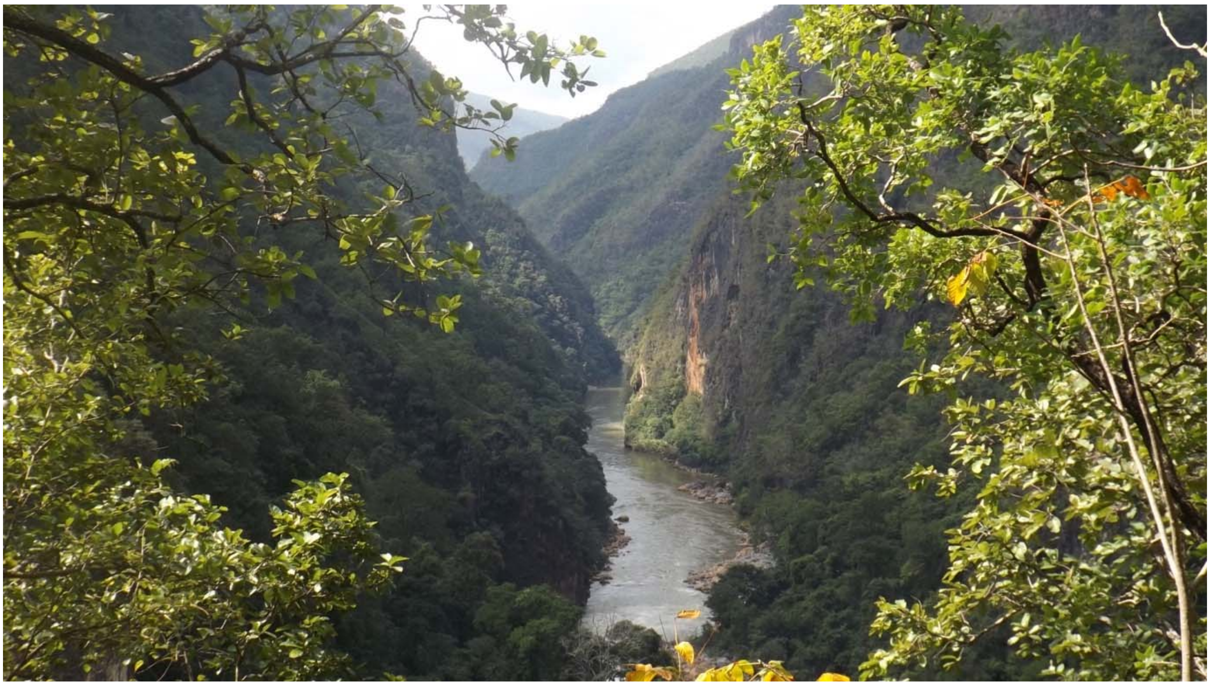
ANNEX 2C

Biodiversity Impact Assessment Report of Middle Yeywa Hydropower Dam

BIODIVERSITY IMPACT ASSESSMENT REPORT OF MIDDLE YEYWA HYDROPOWER DAM



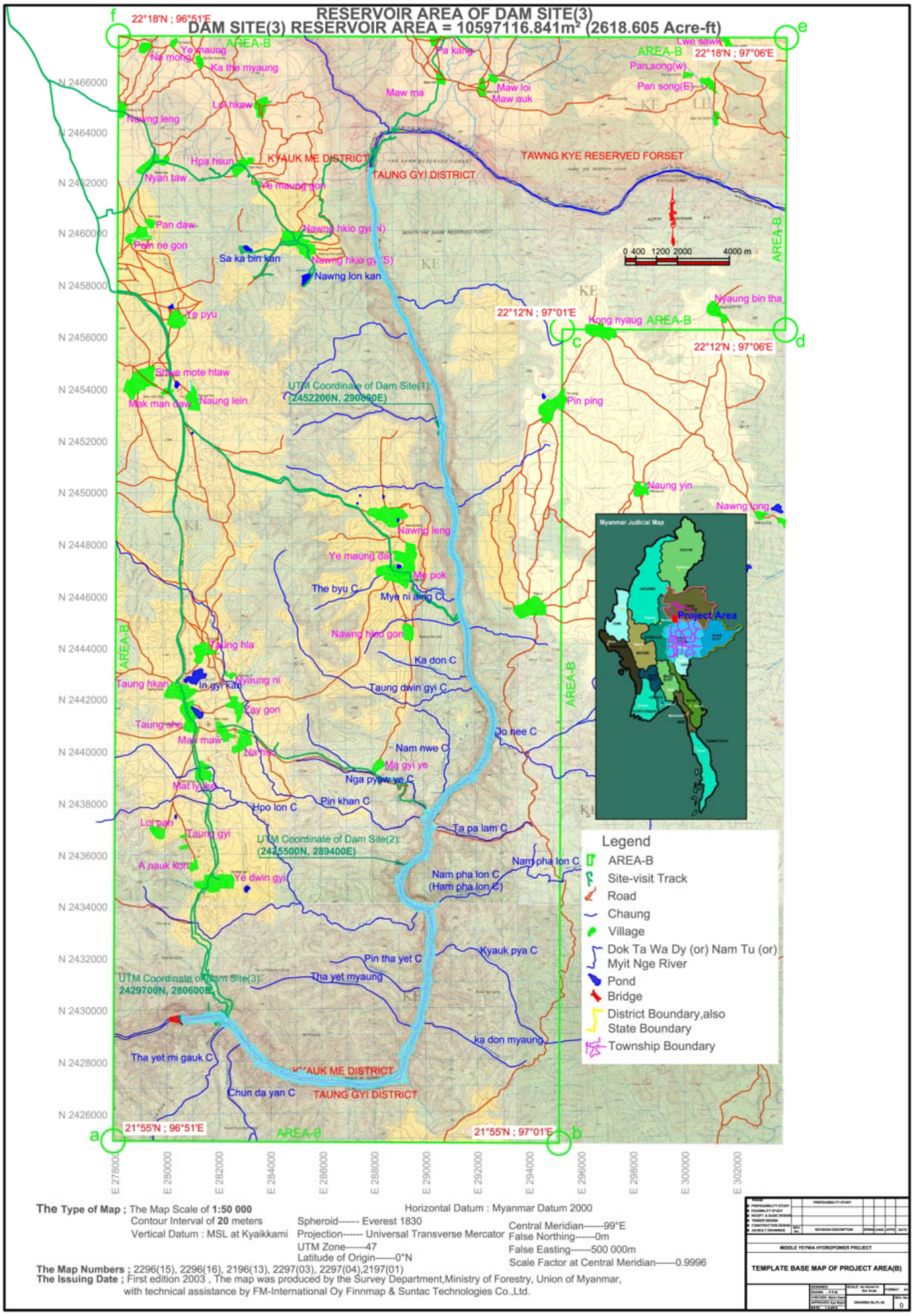
January, 2018

No.	CONTENTS	Pages

I. INTRODUCTION

The Middle Yeywa Hydropower Dam Project is located between 21˚55' N, 96˚51' E and 21˚55' N 97˚01' E near Yetwingyi Village in Naungcho Township, on downstream confluence with Tha-yet-migauk stream and Dokhtawaddy River. (Map I)

Map I.



A series of biodiversity impact assessment was conducted along the both sides of riverbank of Dokhtawaddy River (also called NanTu River and Myintnge River). From March to May of 2015 first biodiversity survey was conducted along the right bank of the river in dry season. From September to October of 2015, second biodiversity survey was conducted along the right bank of the river in raining season. From July to August of 2016 third biodiversity survey was conducted along the left bank of the river in these surveys a series of point quadrants, line transects and wandering transect were conducted and types of vegetation and habitat types in each ecosystem were analyzed and recorded. The habitat surveys include area along the roadsides, steep slope of riverbanks and catchment areas of the river. Datum were collected via visual observation and supported by GPS positioning, photographs and taking physical specimens of plants and animals.

The present survey consists of four representative areas and focus in inundated area (below 320m asl) along the river. The plant specimens were recorded and identified with a focus on rocks along the river, aquatic plants along the river, the river bank of Gohteik stream, the area around Namkam water fall and inundated area in the confluence of Namkam Stream and Dokhtawaddy River.

The fauna survey was focus on the mammals, insects, birds and reptiles in the four representative areas. For big mammals (big cat/Leopards) the camera traps were deployed in the possible representative areas on the both sides of the river especially on left bank. The local village headmen were requested to monitor and takecare the existing of cameras. The fish survey carried out by the expert from MIID was excluded in the present study. Multiple sampling techniques such as visual encounter and acoustic surveys, trapping (Camera traps), interviewing, collecting the wildlife remnant and track and sign surveys to increase the chances of detecting species that occur within the study area, were deployed.

1.1. Objectives

The field survey conducted for the present study has

1. To collect and identify the plant and animal species in the inundated area along the river especially the rocks and cliffs along the river, seasonally flooded area and spray zone of waterfall and wildlife in the direct impact zones.
2. To record the dominant tree species and evaluate the vegetation types.
3. To assess the potential impacts and to suggest the mitigation measure.

1.2. Topography of the research area

The elevation of the mountain ranges in the catchment area around the river is 1000m in height. The river flows in narrow V-shaped valley and has steep banks. The flooded area due to dam will be narrow and long. The flooded area is estimated to be approximately 1,100 hectare, according to the references. The normal pool level will be 320m asl.

The lower Yeywa Dam is located on the downstream 80.4km away from Middle Yeywa HPP dam site. The Upper Yeywa HPP dam is located on the upstream 49.6km away from the Middle Yeywa HPP dam. The lowest elevation in the Middle Yeywa dam area is 218m asl near Yetwingyi Village. The highest elevation of Middle Yeywa HPP dam in the inundated area is 320m asl. The elevation level near Naungchogyi Village is 325m asl. It is estimated 68km away from the Upper Yeywa HPP dam. Therefore the tail of Middle Yeywa Dam may not reach the Upper Yeywa Dam.

The project area exists in a Monsoon climatic zone. The average annual rainfall is 1312mm.

II. MATERIALS AND METHOD

2.1 Survey Team

Flora Team

(1) Dr.Win Myint (Associated Professor, ex.), Ecologist

(2) U Nyo Maung (Retired Professor), Taxonomist

(3) Dr. Ei Ei Phyoe, Taxonomist

(4) U Tun Thura, Botanist & GIS/RS

(5) U Thein Phyoe Aung (Assistant Taxonomist)

Fauna Team

(1) U Tin Aung Tun (Bird and Mammal specialist and Fauna Team Leader)

(2) U Min Thein Htet (Amphibians and Reptiles Specialist)

(3) U Kyaw Naing Oo (Insect and other Invertebrates Specialist)

2.2. Methodology (Flora)

The floristic Survey in the project area had been divided into four representative areas.

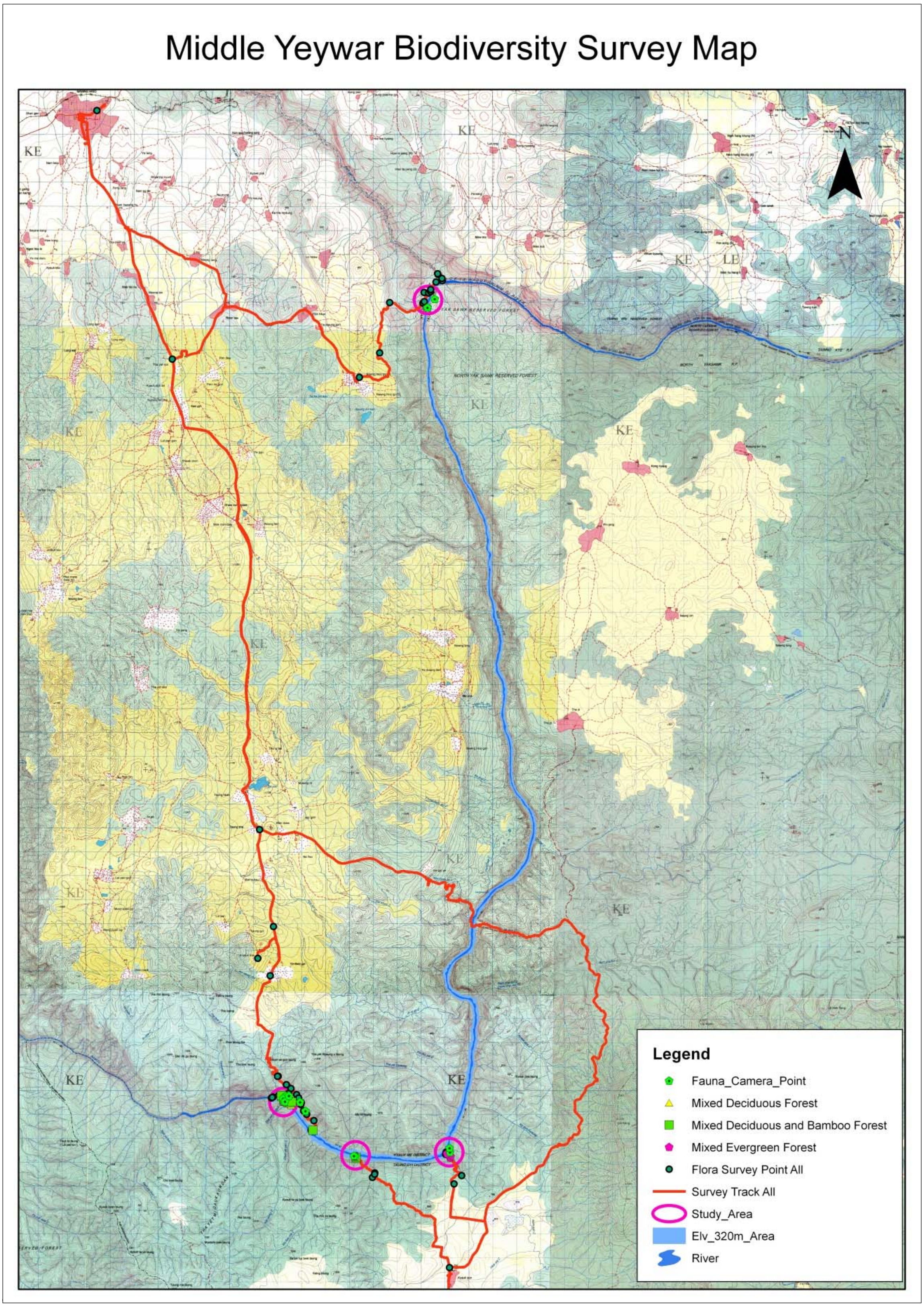
The first research area includes the inundated area closed to the dam site, estimate 6.4km away from Yetwingyi Village on the right bank of the river. The lowest elevation in this area is 222m asl.

The second research area includes the downstream confluence of Dokhtawaddy River and Gohteik Stream. The lowest elevation in this area is 320m asl.

The third research area includes the Namkam waterfall area and the inundated area at the confluence of Namkam Stream and Dokhtawaddy River. The lowest elevation in this area is 265m asl.

The fourth research area includes the previously used as boat jetty on the riverbank near Kyauk-sone Village. The lowest elevation in the area is 260m asl.

Map II.


Middle Yeywar Biodiversity Survey Map
N
Legend
Fauna_Camera_Point
Mixed Deciduous Forest
Mixed Deciduous and Bamboo Forest
Mixed Evergreen Forest
Flora Survey Point All
Survey Track All
Study_Area
Elv_320m_Area
River

The floristic data and ecological data collection were conducted by the following methods in the study Area.

2.2.1.1 Sample Plotting

The Global Positioning System was used to navigate and mark the coordinates of the sample plots. In order to obtain essential data for predicting of tree species composition in the forest and vegetation types, 20x20 and 30x30 meter quadrants, were set up and tree species in the plot were collected and population of each species were also counted. For the Bamboo survey, 20x20 and 30x30 meter quadrants were set up and bamboo species were collected and number of clump of each species were also counted. The species identification was carried out by using key to families of flowering plants and appropriate literature and confirmed by matching with herbarium specimens of Department of Botany, University of Yangon.

2.2.1.2 Random Transecting

To get representative checklists of the tree species and bamboo species, plant collection was also carried out by random transect lines along the roadside and between one plot and another wherever possible. Specimen collection was made within 10 meter on either side of the transect line.

2.2.1.3 Mapping

Location maps are set by the method based on the UTM map and coordinate system WGS 1984 UTM zone 47 to determine the forests of the proposed areas.

2.1.2 Materials

Materials used for recording are strings for sample plotting and transecting, digital camera for recording, GPS, maps, heavy duty plastic bags, old newspapers, corrugated paper, alcohol, spray jug (for fixing specimens), 10x lens, permanent marker, field note books, field press, drying press and dryers.

2.1.3 Data Analysis

After field survey, data entry was carried out in excel work sheet. Analysis of population per hectare percentage was conducted using excel work 2007.

2.1.3.1 Population of Individual Species (per hectare)

The population of species will show not only the composition of species but also the richness of the species in the study area. The population of individual species (per hectare) is determined by following formula. (Ref: R.He'dl, M Sva'tek, M. Dancak, Rodzay A.W., M. Salleh A.B., Kamariah A.S.(2009).

$$\text{Population of Individual Species} = \frac{\text{Total Individual species}}{\text{Total Plots Area } (m^2)} \times 10000m^2 (1ha)$$

2.1.3.2 Relative Density of Tree species

The density of a species refers to the numerical representation of its individual and the availability of space in a unit area. The density index shows not only the richness of the texa but also the relative distribution of the individuals. According to Curtis (1959), the density index is determined by the following formula.

$$\text{Relative Density of Tree species} = \frac{\text{No. of Individual species}}{\text{Total no. of all individual Species}} \times 100$$

2.1.3.3 Relative frequency of Tree species

The relative frequency of a species refers to the percentage occurrence of its individuals and shows the frequency of different species growing in the study area. The species that fall in high frequency class can be considered as the most common species in the study area. According to Curtis (1959), the relative frequency is determined by the following formula.

$$\text{Relative frequency of Tree species} = \frac{\text{No. of sample plot occurs}}{\text{Total no. of all species occur}} \times 100$$

2.1.3.4 Species distribution by frequency class

According to Raunkiaer's Law of frequency (1934), each species was grouped into one of five-frequency class (FC); Frequency range (1-20%) represents rare species, (20 - 40%) represents seldom species, (40 - 60%) represents often species, (60 - 80%) represents mostly species, and (80 - 100%) represents constantly present species. This frequency class will also clarify the homogeneity or heterogeneity of the floristic distribution in the study area.

2.1.3.5 Tree species in DBH class interval

Tree species in DBH class interval is calculated by

$$\text{Population of DBH class interval} = \frac{\text{No. of species}}{\text{Total no. of all species}} \times 100$$

Low DBH class interval shows the degraded and secondary forest height DBH class interval shows the primary forest.

2.1.3.6 Tree species in Height class interval

Tree species in Height class interval is calculated by

$$\text{Population of Height class interval} = \frac{\text{No. of species}}{\text{Total no. of all species}} \times 100$$

Low height class interval shows the degraded and secondary forest and high height class interval shows the primary forest.

2.1.3.7. Impact Analysis

Potential threats have been assessed according to four parameters. The four parameters are assigned a score from 1 to 3 based on the grading, which is indicated in the table below; this then allows an assessment of overall significance to emerge.

Score	Extant	Duration	Magnitude	Probability
1.	Direct threats zone: within study side and immediate surrounding	Short term: 0 to 12 month	Low: No or negligible	Low
2.	Locally: measurable outside study area and immediate surrounding	Medium term: 1 to 2 years	Medium: modified the natural ecosystem	Medium
3.	Wide Area: threats activities on large scale.	Long term: Threats persists	High: Environmental function altered or Socio-economic condition highly modified	High

Based on the scores related to extent, duration, magnitude and probability of a specific threat, the significant of threat calculated.

Significance indicator = [Extant + Duration + Probability] x Magnitude

2.3. MATERIALS AND METHODS (Fauna)

The survey was conducted from 10^{th} to 19^{th} of December 2017. Survey sites were selected based on satellite images and on consultation held with international and local experts and local people. Four survey sites were divided base on habitats. Globally threatened status of Fauna species were categorized using The IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.)., i.e Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near threatened (NT) and Least Concern (LC). Equipment used for species identification included: binoculars (8x42), cameras with long telephoto lens, field guides, call recorders. Geographic coordinates for each location (tracks and waypoints) were recorded using GPS devices (Garmin etrex 10 receiver). Coordinates were recorded as latitude and longitude in decimal degrees, and referenced to the WGS84 (World Geodetic System of 1984) datum. Data were collected using a data collection sheet specifically developed for the purpose, and organized at a later stage using a specific archive in a Microsoft Excel spread sheet and analysed using a Geographic Information System. The open source software Quantum GIS (QGIS) was used for GIS data analysis.

Birds: Transects were performed on along the footpath, during the morning to late afternoon. Transect length varied between 3 km to 6 km. The population status of bird species and their habitats were carried out by line transects method. Binoculars 10x42, Camera and long telephoto lens, Garmin GPS etrex 10 receivers, Digital Audio Recorder, Bamboo Flute (Owlet sound) and Field Guide Books (Craig Robson, 2011) were used for identification of bird's species during the survey period. Binoculars are used for visual sighting and recorded birdcalls for further detail identification. Listening to bird's calls is for aural identification. Recording or play back of bird's calls, or using owlet sound with bamboo flute to attract birds. Camera was used for the photograph record of some bird species such as new record for Myanmar and Regional. The geographic co-ordinates for each line transect were recorded using GPS device. Data sheet was also used during the survey period.

Mammals: Survey was performed using two methods. These are tracks and signs surveys and interview survey method. Direct observations of tracks and signs was applied mainly on existing trails and following route across the forest identified by local people. The team collected and recorded animal tracks and signs in a systematic manner. Direct survey method includes direct sightings and hearings. Indirect survey includes observing of tracks and signs such as footprints/spoors, faeces/ scats/ dungs, resting sites, scratching places, eating signs etc. Records of structure and the measurements of footprints were also made for identification. The surveys were mainly conducted on the jungle paths and animal trails. Salt lick and small streams were also investigated during survey period. In addition, a number of local people such as hunter or ex hunter were interviewed from village near survey area. Verbal reports by reliable persons and old records from the area were also recorded. During the survey period, 12 camera traps were installed in four survey sites. The mammals were identified with the references to John W. K. Parr., U Tin Than., 2000. *A Field guide to the Large Mammals of Myanmar.* Yon Kyi Chat Sarpe Publisher, Myanmar, 274 pp and Francis, C. M. (2008). *A field* *guide to the mammals of South-East Asia*. Asia Books, Bangkok, 392 pp. All data on the presence and species composition of mammal species were compiled.

Amphibian and Reptile: Surveys were conducted during the survey period. Specimens were observed by visual encounter surveys (Heyer et. al. 1994) supplemented with acoustic searching, turning rocks and logs, peeling bark, digging through leaf litter, and excavating burrows. Specimens were collected by hand or rubber ring and snake tongs were used to capture poisonous snakes. All species encountered are recorded during the survey period. Geographic coordinates for each survey site were determined in the field with Garmin GPS etrex 10 receivers. Coordinates were recorded as latitude and longitude in decimal degrees, and referenced to the WGS84 (World Geodetic System of 1984) datum.

Insect and other invertebrate: Survey applying standard method was conducted randomly around the survey area and along the trails or footpath in the survey area. Identification of Butterfly species was primarily made directly in the field. In some cases, if the encountered butterflies were not identified directly in the field, specimens were collected by using the long-handled aerial nets, net patch 1 millimetre, ring size 15 inches diameter. At the camp, collected specimens were observed and recorded for their morphological characters such as patterns, spots, stripes and colour. The mouth parts were carefully examined and the body and wing's length, measured. The specimens were taken picture and released back into the field. Some specimens were kept separately in the triangle envelopes. All separated envelopes were preserved in the airtight plastic containers to avoid humidity and also put mothballs inside containers to prevent from the growth of mould. Insects and other small invertebrates were taken voucher specimens although familiar species and some others were only taken picture.

III.RESULTS

3.1 Flora

3.1.1. First Research Area

Map III.

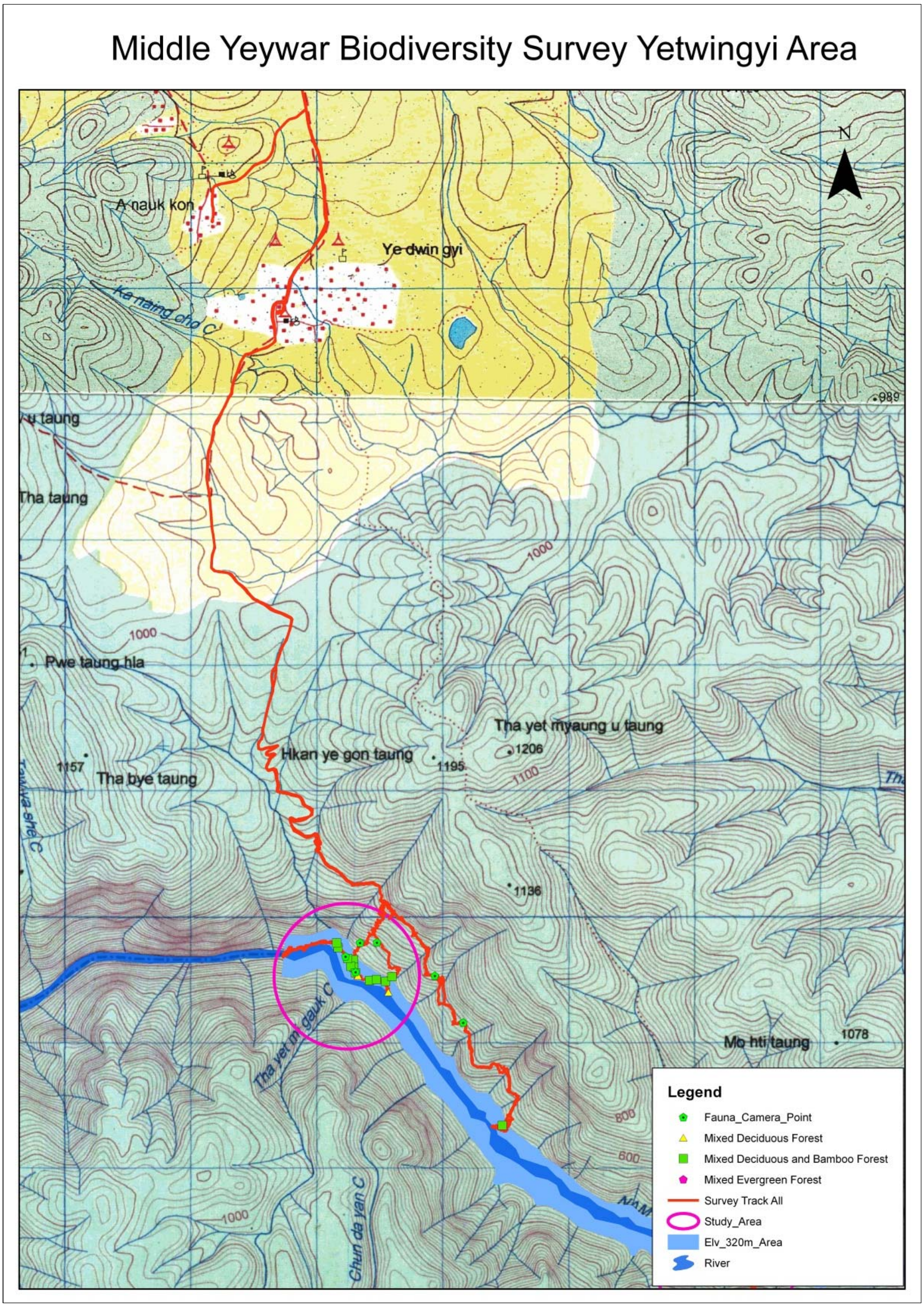
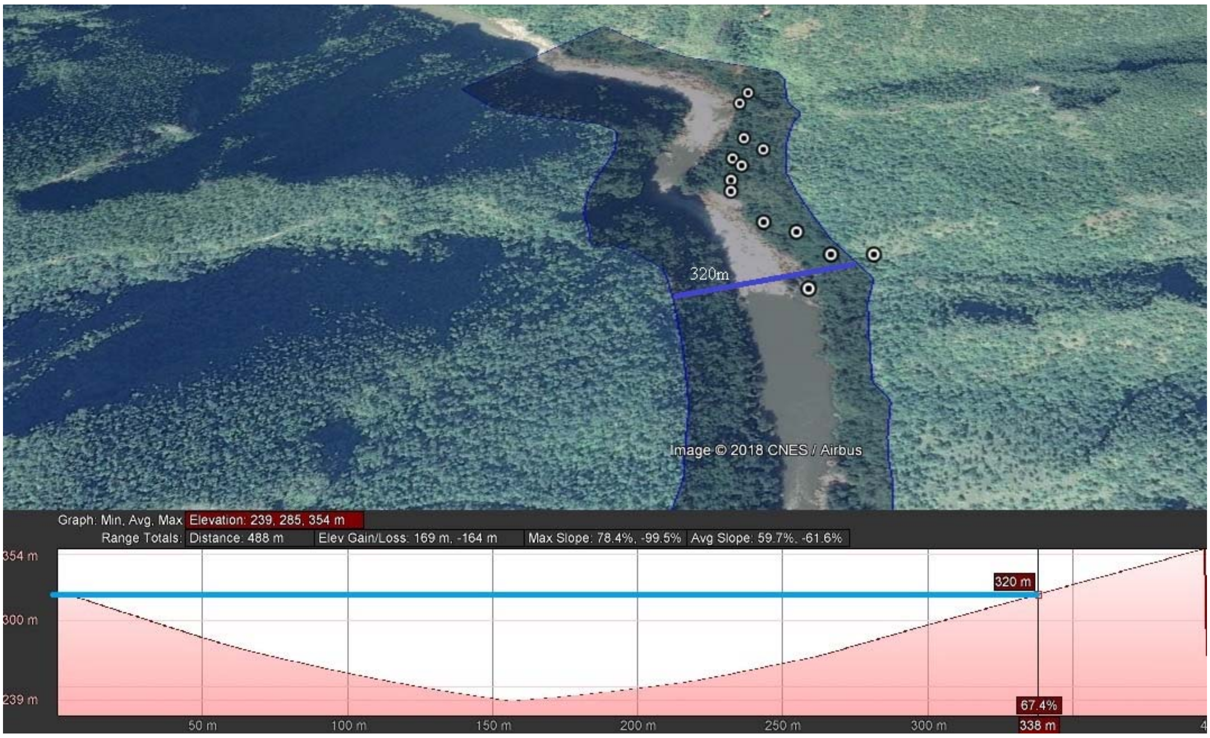


Photo Map IV.



Mixed Deciduous Forest


Mixed Deciduous Forest

3.1.1.1. Floristic composition

The total number of tree species collected in 14 representative sample plots in this area is 31 species belonging to 30 genera. The dominant tree species in this area are *Chukrasia velutina* Roem. (Taw-yin-ma) and *Pterocarpus indicus*Willd. (Taw-pa-dauk) followed by *Eugenia operculata* Roxb. (Ye-tha-bye), *Shorea siamensis*(Kurz)Miq. (In-gyin), and *Homonoia riparia* (Ye-mo-ma-kha/Gyin-ye).

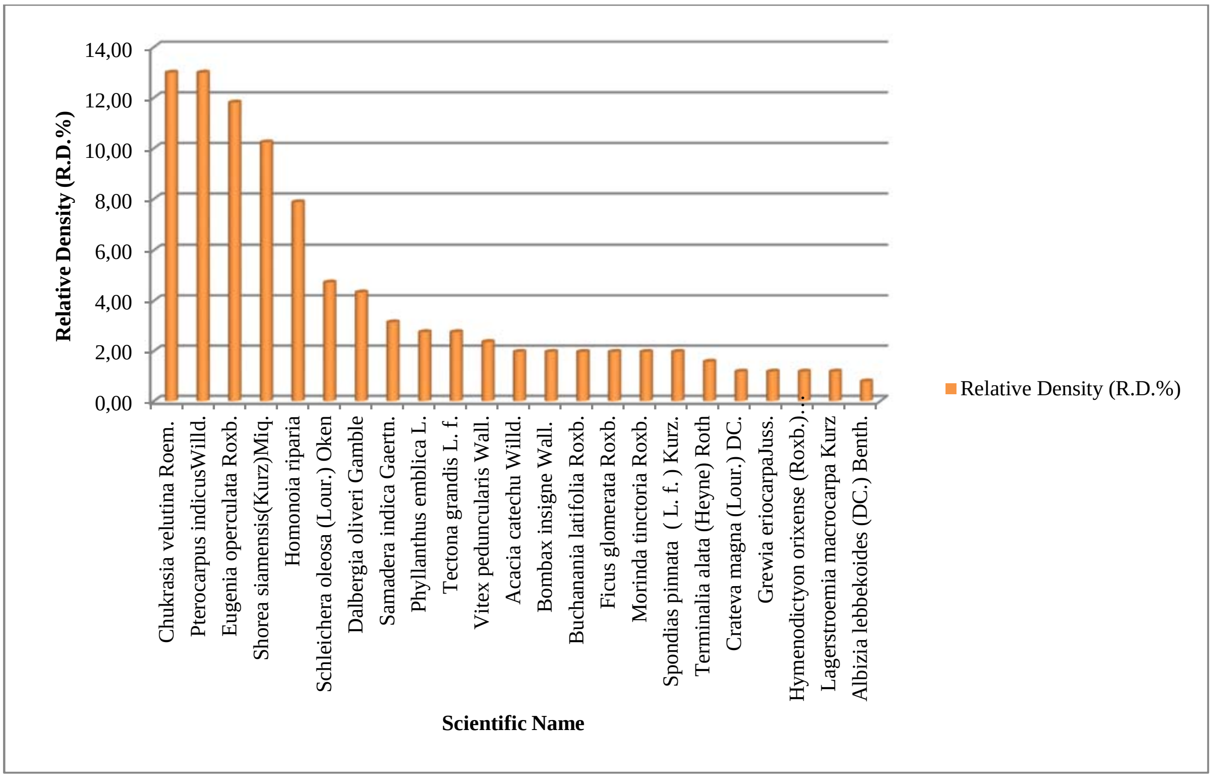
3.1.1.2. Tree Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Acacia catechu* Willd.	5	8.93	1.97
2	*Adina indivisa* Lance	1	1.79	0.39
3	*Albizia lebbekoides* (DC.) Benth.	2	3.57	0.79
4	*Anogeissus acuminata* Wall.	2	3.57	0.79
5	*Anthocephalus morindaefolius* Korth.	1	1.79	0.39
6	*Bombax insigne* Wall.	5	8.93	1.97
7	*Buchanania latifolia* Roxb.	5	8.93	1.97
8	*Chukrasia velutina* Roem.	33	58.93	12.99
9	*Crateva magna* (Lour.) DC.	3	5.36	1.18
10	*Dalbergia cultrata* Grah.	2	3.57	0.79
11	*Dalbergia oliveri* Gamble	11	19.64	4.33
12	*Eugenia operculata* Roxb.	30	53.57	11.81
13	*Ficus glomerata* Roxb.	5	8.93	1.97
14	*Flacourtia indica* (Burm. f.) Merr.	2	3.57	0.79
15	*Grewia eriocarpa*Juss.	3	5.36	1.18
16	*Homonoia riparia*	20	35.71	7.87
17	*Hymenodictyon orixense* (Roxb.) Mabb.	3	5.36	1.18
18	*Lagerstroemia macrocarpa* Kurz	3	5.36	1.18
19	*Millettia ovalifolia* Kurz	2	3.57	0.79
20	*Morinda tinctoria* Roxb.	5	8.93	1.97
21	*Phyllanthus emblica* L.	7	12.50	2.76
22	*Pterocarpus indicus*Willd.	33	58.93	12.99
23	*Samadera indica* Gaertn.	8	14.29	3.15
24	*Schleichera oleosa* (Lour.) Oken	12	21.43	4.72
25	*Schrebera swietenioides* Roxb.	1	1.79	0.39
26	*Shorea siamensis*(Kurz)Miq.	26	46.43	10.24
27	*Spondias pinnata* (L. f.) Kurz.	5	8.93	1.97
28	*Stereospermum colais* (Buch.-Ham. ex Dillwyn) Mabb.	2	3.57	0.79
29	*Tectona grandis* L. f.	7	12.50	2.76
30	*Terminalia alata* (Heyne) Roth	4	7.14	1.57
31	*Vitex peduncularis* Wall.	6	10.71	2.36
	Total	**254**	**453.57**	**100.00**

3.1.1.3. Relative density

Among the sample plots species density per hectare varied and the highest density was observed *Chukrasia velutina* Roem., and *Pterocarpus indicus*Willd followed by *Eugenia operculata* Roxb., *Shorea siamensis*(Kurz)Miq., and *Homonoia riparia*. This shows that these five species are abundant in this area.

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Chukrasia velutina* Roem.	2.36	12.99
2	*Pterocarpus indicus*Willd.	2.36	12.99
3	*Eugenia operculata* Roxb.	2.14	11.81
4	*Shorea siamensis*(Kurz)Miq.	1.86	10.24
5	*Homonoia riparia*	1.43	7.87
6	*Schleichera oleosa* (Lour.) Oken	0.86	4.72
7	*Dalbergia oliveri* Gamble	0.79	4.33
8	*Samadera indica* Gaertn.	0.57	3.15
9	*Phyllanthus emblica* L.	0.50	2.76
10	*Tectona grandis* L. f.	0.50	2.76
11	*Vitex peduncularis* Wall.	0.43	2.36
12	*Acacia catechu* Willd.	0.36	1.97
13	*Bombax insigne* Wall.	0.36	1.97
14	*Buchanania latifolia* Roxb.	0.36	1.97
15	*Ficus glomerata* Roxb.	0.36	1.97
16	*Morinda tinctoria* Roxb.	0.36	1.97
17	*Spondias pinnata* (L. f.) Kurz.	0.36	1.97
18	*Terminalia alata* (Heyne) Roth	0.29	1.57
19	*Crateva magna* (Lour.) DC.	0.21	1.18
20	*Grewia eriocarpa*Juss.	0.21	1.18
21	*Hymenodictyon orixense* (Roxb.) Mabb.	0.21	1.18
22	*Lagerstroemia macrocarpa* Kurz	0.21	1.18
23	*Albizia lebbekoides* (DC.) Benth.	0.14	0.79
24	*Anogeissus acuminata* Wall.	0.14	0.79
25	*Dalbergia cultrata* Grah.	0.14	0.79
26	*Flacourtia indica* (Burm. f.) Merr.	0.14	0.79
27	*Millettia ovalifolia* Kurz	0.14	0.79
28	*Stereospermum colais* (Buch.-Ham. ex Dillwyn) Mabb.	0.14	0.79
29	*Adina indivisa* Lance	0.07	0.39
30	*Anthocephalus morindaefolius* Korth.	0.07	0.39
31	*Schrebera swietenioides* Roxb.	0.07	0.39

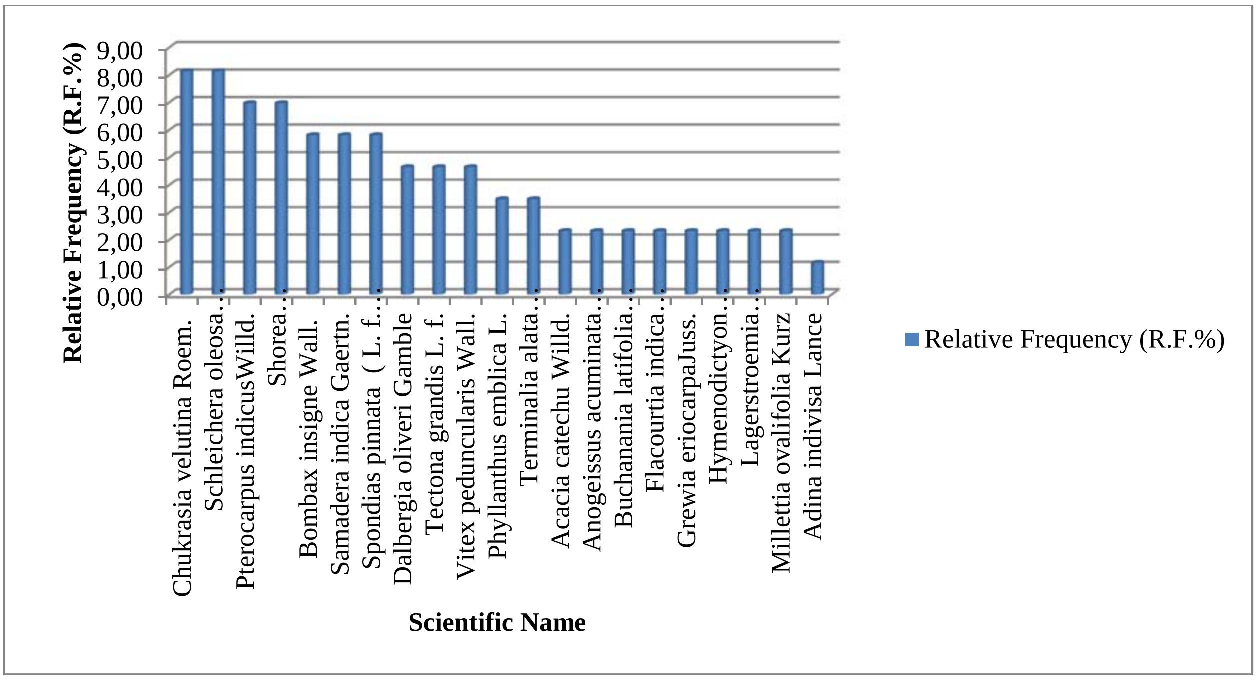


3.1.1.4. Relative frequency of Tree species

Relative frequency is the frequency of one species compared to the total frequency of all the species. According to the results**,** *Chukrasia velutina* Roem., and *Schleichera oleosa* (Lour.) Oken are (8%) high relative frequency class, followed by *Pterocarpus indicus*Willd. and *Shorea siamensis* (Kurz) Miq., (7%) are equally; *Bombax insigne* Wall., *Samadera indica* Gaertn. *and Spondias pinnata* (L. f.) Kurz., are (6%) respectively. Therefore these species occur everywhere in the study area. The lower frequency of some species is *Adina indivisa* Lance, *Homonoia riparia*, and *Stereospermum colais* (Buch.-Ham. ex Dillwyn) Mabb., are demarcated as rare species in the area.

No.	Scientific Name	Frequency (F)	Relative Frequency (R.F.%)
1	*Chukrasia velutina* Roem.	0.50	8.14
2	*Schleichera oleosa* (Lour.) Oken	0.50	8.14
3	*Pterocarpus indicus*Willd.	0.43	6.98
4	*Shorea siamensis*(Kurz)Miq.	0.43	6.98
5	*Bombax insigne* Wall.	0.36	5.81
6	*Samadera indica* Gaertn.	0.36	5.81
7	*Spondias pinnata* (L. f.) Kurz.	0.36	5.81
8	*Dalbergia oliveri* Gamble	0.29	4.65
9	*Tectona grandis* L. f.	0.29	4.65
10	*Vitex peduncularis* Wall.	0.29	4.65
11	*Phyllanthus emblica* L.	0.21	3.49
12	*Terminalia alata* (Heyne) Roth	0.21	3.49
13	*Acacia catechu* Willd.	0.14	2.33

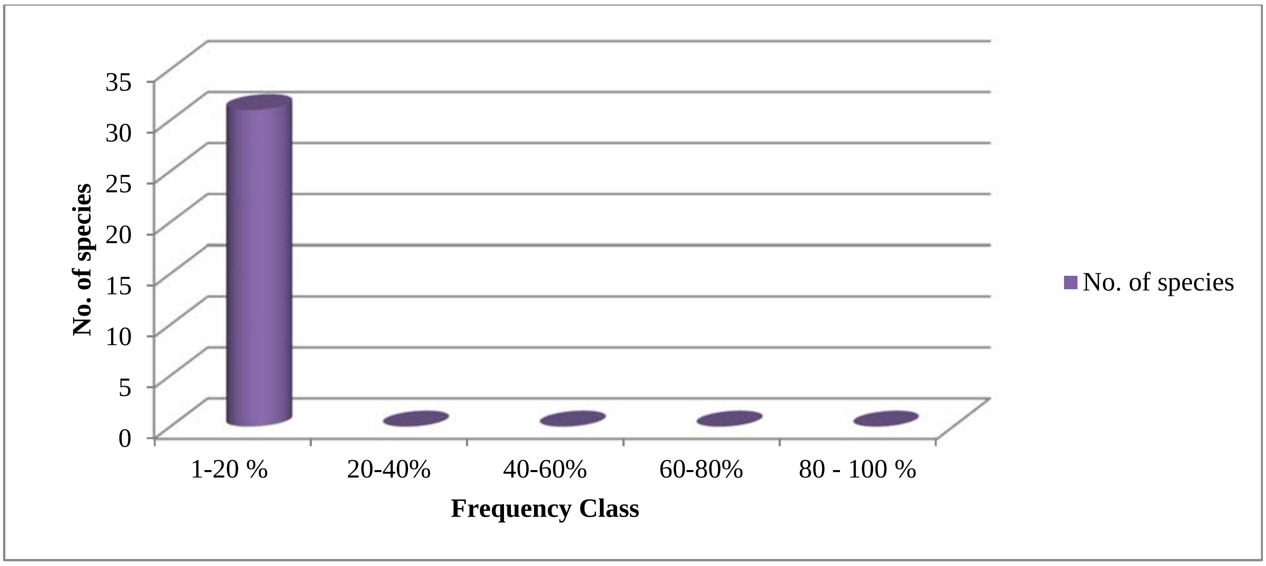
14	*Anogeissus acuminata* Wall.	0.14	2.33
15	*Buchanania latifolia* Roxb.	0.14	2.33
16	*Flacourtia indica* (Burm. f.) Merr.	0.14	2.33
17	*Grewia eriocarpa*Juss.	0.14	2.33
18	*Hymenodictyon orixense* (Roxb.) Mabb.	0.14	2.33
19	*Lagerstroemia macrocarpa* Kurz	0.14	2.33
20	*Millettia ovalifolia* Kurz	0.14	2.33
21	*Adina indivisa* Lance	0.07	1.16
22	*Albizia lebbekoides* (DC.) Benth.	0.07	1.16
23	*Anthocephalus morindaefolius* Korth.	0.07	1.16
24	*Crateva magna* (Lour.) DC.	0.07	1.16
25	*Dalbergia cultrata* Grah.	0.07	1.16
26	*Eugenia operculata* Roxb.	0.07	1.16
27	*Ficus glomerata* Roxb.	0.07	1.16
28	*Homonoia riparia*	0.07	1.16
29	*Morinda tinctoria* Roxb.	0.07	1.16
30	*Schrebera swietenioides* Roxb.	0.07	1.16
31	*Stereospermum colais* (Buch.-Ham. ex Dillwyn) Mabb.	0.07	1.16



3.1.1.5. Species distribution by frequency class

In order to clarify the homogeneity and heterogeneity of the floristic distribution in the area, the species distribution by frequency class was examined. According to the outcome of the frequency classes only zero species is in high frequency class and 31 species are in low frequency class. This shows that this area is floristically low degree of homogeneity.

Frequency class	No. of species
1-20 %	31
20-40%	0
40-60%	0
60-80%	0
80 - 100 %	0



3.1.1.6. Tree species in DBH class interval

The distribution of DBH interval class reveals the dominant of small stem individuals in the area 95% of the tree species are less than 40cm DBH. Large stem individuals with DBH more than 60cm are of 5 %. Majority of the trees are less than 40cm in diameter, which indicates that the forests secondary types.

DBH Class	No. of species	Total number of individual	% of total population
<40cm	241	430.36	94.88
41-60cm	7	12.50	2.76
61-80cm	3	5.36	1.18
81-100cm	3	5.36	1.18
>101cm	0	0.00	0.00
Total	**254**	**453.57**	**100.00**

3.1.1.7. Tree species in Height class interval

The distribution of Height shows that 228 individuals are less than 10 meter, comprising 90% of the total population and 26 individuals are 15meter and above, comprising the 10%. Since most canopy height classes are less than 10m, the forests in the area could be classified as secondary forests.

Height Class	No. of species	Total number of individual	% of total population
<10m	228	407.14	89.76
11-15m	17	30.36	6.69
16-20m	5	8.93	1.97
21-25m	4	7.14	1.57
>26m	0	0.00	0.00
Total	**254**	**453.57**	**100.00**

3.1.1.8. Vegetation type in the study area

No.	Sample Quadrant	Vegetation type	Longitude	Latitude	Altitude(m)	Dominant species
1	IQ I	Mixed Deciduous and Bamboo Forest	96.888356	21.960507	321	*Chukrasia velutina* Roem. , *Pterocarpus indicus*Willd., *Eugenia operculata* Roxb., *Shorea siamensis*(Kurz)Miq., *Homonoia riparia, Schleichera oleosa* (Lour.) Oken, *Dendrocalamus membranaceus* Munro, *Dalbergia oliveri* Gamble, *Samadera indica* Gaertn., *Phyllanthus emblica* L., *Tectona grandis* L. f.
2	IQ II	"	96.888381	21.959968	305	
3	IQ III	"	96.888141	21.960037	289	
4	IQ IV	"	96.887899	21.960583	282	
5	IQ V	"	96.887140	21.961363	262	
6	IQ VI	"	96.887027	21.961703	256	
7	IQ VII	"	96.888513	21.959573	260	
8	IQ VIII	Mixed Deciduous Forest	96.888706	21.959349	240	
9	IQ IX	Mixed Deciduous and Bamboo Forest	96.889599	21.959029	259	
10	IQ X	"	96.890125	21.959117	272	
11	IQ XI	Mixed Deciduous Forest	96.891060	21.958209	255	
12	IQ XII	Mixed Deciduous and Bamboo Forest	96.890841	21.958980	289	
13	IQ XIII	"	96.891319	21.959323	318	
14	IQ XIV	"	96.899976	21.948767	300	
IQ =Inundated Quadrant						

3.1.1.9. Species Inventory List of Inundated Area

No	Scientific Name	Common Name	Family Name	Habits
1	*Acacia concinna* (Willd.) DC.	Ka-mon-chin	Mimosaceae	S
2	*Acacia pennata* (L.) Willd.	Su-yit	Mimosaceae	CL
3	*Adenanthera pavonina* L.	Ywe-gyi	Mimosaceae	T
4	*Adiantum latifolium*	Not known	Pteridaceae	F
5	*Adina indivisa* Lance	Hnaw	Rubiaceae	T
6	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae	T
7	*Anogeissus acuminata* Wall.	Yon	Combretaceae	T
8	*Anthocephalus morindaefolius* Korth.	Ma-u-let-tan-shae	Rubiaceae	T
9	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae	CL
10	*Barleria cristata*	Pyo-ma-naing	Acanthaceae	S
11	*Bidens alba*	Not known	Asteraceae	H
12	*Boehmeria nivea* (L.) Gaud.	Phet-ya	Urticaceae	S

No	Scientific Name	Common Name	Family Name	Habits
13	*Bombax ceiba* L.	Let-pan	Bombacaceae	T
14	*Bombax insigne* Wall.	De-du	Bombacaceae	T
15	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae	T
16	*Canscora diffusa* (Vahl) R.Br.	Kyauk-pan	Gentianaceae	H
17	*Cassia fistula* L.	Ngu	Caesalpiniaceae	T
18	*Chukrasia velutina*	Taw-yin-ma	Meliaceae	T
19	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae	ST
20	*Crateva magna* (Lour.) DC.	Ye-ka-det	Capparaceae	T
21	*Cyperus exaltatus*	Not known	Cyperaceae	H
22	*Cyperus nutans*	Not known	Cyperaceae	H
23	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	T
24	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	T
25	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	B
26	*Dioscorea alata*	Myauk-u	Dioscoreaceae	CL
27	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae	CL
28	*Dioscorea* sp.	Kywe	Dioscoreaceae	CL
29	*Elatostema reticulatum*	Wet-sa	Urticaceae	H
30	*Entada scandens* Benth.	Doe-nwee	Mimosaceae	CL
31	*Equisetum hyemale*	Not known	Equisetaceae	H
32	*Eugenia operculata* Roxb.	Ye-tha-bye	Myrtaceae	T
33	*Euphorbia bifida*	Say-pa-le	Euphorbiaceae	H
34	*Euphorbia hypericifolia* L.	Seik-noe-ma-htwet	Euphorbiaceae	H
35	*Ficus glomerata* Roxb.	Ye-tha-phan	Moraceae	T
36	*Ficus pumila* L.	Kyauk-kat-nyaung	Moraceae	CL
37	*Ficus variegate*	Kon-tha-phan	Moraceae	T
38	*Flacourtia indica* (Burm. f.) Merr.	Na-ywe	Flacourtiaceae	ST
39	*Flemingia strobilifera*	Se-laik-pya	Fabaceae	S
40	*Grewia eriocarpa*Juss.	Ta-yaw	Tiliaceae	ST
41	*Grimmia* sp.	Not known	Grimmiaceae	Br
42	*Grimmia trichophylla*	Not known	Grimmiaceae	Br
43	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae	S
44	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae	S
45	*Hymenodictyon orixense* (Roxb.) Mabb.	Khu-san	Rubiaceae	T
46	*Indigofera pulchella* Roxb.	Taw-me	Fabaceae	S
47	*Lagerstroemia macrocarpa* Kurz	Pyin-ma-ywet-gyi	Lythraceae	T
48	*Leea hirta* Banks	Naga-mauk-phyu	Leeaceae	ST
49	*Leea rubra* Blume.	Na-ga-mauk-ni	Leeaceae	S
50	*Lygodium circinnatum*	Not known	Lygodiaceae	F
51	*Marchantia berteroana*	Not known	Marchantiaceae	Br
52	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae	CL
53	*Millettia ovalifolia* Kurz	Thin-win-phyu	Fabaceae	T
54	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	H
55	*Morinda persicaefolia* Buch.-Ham.	Ni-ba-sae	Rubiaceae	S

No	Scientific Name	Common Name	Family Name	Habits
56	*Najas minor*	Brittleleaf	Najadaceae	AqH
57	*Neyraudia reynaudiana* (Kunth) Keng ex Hitchc.	Kyu	Poaceae	G
58	*Pentasachme caudatum* Wall. Ex Wight	Not known	Asclepiadaceae	H
59	*Phyllanthus amarus*	Myay-zi-phyu	Euphorbiaceae	H
60	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	ST
61	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae	H
62	*Plagiochila obscura*	Not known	Plagiothecieae	Br
63	*Pogonatherum crinitum* (Thunb.) Kunth	Not known	Poaceae	G
64	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	AqH
65	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	T
66	*Saccharum spontaneum* L.	Thet-kel-gyi	Poaceae	G
67	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae	ST
68	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	T
69	*Schrebera swietenioides* Roxb.	Thit-swe-le	Oleaceae	ST
70	*Selaginella willdenowii*	Peacock Fern	Selaginellaceae	F
71	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	T
72	*Spirogyra* sp.	Algae	Zygnemataceae	Al
73	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae	T
74	*Stephania venosa* (Blume) Spreng.	Taung-kya	Menispermaceae	CL
75	*Stereospermum colais* (Buch.-Ham. ex Dillwyn) Mabb.	Than-de	Bignoniaceae	T
76	*Strobilanthes* sp.	Pan-thin	Acanthaceae	S
77	*Tadehagi triquetrum* (L.)H. Ohashi	Lauk-thay	Fabaceae	S
78	*Tamarindus indica* L.	Ma-gyi	Caesalpiniaceae	T
79	*Tectona grandis* L. f.	Kyun	Verbenaceae	T
80	*Triumfetta rotundifolia* Lam.	Kat-se-ne-thay	Tiliaceae	S
81	*Utricularia* sp.	Ye-bu-baung	Lentibulariaceae	AqH
82	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae	ST
83	*Vitex pubescens* Vahl	Kyet-yo	Verbenaceae	T
84	*Vitis trifolia*	Not known	Vitaceae	CL
85	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae	ST
Al=Algae, AqH=Aquatic Herbs, B=Bamboo, Br=Bryophyte, CL=Climber, F=Fern, G=Grass, H=Herbs, S=Shrubs, ST=Small Tree, T=Tree				

3.1.1.10. Bamboo Forest

Bamboo Forest

3.1.1.10.1 Bamboo Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Dendrocalamus membranaceus* Munro	108	225.00	100.00

3.1.1.10.2. Relative density

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Dendrocalamus membranaceus* Munro	9.00	100.00

3.1.1.10.3. Species distribution

No.	Scientific Name	Frequency (F)	Relative Frequency (R.F.%)
1	*Dendrocalamus membranaceus* Munro	1.00	100.00

3.1.1.11. Species List of Aquatic Plants

Najas minor

Potamogeton crispus L.

No	Scientific Name	Common Name	Family Name
1	*Equisetum hyemale*	Not known	Equisetaceae
2	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae
3	*Najas minor*	Brittleleaf	Najadaceae
4	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae
5	*Spirogyra* sp.	Algae	Zygnemataceae
6	*Utricularia* sp.	Ye-bu-baung	Lentibulariaceae

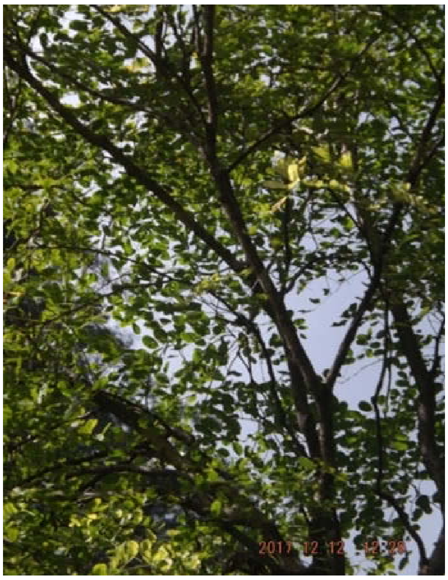
3.1.1.12. Species List of Bryophytes and Algae

Plagiochila obscura

Grimmia trichophylla

No	Scientific Name	Common Name	Family Name
1	*Grimmia* sp.	Not known	Grimmiaceae
2	*Grimmia trichophylla*	Not known	Grimmiaceae
3	*Marchantia berteroana*	Not known	Marchantiaceae
4	*Plagiochila obscura*	Not known	Plagiothecieae

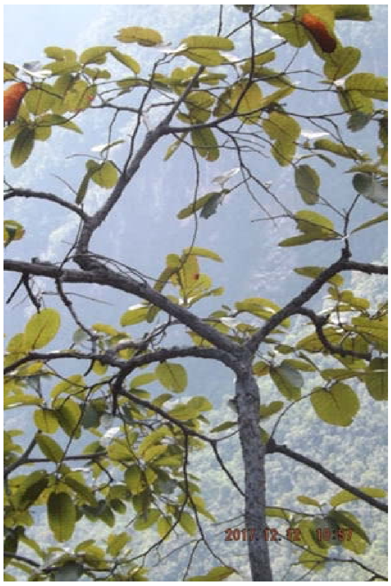
3.1.1.13. IUCN red list species, 2017-3



Dalbergia cultrata Grah.

Dalbergia oliveri Gamble

*Pterocarpus indicus*Willd.



Shorea siamensis(Kurz)Miq.

No	Scientific Name	Common Name	Family Name	IUCN Criteria (2017-3)
1	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae	NT ver 3.1
2	***Dalbergia oliveri* Gamble**	**Ta-ma-lan**	**Fabaceae**	**EN A1cd ver 2.3**
3	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae	LC ver 3.1
4	*Equisetum hyemale*	Not known	Equisetaceae	LC ver 3.1
5	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae	LC ver 3.1
6	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	LC ver 3.1
7	*Najas minor*	Brittleleaf	Najadaceae	LC ver 3.1
8	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	LC ver 3.1
9	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	VU A1d ver 2.3
10	*Saccharum spontaneum* L.	Thet-kel-gyi	Poaceae	LC ver 3.1
11	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/lc ver 2.3
12	*Tamarindus indica* L.	Ma-gyi	Caesalpiniaceae	LC ver 3.1
EN=Endangered, LC=Least Concern, LR/lc=Lower Risk/least concern, NT=Near Threatened, VU=Vulnerable				

3.1.2. Second Research Area

Map V.

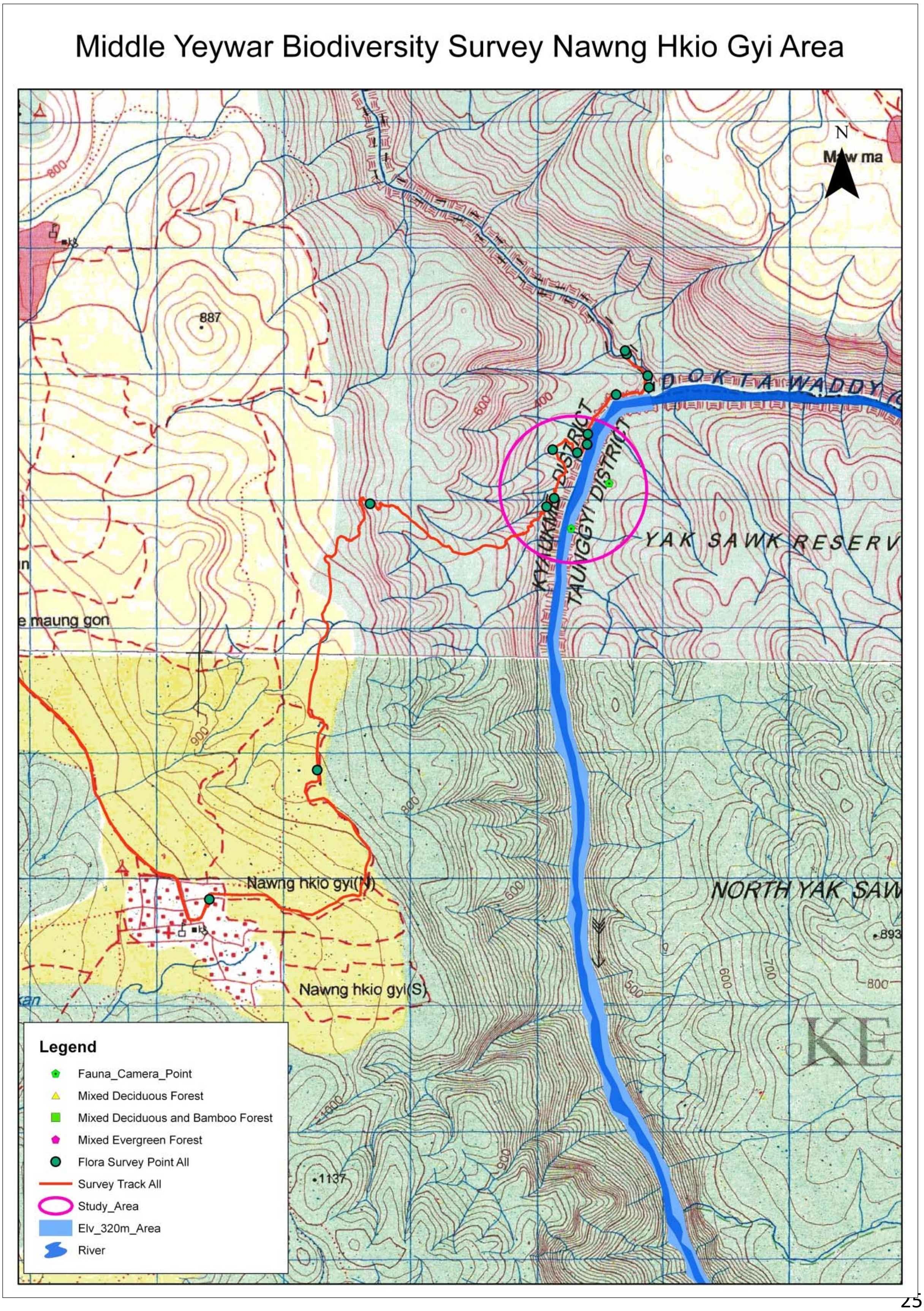
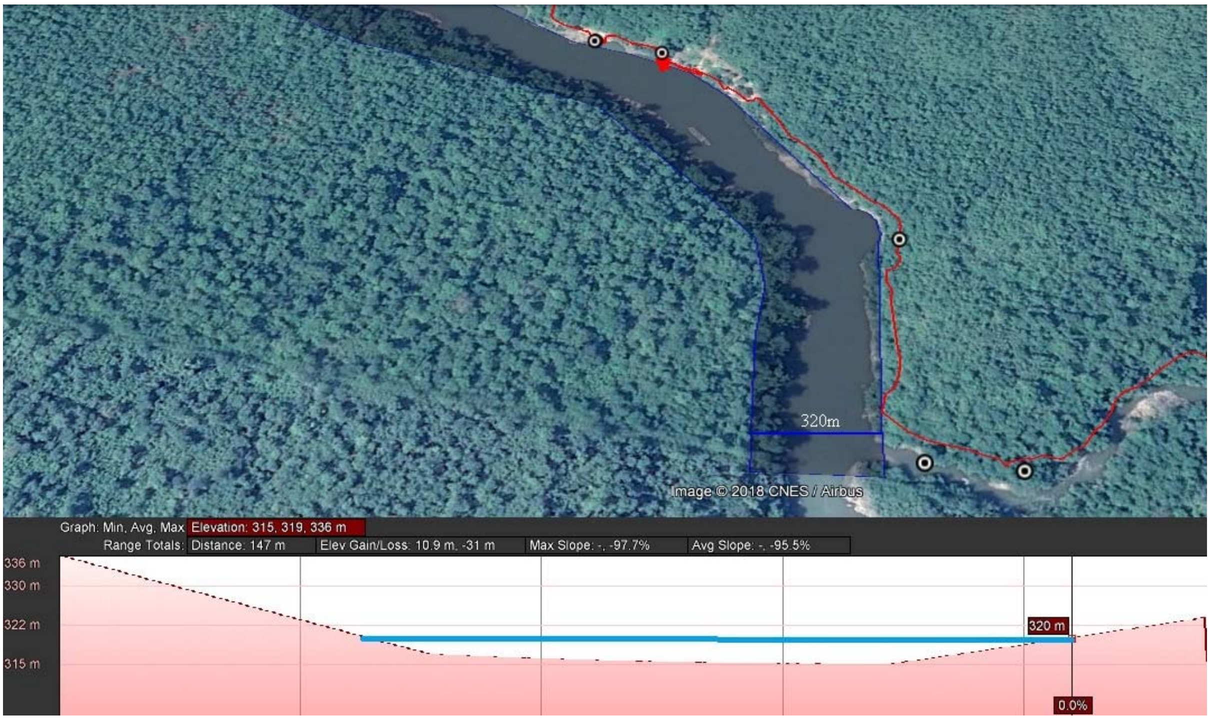


Photo Map VI.



Vegetation at the confluence of Dokhtawaddy River and Gohteik Stream

3.1.2.1. Species Inventory List at the confluence of Dokhtawaddy River and Gohteik Stream

No	Scientific Name	Common Name	Family Name	Habits
1	*Acer oblongum* Wall.	Himalayan maple	Aceraceae	ST
2	*Adiantum peruvianum*	Adiantum	Pteridaceae	F
3	*Alternanthera sessilis*	Pa-zun-sa-yaing	Amaranthaceae	H
4	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae	S
5	*Asparagus densiflorus*	Shint-ma-tet	Asparagaceae	CL
6	*Cibotium barometz* (Linn.) J. Sm.	Da-yin-kauk	Dicksoniaceae	F

No	Scientific Name	Common Name	Family Name	Habits
7	*Desmodium gangeticum* L.	Not known	Fabaceae	S
8	*Echinodorus quadricostatus*	Not known	Alismataceae	AqH
9	*Equisetum hyemale*	Not known	Equisetaceae	H
10	*Eriochloa procera* (Retz.) C.E. Hubb.	Myet-kha	Poaceae	F
11	*Eugenia operculata* Roxb.	Ye-tha-bye	Myrtaceae	ST
12	*Ficus carica*	Not known	Moraceae	S
13	*Ficus pumila* L.	Kyauk-kat-nyaung	Moraceae	CL
14	*Flemingia strobilifera*	Se-laik-pya	Fabaceae	S
15	*Flueggea leucopyrus* Willd.	Ye-chin-ya	Euphorbiaceae	S
16	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae	S
17	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae	CL
18	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	H
19	*Passiflora foetida* L.	Taw-su-ka	Passifloraceae	CL
20	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	AqH
21	*Pteris esquirolii* Christ	Not known	Pteridaceae	F
22	*Schistostega pennata*	Not known	Schistostegaceae	Br
23	*Selaginella willdenowii*	Peacock Fern	Selaginellaceae	F
24	*Solanum indicum*L.	Ka-zaw-kha	Solanaceae	H
25	*Tetrastigma planicaule*	Not known	Vitaceae	CL
AqH=Aquatic Herbs, Br=Bryophyte,CL=Climber,F=Fern,H=Herbs,S=Shrubs,ST=Small Tree				

3.1.2.2. Species List of Aquatic Plants

Potamogeton crispus L.

Echinodorus quadricostatus

No	Scientific Name	Common Name	Family Name
1	*Cibotium barometz* (Linn.) J. Sm.	Da-yin-kauk	Dicksoniaceae
2	*Echinodorus quadricostatus*	Not known	Alismataceae
3	*Flueggea leucopyrus* Willd.	Ye-chin-ya	Euphorbiaceae
4	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae
5	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae

3.1.2.3. Species List of Bryophyte

Schistostega pennata

No	Scientific Name	Common Name	Family Name
1	*Schistostega pennata*	Not known	Schistostegaceae

3.1.2.4. IUCN red list species, 2017-3

Homonoia riparia

Equisetum hyemale

Acer oblongum Wall.

Eriochloa procera (Retz.) C.E. Hubb.

No	Scientific Name	Common Name	Family Name	IUCN Criteria (2017-3)
1	*Acer oblongum* Wall.	Himalayan maple	Aceraceae	LC ver 3.1
2	*Alternanthera sessilis*	Pa-zun-sa-yaing	Amaranthaceae	LC ver 3.1
3	*Equisetum hyemale*	Not known	Equisetaceae	LC ver 3.1
4	*Eriochloa procera* (Retz.) C.E. Hubb.	Myet-kha	Poaceae	LC ver 3.1
5	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae	LC ver 3.1
6	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	LC ver 3.1
7	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae	LC ver 3.1
LC=Least Concern				

3.1.3. Third Research Area

Map VII.

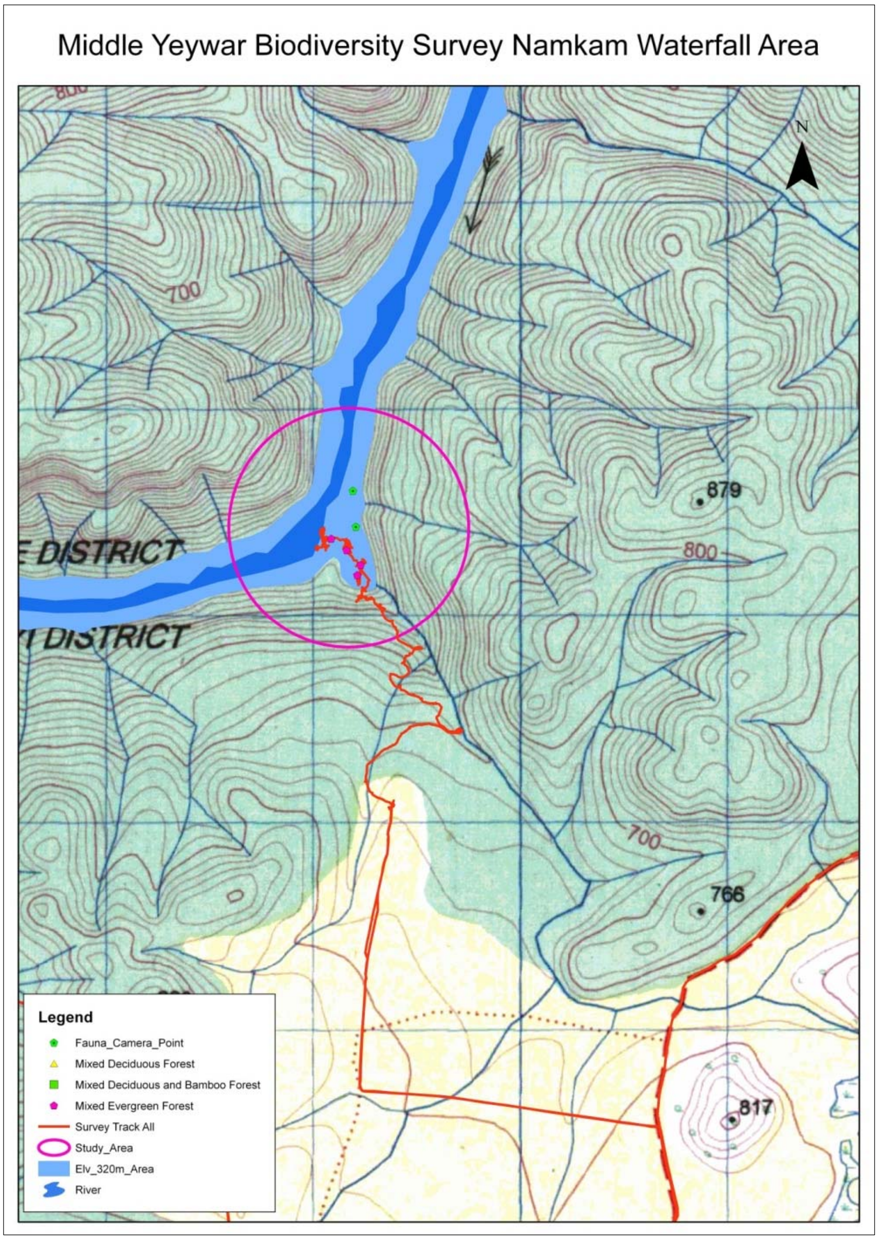
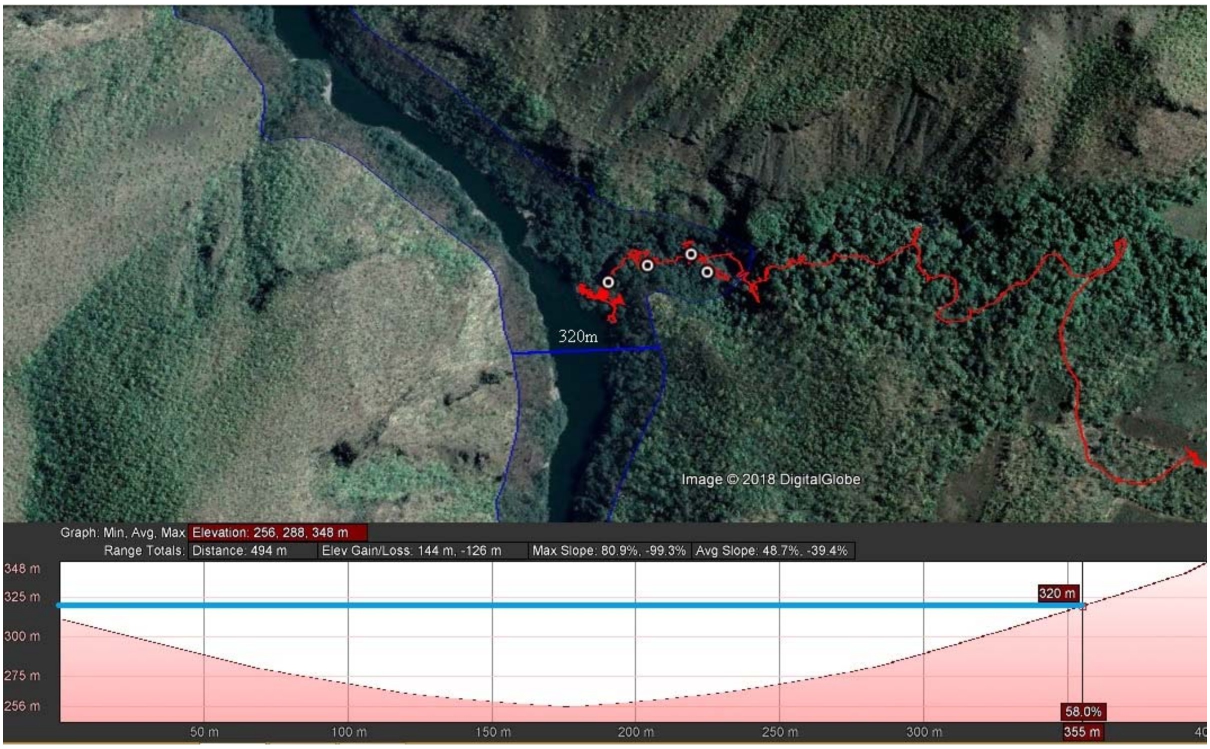


Photo Map VIII.



Mixed Evergreen Forest

Mixed Evergreen Forest

3.1.3.1. Floristic composition

The total number of tree species collected in 4 representative sample plots in this area is 18 species belonging to 18 genera. The dominant tree species in this area are *Polyalthia viridis* (Ka-naing-thit) followed by *Mesua nervosa* Planch. & Triana (Taw-gan-gaw) and *Mangifera indica* L.(Taw-tha-yet), *Anthocephalus morindaefolius* Korth. (Ma-u-let-tan-shae), *Bombax ceiba* L. (Let-pan), and *Garcinia cowa* Roxb. (Tha-le).

3.1.3.2. Tree Species Population

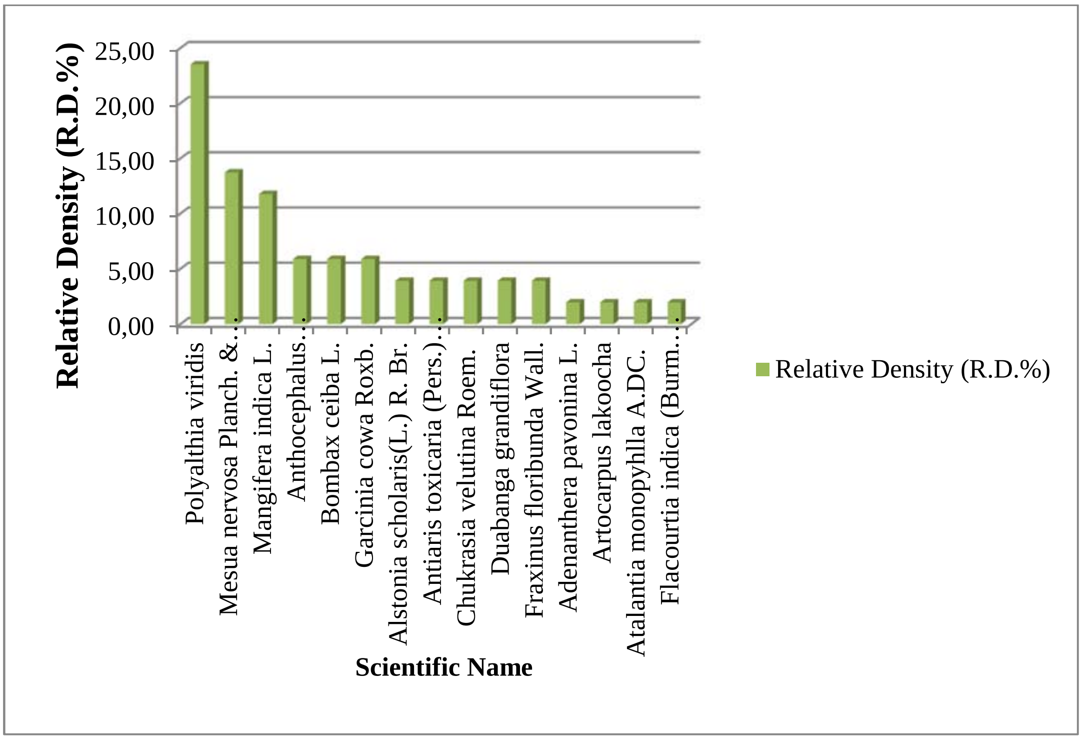
No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Adenanthera pavonina* L.	1	6.25	1.96
2	*Alstonia scholaris*(L.) R. Br.	2	12.5	3.92
3	*Anthocephalus morindaefolius* Korth.	3	18.75	5.88
4	*Antiaris toxicaria* (Pers.) Lesch.	2	12.5	3.92
5	*Artocarpus lakoocha*	1	6.25	1.96
6	*Atalantia monopyhlla* A.DC.	1	6.25	1.96
7	*Bombax ceiba* L.	3	18.75	5.88
8	*Chukrasia velutina* Roem.	2	12.5	3.92
9	*Duabanga grandiflora*	2	12.5	3.92
10	*Flacourtia indica* (Burm. f.) Merr.	1	6.25	1.96
11	*Fraxinus floribunda* Wall.	2	12.5	3.92
12	*Garcinia cowa* Roxb.	3	18.75	5.88
13	*Gmelina arborea* Roxb.	1	6.25	1.96
14	*Mangifera indica* L.	6	37.5	11.76
15	*Mesua nervosa* Planch. & Triana	7	43.75	13.73
16	*Pandanus odoratissimus* L.f.	1	6.25	1.96
17	*Polyalthia viridis*	12	75	23.53
18	*Trevesia palmate*	1	6.25	1.96
	Total	**51**	**318.75**	**100.00**

3.1.3.3. Relative density

Among the sample plots, species density per hectare is varied and the highest density was observed the *Polyalthia viridis*, *Mesua nervosa* Planch. & Triana, *Mangifera indica* L., and *Anthocephalus morindaefolius* Korth., followed by *Bombax ceiba* L., and *Garcinia cowa* Roxb.. This shows that these five species are abundant in this area.

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Polyalthia viridis*	3	23.53
2	*Mesua nervosa* Planch. & Triana	1.75	13.73
3	*Mangifera indica* L.	1.5	11.76
4	*Anthocephalus morindaefolius* Korth.	0.75	5.88
5	*Bombax ceiba* L.	0.75	5.88
6	*Garcinia cowa* Roxb.	0.75	5.88
7	*Alstonia scholaris*(L.) R. Br.	0.5	3.92
8	*Antiaris toxicaria* (Pers.) Lesch.	0.5	3.92
9	*Chukrasia velutina* Roem.	0.5	3.92
10	*Duabanga grandiflora*	0.5	3.92
11	*Fraxinus floribunda* Wall.	0.5	3.92
12	*Adenanthera pavonina* L.	0.25	1.96

13	*Artocarpus lakoocha*	0.25	1.96
14	*Atalantia monopyhlla* A.DC.	0.25	1.96
15	*Flacourtia indica* (Burm. f.) Merr.	0.25	1.96
16	*Gmelina arborea* Roxb.	0.25	1.96
17	*Pandanus odoratissimus* L.f.	0.25	1.96
18	*Trevesia palmata*	0.25	1.96

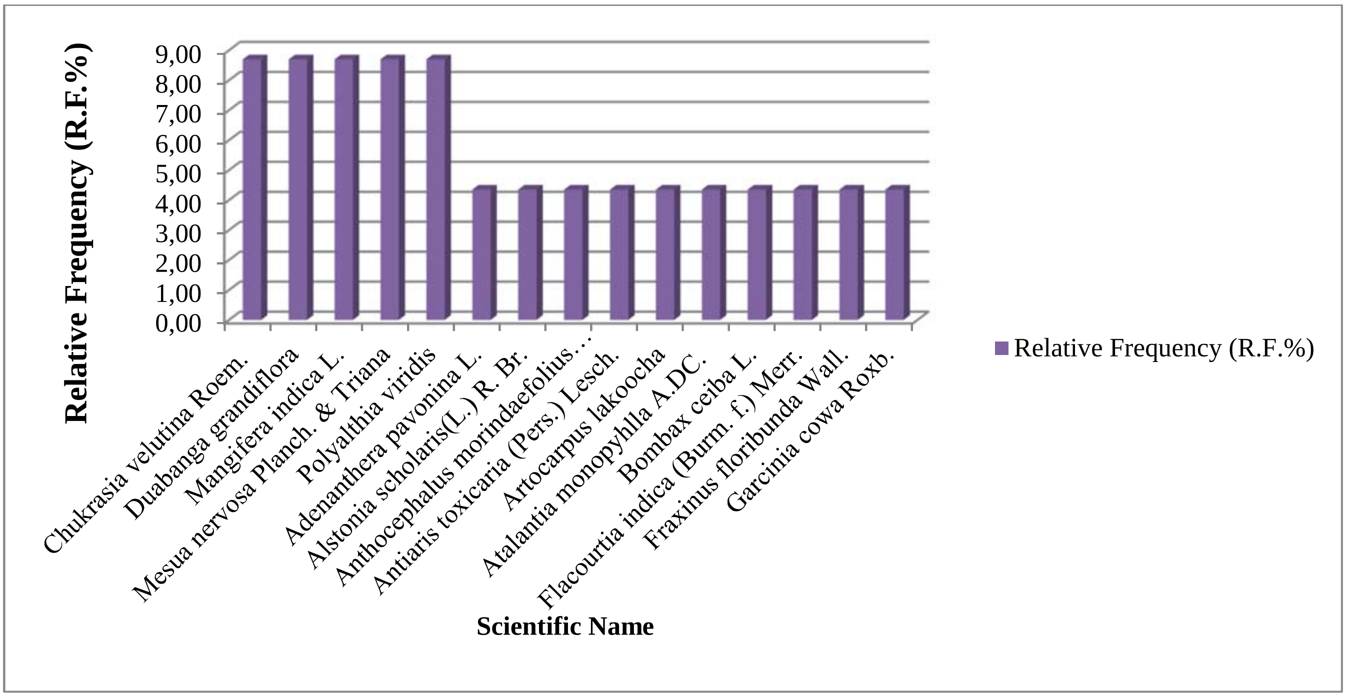


3.1.3.4. Relative frequency of Tree species

Relative frequency is the frequency of one species compared to the total frequency of all the species. According to the results**,** *Chukrasia velutina* Roem., *Duabanga grandiflora*, *Mangifera indica* L., *Mesua nervosa* Planch. & Triana and *Polyalthia viridis*, are high relative frequency value (9%). Therefore these species occur everywhere in the study area. The lower frequency of *Adenanthera pavonina* L., and other twelve species are demarcated as rare species in the area.

No.	Scientific Name	Frequency (F)	Relative Frequency (R.F.%)
1	*Chukrasia velutina* Roem.	0.5	8.70
2	*Duabanga grandiflora*	0.5	8.70
3	*Mangifera indica* L.	0.5	8.70
4	*Mesua nervosa* Planch. & Triana	0.5	8.70
5	*Polyalthia viridis*	0.5	8.70
6	*Adenanthera pavonina* L.	0.25	4.35
7	*Alstonia scholaris*(L.) R. Br.	0.25	4.35
8	*Anthocephalus morindaefolius* Korth.	0.25	4.35

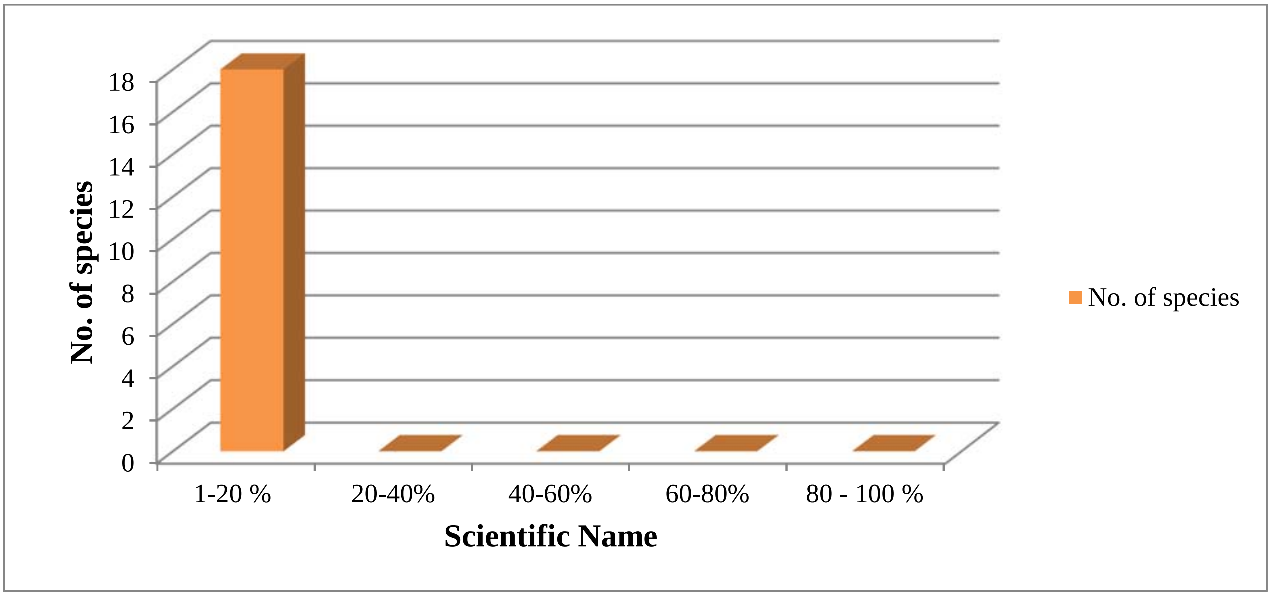
9	*Antiaris toxicaria* (Pers.) Lesch.	0.25	4.35
10	*Artocarpus lakoocha*	0.25	4.35
11	*Atalantia monopyhlla* A.DC.	0.25	4.35
12	*Bombax ceiba* L.	0.25	4.35
13	*Flacourtia indica* (Burm. f.) Merr.	0.25	4.35
14	*Fraxinus floribunda* Wall.	0.25	4.35
15	*Garcinia cowa* Roxb.	0.25	4.35
16	*Gmelina arborea* Roxb.	0.25	4.35
17	*Pandanus odoratissimus* L.f.	0.25	4.35
18	*Trevesia palmate*	0.25	4.35



3.1.3.5. Species distribution by frequency class

In order to clarify the homogeneity and heterogeneity of the floristic distribution in the area, the species distribution by frequency class was examined. According to the outcome of the frequency classes zero specie is in high frequency class and 18 species are in low frequency class. This shows that this area is floristically low degree of homogeneity.

Frequency class	No. of species
1-20 %	18
20-40%	0
40-60%	0
60-80%	0
80 - 100 %	0



3.1.3.6. Tree species in DBH class interval

The distribution of DBH interval class reveals the dominant of small stem individuals in the area 76% of the tree species are less than 40cm DBH. Large stem individuals with DBH 60cm and above are of 24 %. Majority of the trees are less than 40cm in diameter, which indicates that the forests secondary types.

DBH Class	No. of species	Total number of individual	% of total population
<40cm	39	243.75	76.47
41-60cm	7	43.75	13.73
61-80cm	2	12.50	3.92
81-100cm	2	12.50	3.92
>101cm	1	6.25	1.96
Total	**51**	**318.75**	**100.00**

3.1.3.7. Tree species in Height class interval

The distribution of Height shows that 213 individuals are less than 10 meter, comprising 67% of the total population and 106 individuals are 15meter and above, comprising the 33%. Since most canopy height classes are less than 10m, the forests in the area could be classified as secondary forests.

Height Class	No. of species	Total number of individual	% of total population
<10m	34	212.50	66.67
11-15m	8	50.00	15.69
16-20m	4	25.00	7.84
21-25m	5	31.25	9.80
>26m	0	0.00	0.00
Total	**51**	**318.75**	**100.00**

3.1.3.8. Vegetation type in the study area

No.	Sample Quadrant	Vegetation type	Longitude	Latitude	Altitude(m)	Dominant species
1	IQ XV	Mixed Evergreen Forest	96.955661	21.939188	315	*Chukrasia velutina* Roem. , *Pterocarpus indicus*Willd., *Eugenia operculata* Roxb., *Shorea siamensis*(Kurz)Miq., *Homonoia riparia, Schleichera oleosa* (Lour.) Oken, *Dalbergia oliveri* Gamble, *Samadera indica* Gaertn., *Phyllanthus emblica* L., *Tectona grandis* L. f.
2	IQ XVI	"	96.955818	21.939636	295	
3	IQ XVII	"	96.955150	21.940265	283	
4	IQ XVIII	"	96.954427	21.940764	283	
IQ =Inundated Quadrant						

3.1.3.9. Species Inventory List of Inundated Area

No.	Scientific Name	Common Name	Family Name	Habit
1	*Acer oblongum* Wall.	Himalayan maple	Aceraceae	T
2	*Adenanthera pavonina* L.	Ywe-gyi	Mimosaceae	T
3	*Alstonia scholaris*(L.) R. Br.	Taung-ma-yoe	Apocynaceae	ST
4	*Anthocephalus morindaefolius* Korth.	Ma-u-let-tan-shae	Rubiaceae	T
5	*Antiaris toxicaria* (Pers.) Lesch.	Aseik-pin	Moraceae	T
6	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae	CL
7	*Artocarpus lakoocha*	Taung-pein-ne	Moraceae	T
8	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae	ST
9	*Balanophora indica* Wall.	Not known	Balanophoraceae	SP H
10	*Begonia semperflorens*	Kyauk-chin-pan	Begoniaceae	H
11	*Bombax ceiba* L.	Let-pan	Bombacaceae	T
12	*Chukrasia velutina* Roem.	Taw-yin-ma	Meliaceae	ST
13	*Crateva magna* (Lour.)DC.	Ye-ka-det	Capparaceae	ST
14	*Dichodontium pellucidum* (Hedw.) Schimp	Not known	Dicranaceae	Br
15	*Dracaena sanderiana*	Zaw-sein	Asparagaceae	H
16	*Duabanga grandiflora*	Myauk-ngo	Lythraceae	T
17	*Dumortiera hirsuta* (Swaegr.) Nees ssp. *nepalensis* (Tay.) Frye & Clark	Not known	Marchantiaceae	Br
18	*Equisetum hyemale*	Not known	Equisetaceae	H
19	*Euphorbia bifida*	Say-pa-le	Euphorbiaceae	H
20	*Ficus benguetensis*	Not known	Moraceae	S
21	*Ficus pumila* L.	Kyauk-kat-nyaung	Moraceae	CL
22	*Flacourtia indica* (Burm. f.) Merr.	Na-ywe	Flacourtiaceae	ST
23	*Flemingia strobilifera*	Se-laik-pya	Fabaceae	S
24	*Fraxinus floribunda* Wall.	Say-kha-gyi	Oleaceae	T
25	*Garcinia cowa* Roxb.	Tha-le	Hypericaceae	T
26	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae	T
27	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae	S
28	*Mangifera indica* L.	Taw-tha-yet	Anacardiaceae	T

No.	Scientific Name	Common Name	Family Name	Habit
29	*Mesua nervosa* Planch. & Triana	Taw-gan-gaw	Hypericaceae	ST
30	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae	CL
31	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	H
32	*Oxyspora paniculata* (D. Don) DC.	Not known	Melastomataceae	S
33	*Pandanus odoratissimus* L.f.	Set-thwa-phu	Pandanaceae	ST
34	*Piper cubebe* L. f.	Peik-chin	Piperaceae	Cl
35	*Polyalthia viridis*	Ka-naing-thit	Annonaceae	T
36	*Pteris esquirolii* Christ	Not known	Pteridaceae	F
37	*Saccharum spontaneum* L.	Thet-kel-gyi	Poaceae	G
38	*Schistostega pennata*	Not known	Schistostegaceae	Br
39	*Selaginella willdenowii*	Peacock Fern	Selaginellaceae	F
40	*Sphagnum* sp.	Not known	Sphagnaceae	Br
41	*Trevesia palmata* (Roxb. ex Lindl.) Vis.	Phaw-bu	Araliaceae	ST
Br=Bryophyte, CL=Climber, F=Fern, G=Grass, H=Herbs, S=Shrubs, SP H= Saprophytic Herb, ST=Small Tree, T=Tree				

3.1.3.10. Species List of Aquatic Plants

Homonoia riparia

Acer oblongum Wall.

No.	Scientific Name	Common Name	Family Name
1	*Acer oblongum* Wall.	Himalayan maple	Aceraceae
2	*Crateva magna* (Lour.)DC.	Ye-ka-det	Capparaceae
3	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae
4	*Saccharum spontaneum* L.	Thet-kel-gyi	Poaceae

3.1.3.11. Species List of Bryophyte

Dumortiera hirsuta (Swaegr.) Nees ssp. *nepalensis* (Tay.) Frye & Clark   *Dichodontium pellucidum* (Hedw.) Schimp

No.	Scientific Name	Common Name	Family Name
1	*Dichodontium pellucidum* (Hedw.) Schimp	Not known	Dicranaceae
2	*Dumortiera hirsuta* (Swaegr.) Nees ssp. *nepalensis* (Tay.) Frye & Clark	Not known	Marchantiaceae
3	*Schistostega pennata*	Not known	Schistostegaceae
4	*Sphagnum* sp.	Not known	Sphagnaceae

3.1.3.12. IUCN red list species, 2017-3

Alstonia scholaris(L.) R. Br.

Saccharum spontaneum L.

Mimosa pudica L.

Equisetum hyemale

No.	Scientific Name	Common Name	Family Name	IUCN Criteria (2017-3)
1	*Acer oblongum* Wall.	Himalayan maple	Aceraceae	LC ver 3.1
2	*Alstonia scholaris*(L.) R. Br.	Taung-ma-yoe	Apocynaceae	LR/lc ver 2.3
3	*Equisetum hyemale*	Not known	Equisetaceae	LC ver 3.1
4	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae	LC ver 3.1
5	*Mangifera indica* L.	Taw-tha-yet	Anacardiaceae	DD ver 2.3
6	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	LC ver 3.1
7	*Saccharum spontaneum* L.	Thet-kel-gyi	Poaceae	LC ver 3.1
DD=Data Deficient, LC=Least Concern, LR/lc=Lower Risk/least concern				

3.1.4. Fourth Research Area

Map IX.

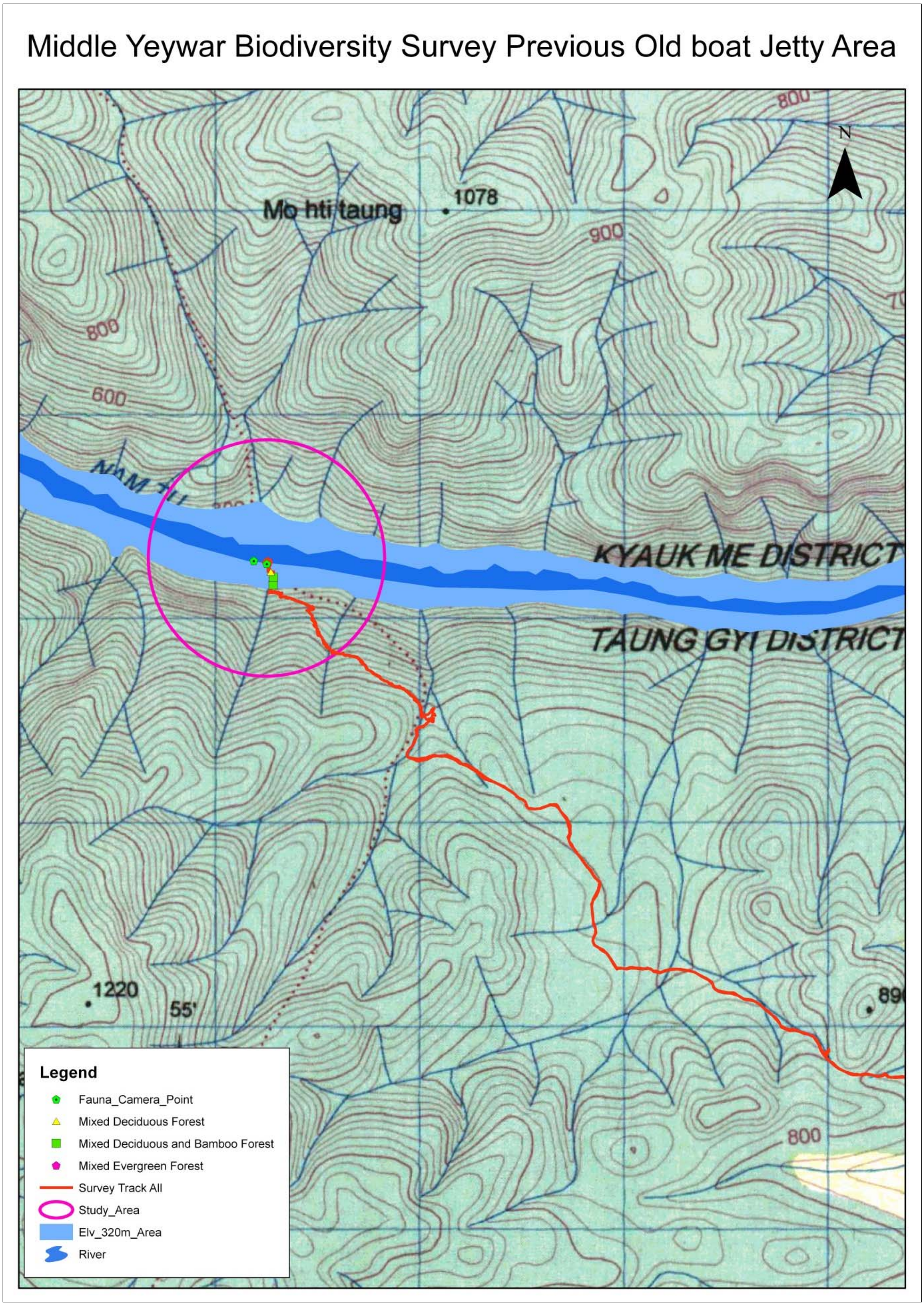


Photo Map X.

Mixed Deciduous Forest

Mixed Deciduous Forest

3.1.4.1. Floristic composition

The total number of tree species collected in 3 representative sample plots in this area is 17 species belonging to 17 genera. The dominant tree species in this area are *Tectona grandis* L.f. (Kyun) and *Shorea siamensis* (Kurz)Miq., (In-gyin), *Pterocarpus indicus*Willd. (Taw-pa-dauk), and *Atalantia monopyhlla* A.DC. (Taw-shauk).

3.1.4.2. Tree Species Population

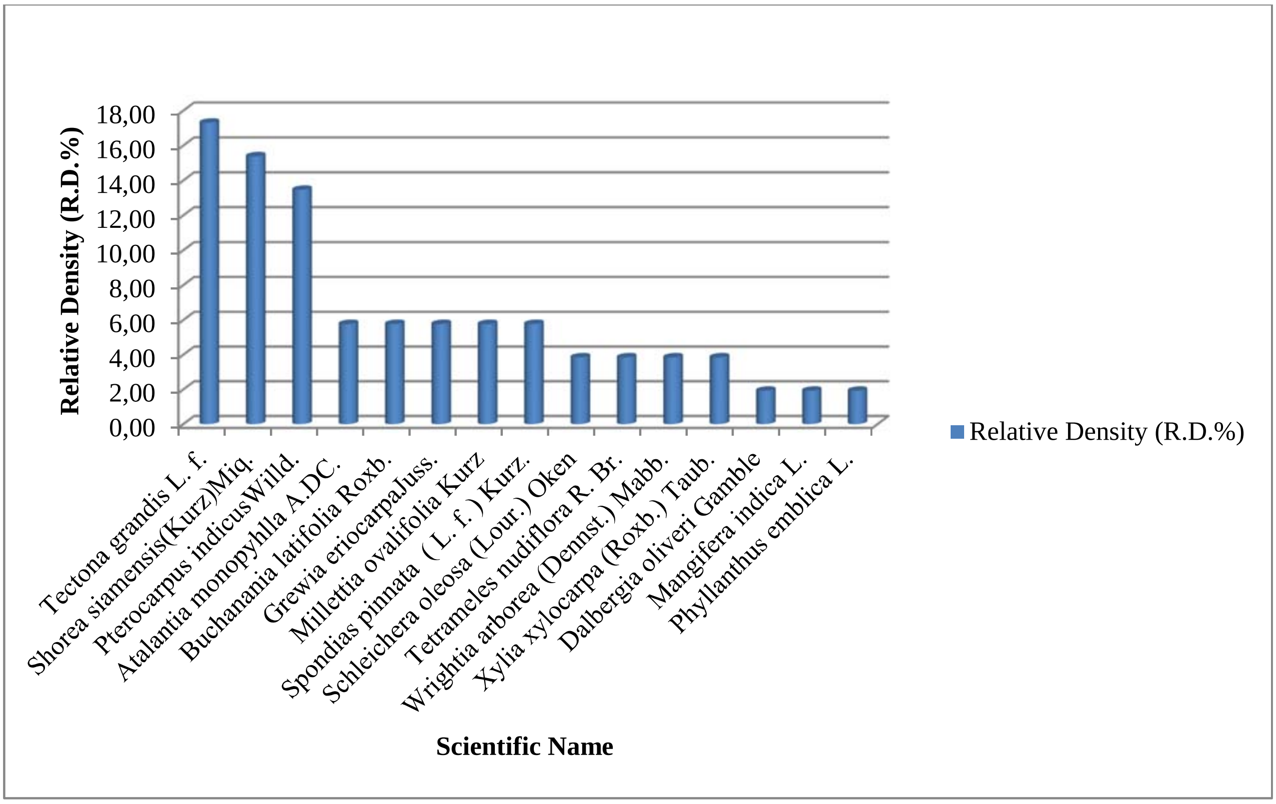
No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Atalantia monopyhlla* A.DC.	3	25.00	5.77
2	*Buchanania latifolia* Roxb.	3	25.00	5.77
3	*Dalbergia oliveri* Gamble	1	8.33	1.92
4	*Grewia eriocarpa*Juss.	3	25.00	5.77
5	*Mangifera indica* L.	1	8.33	1.92
6	*Millettia ovalifolia* Kurz	3	25.00	5.77
7	*Phyllanthus emblica* L.	1	8.33	1.92
8	*Polyalthia viridis*	1	8.33	1.92
9	*Pterocarpus indicus*Willd.	7	58.33	13.46
10	*Samadera indica* Gaertn.	1	8.33	1.92
11	*Schleichera oleosa* (Lour.) Oken	2	16.67	3.85
12	*Shorea siamensis*(Kurz)Miq.	8	66.67	15.38
13	*Spondias pinnata* (L. f.) Kurz.	3	25.00	5.77
14	*Tectona grandis* L. f.	9	75.00	17.31
15	*Tetrameles nudiflora* R. Br.	2	16.67	3.85
16	*Wrightia arborea* (Dennst.) Mabb.	2	16.67	3.85
17	*Xylia xylocarpa* (Roxb.) Taub.	2	16.67	3.85
	Total	**52**	**433.33**	**100.00**

3.1.4.3. Relative density

Among the sample plots species density per hectare was varied and the highest density was observed *Tectona grandis* L.f., followed by *Shorea siamensis* (Kurz)Miq., and *Pterocarpus indicus*Willd..The result shows that these three species are abundant in this area.

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Tectona grandis* L. f.	3.00	17.31
2	*Shorea siamensis*(Kurz)Miq.	2.67	15.38
3	*Pterocarpus indicus*Willd.	2.33	13.46
4	*Atalantia monopyhlla* A.DC.	1.00	5.77
5	*Buchanania latifolia* Roxb.	1.00	5.77
6	*Grewia eriocarpa*Juss.	1.00	5.77
7	*Millettia ovalifolia* Kurz	1.00	5.77
8	*Spondias pinnata* (L. f.) Kurz.	1.00	5.77
9	*Schleichera oleosa* (Lour.) Oken	0.67	3.85
10	*Tetrameles nudiflora* R. Br.	0.67	3.85
11	*Wrightia arborea* (Dennst.) Mabb.	0.67	3.85
12	*Xylia xylocarpa* (Roxb.) Taub.	0.67	3.85
13	*Dalbergia oliveri* Gamble	0.33	1.92

14	*Mangifera indica* L.	0.33	1.92
15	*Phyllanthus emblica* L.	0.33	1.92
16	*Polyalthia viridis*	0.33	1.92
17	*Samadera indica* Gaertn.	0.33	1.92

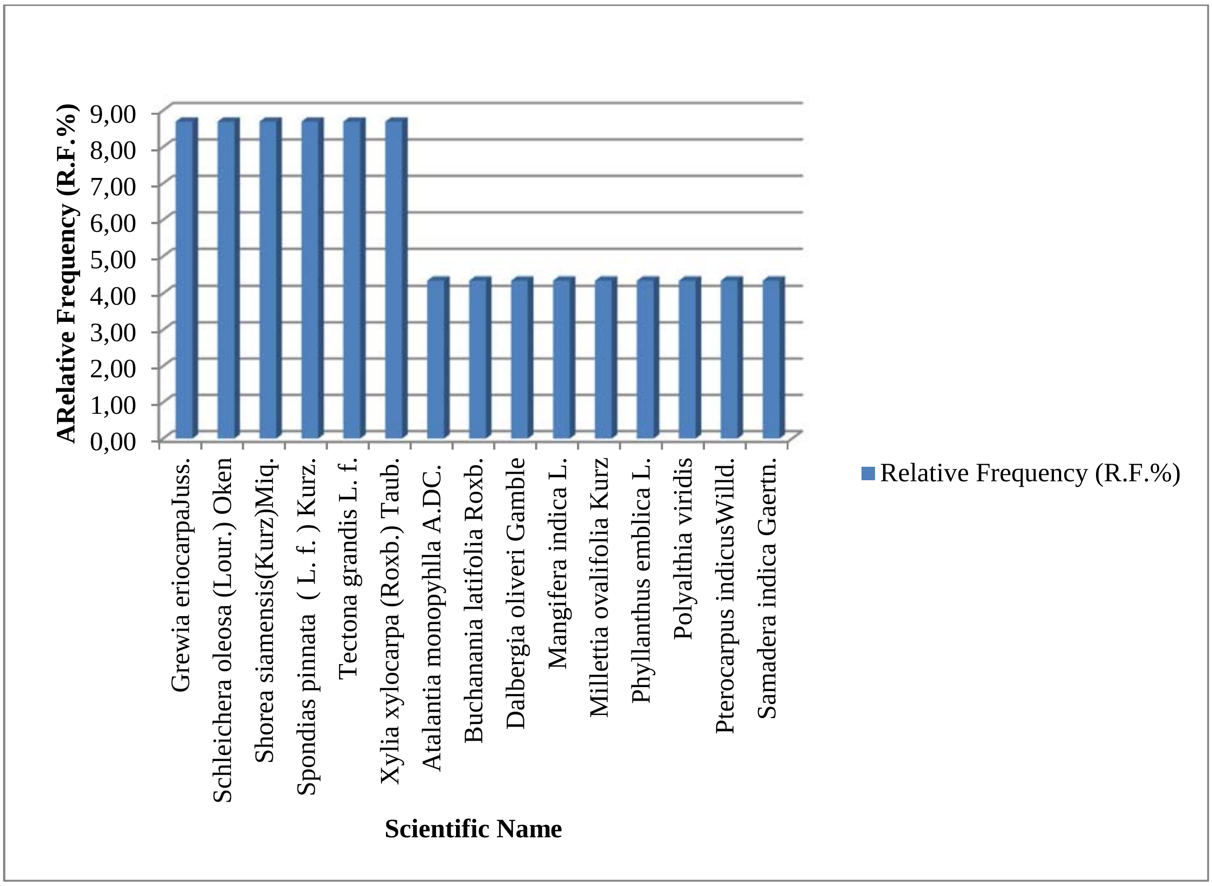


3.1.4.4. Relative frequency of Tree species

Relative frequency is the frequency of one species compared to the total frequency of all the species. According to the results, *Grewia eriocarpa*Juss., and other five species are high relative frequency value (9%) equally and respectively. Therefore these species occur everywhere in the study area. The lower frequency of some species is *Atalantia monopyhlla* A.DC. and other ten species in lower position in table are demarcated as rare species in the area.

No.	Scientific Name	Frequency (F)	Relative Frequency (R.F.%)
1	*Grewia eriocarpa*Juss.	0.67	8.70
2	*Schleichera oleosa* (Lour.) Oken	0.67	8.70
3	*Shorea siamensis*(Kurz)Miq.	0.67	8.70
4	*Spondias pinnata* (L. f.) Kurz.	0.67	8.70
5	*Tectona grandis* L. f.	0.67	8.70
6	*Xylia xylocarpa* (Roxb.) Taub.	0.67	8.70
7	*Atalantia monopyhlla* A.DC.	0.33	4.35
8	*Buchanania latifolia* Roxb.	0.33	4.35
9	*Dalbergia oliveri* Gamble	0.33	4.35
10	*Mangifera indica* L.	0.33	4.35

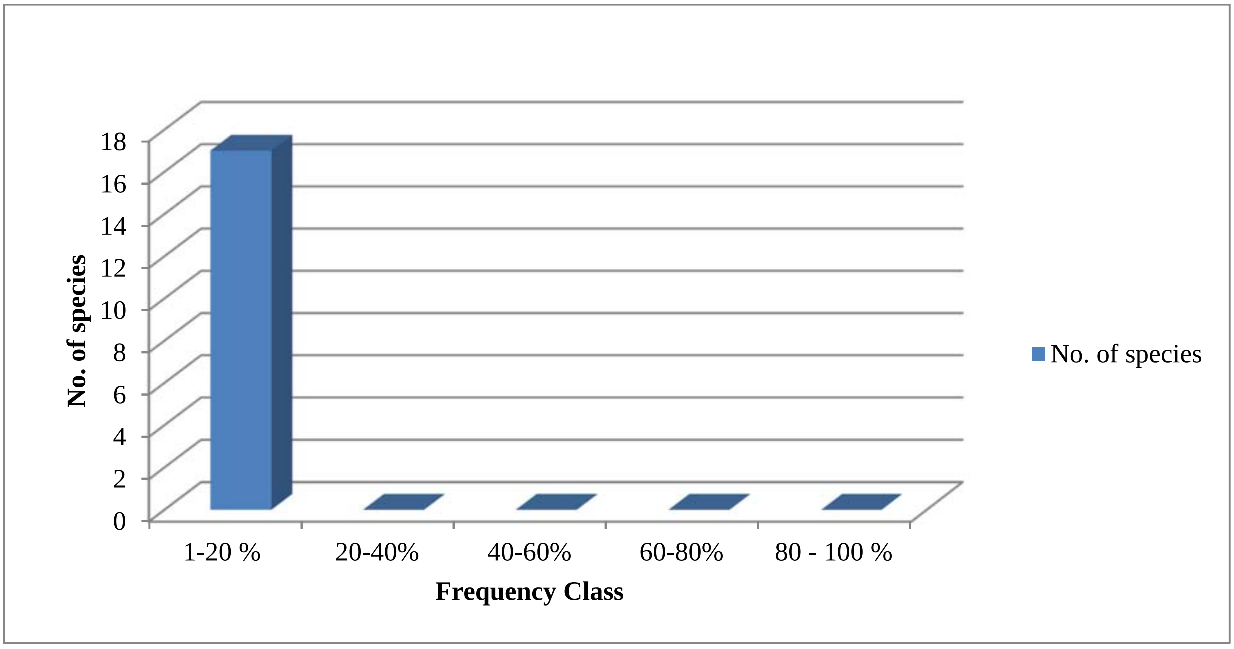
11	*Millettia ovalifolia* Kurz	0.33	4.35
12	*Phyllanthus emblica* L.	0.33	4.35
13	*Polyalthia viridis*	0.33	4.35
14	*Pterocarpus indicus*Willd.	0.33	4.35
15	*Samadera indica* Gaertn.	0.33	4.35
16	*Tetrameles nudiflora* R. Br.	0.33	4.35
17	*Wrightia arborea* (Dennst.) Mabb.	0.33	4.35



3.1.4.5. Species distribution by frequency class

In order to clarify the homogeneity and heterogeneity of the floristic distribution in the area, the species distribution by frequency class was examined. According to the outcome of the frequency classes, zero species is in high frequency class and 17 species are in low frequency class. This shows that this area is floristically high degree of homogeneity.

Frequency class	No. of species
1-20 %	17
20-40%	0
40-60%	0
60-80%	0
80 - 100 %	0



3.1.4.6. Tree species in DBH class interval

The distribution of DBH interval class reveals the dominant of small stem individuals in the area. 100 % of the tree species are less than 40cm DBH. Large stem individuals with DBH 60cm and above are of 0%. Majority of the trees are less than 40cm in diameter, which indicates that the forests secondary types.

DBH Class	No. of species	Total number of individual	% of total population
<40cm	52	433.33	100.00
41-60cm	0	0.00	0.00
61-80cm	0	0.00	0.00
81-100cm	0	0.00	0.00
>101cm	0	0.00	0.00
Total	**52**	**433.33**	**100.00**

3.1.4.7. Tree species in Height class interval

The distribution of Height class interval shows that 392 individuals are less than 10 meter, comprising 90% of the total population and 42 individuals are 15meter and above, comprising the 10%. Since most canopy height classes are less than 10m, the forests in the area could be classified as secondary forests.

Height Class	No. of species	Total number of individual	% of total population
<10m	47	391.67	90.38
11-15m	5	41.67	9.62
16-20m	0	0.00	0.00
21-25m	0	0.00	0.00
>26m	0	0.00	0.00
Total	**52**	**433.33**	**100.00**

3.1.4.8. Vegetation type in the study area

No.	Sample Quadrant	Vegetation type	Longitude	Latitude	Altitude (m)	Dominant species
1	IQ XIX	Mixed Deciduous Forest and Bamboo Forest	96.917654	21.938398	321	*Tectona grandis* L. f.,*Shorea siamensis*(Kurz)Miq, *Pterocarpus indicus*Willd.,*Oxytenanthera albociliata* Munro, *Atalantia monopyhlla* A.DC.,*Buchanania latifolia* Roxb.,*Grewia eriocarpa*Juss., *Millettia ovalifolia* Kurz, *Spondias pinnata* (L. f.) Kurz
2	IQ XX	"	96.917664	21.938723	304	
3	IQ XXI	Mixed deciduous Forest	96.917543	21.938970	282	
IQ=Inundated Quadrant						

3.1.4.9. Species Inventory List of Inundated Area

No.	Scientific Name	Common Name	Family Name	Habit
1	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae	CL
2	*Asparagus densiflorus*	Shint-ma-tet	Asparagaceae	CL
3	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae	ST
4	*Bridelia glauca* Blume	Seik-chi	Euphorbiaceae	T
5	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae	T
6	*Crateva magna* (Lour.)DC.	Ye-ka-det	Capparaceae	ST
7	*Crotalaria multiflora* L.	Not known	Fabaceae	H
8	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	T
9	*Echinodorus quadricostatus*	Not known	Alismataceae	AqH
10	*Equisetum hyemale*	Not known	Equisetaceae	H
11	*Eugenia operculata* Roxb.	Ye-tha-bye	Myrtaceae	ST
12	*Ficus carica*	Not known	Moraceae	S
13	*Ficus hispida* L. f.	Kha-aung	Moraceae	ST
14	*Flemingia strobilifera*	Se-laik-pya	Fabaceae	S
15	*Flueggea leucopyrus* Willd.	Ye-chin-ya	Euphorbiaceae	S
16	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae	ST
17	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae	S
18	*Mangifera indica* L.	Taung-tha-yet	Anacardiaceae	T
19	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae	CL
20	*Millettia ovalifolia* Kurz	Thin-win-pho	Fabaceae	T
21	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	H
22	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae	B
23	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae	ST
24	*Polyalthia viridis*	Ka-naing-thit	Annonaceae	T
25	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	T
26	*Racomitrium aciculare*	Not known	Grimmiaceae	Br
27	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae	ST

No.	Scientific Name	Common Name	Family Name	Habit
28	*Schistostega pennata*	Not known	Schistostegaceae	Br
29	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae	T
30	*Selaginella willdenowii*	Peacock Fern	Selaginellaceae	F
31	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	T
32	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae	T
33	*Tectona grandis* L. f.	Kyun	Verbenaceae	T
34	*Tetrameles nudiflora* R. Br.	Thit-pok	Datiscaceae	T
35	*Tetrastigma planicaule*	Not known	Vitaceae	CL
36	*Wrightia arborea* (Dennst.) Mabb.	Let-htok-thein	Apocynaceae	ST
37	*Xylia xylocarpa* (Roxb.) Taub.	Pyin-ka-doe	Mimosaceae	T
	AqH=Aquatic Herbs,B=Bamboo,Br=Bryophyte,CL=Climber,F=Fern,G=Grass,H=Herbs,S=Shrubs,ST=Small Tree, T=Tree			

3.1.4.10. Bamboo Forest


Bamboo Forest

3.1.4.10.1. Bamboo Species Population

No.	Scientific Name	No. of individual	Total no. of individual/ha	Total no. of population/ha(%)
1	*Oxytenanthera albociliata* Munro	7	8.75	100

3.1.4.10.2. Relative density

No.	Scientific Name	Density (D)	Relative Density (R.D.%)
1	*Oxytenanthera albociliata* Munro	3.5	100

3.1.4.10.3. Species distribution

No.	Scientific Name	Frequency (F)	Relative Frequency (R.F.%)
1	*Oxytenanthera albociliata* Munro	1	100

3.1.4.11. Species List of Aquatic Plants

Crateva magna (Lour.)DC.

Equisetum hyemale

No.	Scientific Name	Common Name	Family Name	
1	*Crateva magna* (Lour.)DC.	Ye-ka-det	Capparaceae	ST
2	*Echinodorus quadricostatus*	Not known	Alismataceae	
3	*Equisetum hyemale*	Not known	Equisetaceae	
4	*Flueggea leucopyrus* Willd.	Ye-chin-ya	Euphorbiaceae	
	Homonoia riparia	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae	

3.1.4.12. Species List of Bryophytes

Racomitrium aciculare

Schistostega pennata

No.	Scientific Name	Common Name	Family Name
1	*Racomitrium aciculare*	Not known	Grimmiaceae
2	*Schistostega pennata*	Not known	Schistostegaceae

3.1.4.13. IUCN red list species, 2017-3

Homonoia riparia

*Pterocarpus indicus*Willd.

Shorea siamensis(Kurz)Miq.

Dalbergia oliveri Gamble

No.	Scientific Name	Common Name	Family Name	IUCN Criteria (2017-3)
1	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae	EN A1cd vr 2.3
2	*Equisetum hyemale*	Not known	Equisetaceae	LC ver 3.1
3	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae	LC ver 3.1
4	*Mangifera indica* L.	Taung-tha-yet	Anacardiaceae	DD ver 2.3
5	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae	LC ver 3.1
6	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae	VU A1d ver 2.3
7	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae	LR/lc ver 2.3
8	*Tectona grandis* L. f.	Kyun	Verbenaceae	LR/lc ver 2.3
	DD=Data Deficient, EN=Endangered, LC=Least Concern, LR/lc=Lower Risk/least concern, VU=Vulnerable			

3.1.5. Checklist in the Area

No	Scientific Name	Common Name	Family Name
1	*Acacia concinna* (Willd.) DC.	Ka-mon-chin	Mimosaceae
2	*Acacia pennata* (L.) Willd.	Su-yit	Mimosaceae
3	*Acer oblongum* Wall.	Himalayan maple	Aceraceae
4	*Adenanthera pavonina* L.	Ywe-gyi	Mimosaceae
5	*Adiantum latifolium*	Not known	Pteridaceae
6	*Adiantum peruvianum*	Adiantum	Pteridaceae
7	*Adina indivisa* Lance	Hnaw	Rubiaceae
8	*Albizia lebbekoides* (DC.) Benth.	Taung-ma-gyi	Mimosaceae
9	*Alstonia scholaris*(L.) R. Br.	Taung-ma-yoe	Apocynaceae
10	*Alternanthera sessilis*	Pa-zun-sa-yaing	Amaranthaceae
11	*Anogeissus acuminata* Wall.	Yon	Combretaceae
12	*Anthocephalus morindaefolius* Korth.	Ma-u-let-tan-shae	Rubiaceae
13	*Antiaris toxicaria* (Pers.) Lesch.	Aseik-pin	Moraceae
14	*Argemone mexicana* L.	Kon-kha-ya	Papaveraceae
15	*Aristolochia tagala* Cham.	Eik-tha-ya-muli	Aristolochiaceae
16	*Artocarpus lakoocha*	Taung-pein-ne	Moraceae
17	*Asparagus densiflorus*	Shint-ma-tet	Asparagaceae
18	*Atalantia monopyhlla* A.DC.	Taw-shauk	Rutaceae
19	*Balanophora indica* Wall.	Not known	Balanophoraceae
20	*Barleria cristata*	Pyo-ma-naing	Acanthaceae
21	*Begonia semperflorens*	Kyauk-chin-pan	Begoniaceae
22	*Bidens alba*	Not known	Asteraceae
23	*Boehmeria nivea* (L.) Gaud.	Phet-ya	Urticaceae
24	*Bombax ceiba* L.	Let-pan	Bombacaceae
25	*Bombax insigne* Wall.	De-du	Bombacaceae
26	*Bridelia glauca* Blume	Seik-chi	Euphorbiaceae
27	*Buchanania latifolia* Roxb.	Lun-pho	Anacardiaceae
28	*Canscora diffusa* (Vahl) R.Br.	Kyauk-pan	Gentianaceae
29	*Cassia fistula* L.	Ngu	Caesalpiniaceae
30	*Chukrasia velutina* Roem.	Taw-yin-ma	Meliaceae
31	*Cibotium barometz* (Linn.) J. Sm.	Da-yin-kauk	Dicksoniaceae
32	*Colona floribunda* (Kurz)Craib	Phet-waing	Tiliaceae
33	*Crateva magna* (Lour.) DC.	Ye-ka-det	Capparaceae
34	*Crotalaria multiflora* L.	Not known	Fabaceae
35	*Cyperus exaltatus*	Not known	Cyperaceae
36	*Cyperus nutans*	Not known	Cyperaceae
37	*Dalbergia cultrata* Grah.	Yin-daik	Fabaceae
38	*Dalbergia oliveri* Gamble	Ta-ma-lan	Fabaceae
39	*Dendrocalamus membranaceus* Munro	Hmyin-wa	Poaceae
40	*Desmodium gangeticum* L.	Not known	Fabaceae

No	Scientific Name	Common Name	Family Name
41	*Dichodontium pellucidum* (Hedw.) Schimp	Not known	Dicranaceae
42	*Dioscorea alata*	Myauk-u	Dioscoreaceae
43	*Dioscorea bulbifera* L.	Khat-cho/Ka-la-htaing	Dioscoreaceae
44	*Dioscorea* sp.	Kywe	Dioscoreaceae
45	*Dracaena sanderiana*	Zaw-sein	Asparagaceae
46	*Duabanga grandiflora*	Myauk-ngo	Lythraceae
47	*Dumortiera hirsuta* (Swaegr.) Nees ssp. *nepalensi*s (Tay.) Frye & Clark	Not known	Marchantiaceae
48	*Echinodorus quadricostatus*	Not known	Alismataceae
49	*Elatostema reticulatum*	Wet-sa	Urticaceae
50	*Entada scandens* Benth.	Doe-nwee	Mimosaceae
51	*Equisetum hyemale*	Not known	Equisetaceae
52	*Eriochloa procera* (Retz.) C.E. Hubb.	Myet-kha	Poaceae
53	*Eugenia operculata* Roxb.	Ye-tha-bye	Myrtaceae
54	*Euphorbia bifida*	Say-pa-le	Euphorbiaceae
55	*Euphorbia hypericifolia* L.	Seik-noe-ma-htwet	Euphorbiaceae
56	*Ficus benguetensis*	Not known	Moraceae
57	*Ficus carica*	Not known	Moraceae
58	*Ficus glomerata* Roxb.	Ye-tha-phan	Moraceae
59	*Ficus hispida* L. f.	Kha-aung	Moraceae
60	*Ficus pumila* L.	Kyauk-kat-nyaung	Moraceae
61	*Ficus variegate*	Kon-tha-phan	Moraceae
62	*Flacourtia indica* (Burm. f.) Merr.	Na-ywe	Flacourtiaceae
63	*Flemingia strobilifera*	Se-laik-pya	Fabaceae
64	*Flueggea leucopyrus* Willd.	Ye-chin-ya	Euphorbiaceae
65	*Fraxinus floribunda* Wall.	Say-kha-gyi	Oleaceae
66	*Garcinia cowa* Roxb.	Tha-le	Hypericaceae
67	*Gmelina arborea* Roxb.	Ye-ma-nae	Verbenaceae
68	*Grewia eriocarpa Juss.*	Ta-yaw	Tiliaceae
69	*Grimmia* sp.	Not known	Grimmiaceae
70	*Grimmia trichophylla*	Not known	Grimmiaceae
71	*Harrisonia perforata* Merr.	Su-gyin	Simaroubaceae
72	*Homonoia riparia*	Ye-mo-ma-kha/Gyin-ye	Euphorbiaceae
73	*Hymenodictyon orixense* (Roxb.) Mabb.	Khu-san	Rubiaceae
74	*Indigofera pulchella* Roxb.	Taw-me	Fabaceae
75	*Lagerstroemia macrocarpa* Kurz	Pyin-ma-ywet-gyi	Lythraceae
76	*Leea hirta* Banks	Naga-mauk-phyu	Leeaceae
77	*Leea rubra* Blume.	Na-ga-mauk-ni	Leeaceae
78	*Lygodium circinnatum*	Not known	Lygodiaceae
79	*Mangifera indica* L.	Taw-tha-yet	Anacardiaceae
80	*Marchantia berteroana*	Not known	Marchantiaceae
81	*Mesua nervosa* Planch. & Triana	Taw-gan-gaw	Hypericaceae

No	Scientific Name	Common Name	Family Name
82	*Mikania micrantha* H.B.K.	Bi-zet-nwee	Asteraceae
83	*Millettia ovalifolia* Kurz	Thin-win-pho	Fabaceae
84	*Mimosa pudica* L.	Hti-ka-yone	Mimosaceae
85	*Morinda persicaefolia* Buch.-Ham.	Ni-ba-sae	Rubiaceae
86	*Najas minor*	Brittleleaf	Najadaceae
87	*Neyraudia reynaudiana* (Kunth) Keng ex Hitchc.	Kyu	Poaceae
88	*Oxyspora paniculata* (D. Don) DC.	Not known	Melastomataceae
89	*Oxytenanthera albociliata* Munro	Wa-phyu	Poaceae
90	*Pandanus odoratissimus* L.f.	Set-thwa-phu	Pandanaceae
91	*Passiflora foetida* L.	Taw-su-ka	Passifloraceae
92	*Pentasachme caudatum* Wall. Ex Wight	Not known	Asclepiadaceae
93	*Phyllanthus amarus*	Myay-zi-phyu	Euphorbiaceae
94	*Phyllanthus emblica* L.	Zi-phyu	Euphorbiaceae
95	*Phyllanthus urinaria* L.	Myay-zi-phyu	Euphorbiaceae
96	*Piper cubebe* L. f.	Peik-chin	Piperaceae
97	*Plagiochila obscura*	Not known	Plagiothecieae
98	*Pogonatherum crinitum* (Thunb.) Kunth	Not known	Poaceae
99	*Polyalthia viridis*	Ka-naing-thit	Annonaceae
100	*Potamogeton crispus* L.	Pondweed	Potamogetonaceae
101	*Pteris esquirolii* Christ	Not known	Pteridaceae
102	*Pterocarpus indicus*Willd.	Taw-pa-dauk	Fabaceae
103	*Racomitrium aciculare*	Not known	Grimmiaceae
104	*Saccharum spontaneum* L.	Thet-kel-gyi	Poaceae
105	*Samadera indica* Gaertn.	Ka-di	Simaroubaceae
106	*Schistostega pennata*	Not known	Schistostegaceae
107	*Schleichera oleosa* (Lour.) Oken	Gyo	Sapindaceae
108	*Schrebera swietenioides* Roxb.	Thit-swe-le	Oleaceae
109	*Selaginella willdenowii*	Peacock Fern	Selaginellaceae
110	*Shorea siamensis*(Kurz)Miq.	In-gyin	Dipterocarpaceae
111	*Solanum indicum*L.	Ka-zaw-kha	Solanaceae
112	*Sphagnum* sp.	Not known	Sphagnaceae
113	*Spirogyra* sp.	Algae	Zygnemataceae
114	*Spondias pinnata* (L. f.) Kurz.	Taw-gwe	Anacardiaceae
115	*Stephania venosa* (Blume) Spreng.	Taung-kya	Menispermaceae
116	*Stereospermum colais* (Buch.-Ham. ex Dillwyn) Mabb.	Than-de	Bignoniaceae
117	*Strobilanthes* sp.	Pan-thin	Acanthaceae
118	*Tadehagi triquetrum* (L.)H. Ohashi	Lauk-thay	Fabaceae
119	*Tamarindus indica* L.	Ma-gyi	Caesalpiniaceae
120	*Tectona grandis* L. f.	Kyun	Verbenaceae
121	*Tetrameles nudiflora* R. Br.	Thit-pok	Datiscaceae
122	*Tetrastigma planicaule*	Not known	Vitaceae

No	Scientific Name	Common Name	Family Name
123	*Trevesia palmata* (Roxb. ex Lindl.) Vis.	Phaw-bu	Araliaceae
124	*Triumfetta rotundifolia* Lam.	Kat-se-ne-thay	Tiliaceae
125	*Utricularia* sp.	Ye-bu-baung	Lentibulariaceae
126	*Vitex peduncularis* Wall.	Phet-le-zin	Verbenaceae
127	*Vitex pubescens* Vahl	Kyet-yo	Verbenaceae
128	*Vitis trifolia*	Not known	Vitaceae
129	*Wendlandia tinctoria* DC.	Thit-ni	Rubiaceae
130	*Wrightia arborea* (Dennst.) Mabb.	Let-htok-thein	Apocynaceae
131	*Xylia xylocarpa* (Roxb.) Taub.	Pyin-ka-doe	Mimosaceae

3.2 Fauna

In total, 138 fauna species of 81 genera belonging to 74 families under 22 orders were recorded in four survey sites (Site I, II, III and IV) during the survey period from 10^{th} to 19^{th} December, 2017. All of them 62 bird species, 23 mammal species, 6 amphibians and 11 reptiles and 36 insect and other invertebrates were respectively collected by fauna survey team. According to the IUCN conservation status, one Critically Endangered (CR), three Endangered (EN), six Vulnerable (VU), 3 Near Threatened (NT) and 78 Least Concern (LC) were conducted in four survey sites.

3.2.1 Birds: species composition and status

A total of 62 bird species of 50 genera belonging to 32 families under 11 orders were recorded in four survey sites. In Site I, 38 bird species were observed, 30 bird species were recorded in Site II, 25 bird species were carried out in Site III and 20 bird species were collected in Site IV. According to the globally threatened status of recorded species, two were classified as Near Threatened (NT) (*Vanellus duvaucelii* River Lapwing and *Psittacula longicauda* Long-tailed Parakeet).

3.2.2. Mammals: species composition and status

A total of 23 mammal species of 22 genera belonging to 15 families under six orders were recorded in four survey sites during the survey. Within the survey area, 20 mammal species were observed in Site I, 12 mammal species were recorded in Site II, 14 mammal species were carried out in Site III and 13 mammal species were recorded in IV. Base on globally threatened status of the recorded species, one is classified as Critically Endangered (CR) (*Manis pentadactyla* Chinese Pangolin), two were observed as Endangered (EN) (*Trachypithecus phayrei* Phayre's Langur and *Cuon alpinus* Dhole), six were conducted as Vulnerable (VU) (*Nycticebus bengalensis* Asian Slow Loris, *Macaca arctoides* Stump-tailed Macacaque, *Ursus thibetanus* Asian Black Bear, *Helartos malayanus* Sun Bear, *Arctictis binturong* Binturong and *Neofelis nebulosa* Clouded Leopard), one was observed as Near Threatened (NT) (*Capricornis milneedwardsii* Chinese Serow) and 13 species were carried out as Least Concern (LC).

3.2.3. Amphibians and Reptile: species composition and status

A total six amphibians and 11 reptile species of 14 genera belonging to 11 families under two orders were recorded in four survey sites during the survey. In Site I, 12 species (six reptiles and six amphibians) were observed, seven species (five amphibians and tow reptiles) were recorded in Site II, eight species (one amphibian and seven reptiles) were carried out in Site III and seven species (two amphibians and four reptiles) were recorded in Site IV. Among then, one Endangered EN (*Indotestudo elongate* Elongated Tortoise) and five species Least Concern (LC) (four amphibians and one reptile) were conducted in four survey sites.

3.2.4. Insect and other invertebrates: species composition and status

A total 36 insect and other invertebrate species of 31 genera belonging to 16 families under three orders were recorded in four survey sites during the survey. Totally, 21 butterflies, 10 beetles and five dragonflies were conducted in four survey sites. In Site I, 23 species (14 butterflies, five beetles and four dragonflies) were collected, 20 species (12 butterflies, four beetles and four dragonfly species) were observed in Site II, 19 species (14 butterflies, three beetles and two dragonflies) were carried out in Site III and 16 species (14 butterflies and two dragonflies) were collected in Site IV.

PLATE 1: RECORDED SOME BIRD PHOTOS

A. *Psittacula finschii*

B. *Streptopelia orientalis*

C. *Coracias benghalensis*

D. *Cinnyris jugularis*

E. *Pycnonotus flaviventris*

F. *Pellorneum ruficeps*

G. *Psittacula alexandri*

H. *Saxicola caprata*

PLATE 2: RECORDED SOME MAMMALS PHOTOS

A. *Trachypithecus phayrei*

B. *Capricornis milneedwardsi*

C. *Hystrix brachyura*

D. *Muntiacus muntjak*

E. *Neofelis nebulosa*

F. *Cuon alpinus*

G. *Sus scrofa*

H. *Ursus thibetanus*

PLATE 3: RECORDED SOME AMPHIBIANS AND REPTILES PHOTOS

A. *Kaloula pulchra*

B. *Microhyla ornata*

C. *Bufo melanostictus*

D. *Kaloula pulchra*

E. *Calotes versicolor*

F. *Indotestudo elongata*

G. *Calotes mystaceus*

H. *Cryptelytrops albolabris*

PLATE 4: RECORDED SOME INSECTS AND OTHER INVERTEBRATES PHOTOS

A. *Mycalesis visala*

B. *Catopsilia pyranthe*

C. *Parantica aglea*

D. *Pieris canidia*

E. *Phalanta phalanta*

F. *Orsotriaena medus*

G. *Cycloneda munda*

H. *Scarabaeus viettei*

APPENDIX

APPENDIX 1: RECORDED BIRD SPECIES IN FOUR SURVEY SITES, MIDDLE YEYWA HYDRPOWER PROJECT

ORDER	FAMILY	NO	SCIENTIFIC NAME	COMMON NAME	SITE I	SITE II	SITE III	SITE IV	IUCN STATUS
GALLIFOMES	**PHASIANIDAE**	**1**	*Gallus gallus*	Red Junglefowl			4	2	LC
GALLIFOMES	**PHASIANIDAE**	**2**	*Lophura leucomelanos*	Kalij Pheasant			1		LC
FALCONIFORMES	**FALCONIDAE**	**3**	*Microhierax caerulescens*	Collared Falconet		1	1	2	LC
FALCONIFORMES	**FALCONIDAE**	**4**	*Falco tinnunculus*	Common Kestrel		2		1	LC
FALCONIFORMES	**FALCONIDAE**	**5**	*Pernis ptilorhynchus*	Oriental Honey-Buzzard		1	1		LC
FALCONIFORMES	**FALCONIDAE**	**6**	*Elanus caeruleus*	Black-shouldered Kite	2	1	1		LC
FALCONIFORMES	**FALCONIDAE**	**7**	*Butastur teesa*	White-eyesd Buzzard		1			LC
CHARADRIFORMES	**VANELLIDAE**	**8**	*Vanellus duvaucelii*	River Lapwing				2	NT
COLUMBIFORMES	**COLUMBIDAE**	**9**	*Streptopelia orientalis*	Oriental Turtle-Dove	2	2	1	1	LC
COLUMBIFORMES	**COLUMBIDAE**	**10**	*Streptopelia chinensis*	Spotted Dove	3	1	1	2	LC
PSITTACIFORMES	**PSITTACIDAE**	**11**	*Psittacula finschii*	Grey-headed Parakeet	5	4	2	4	LC
PSITTACIFORMES	**PSITTACIDAE**	**12**	*Psittacula alexandri*	Red-breasted Parakeet	2				LC
PSITTACIFORMES	**PSITTACIDAE**	**13**	*Psittacula longicauda*	Long-tailed Parakeet				2	NT
CUCULIFORMES	**CUCULIDAE**	**14**	*Rhopodytes tristis*	Green-billed Malkoha	1	1			LC
CUCULIFORMES	**CUCULIDAE**	**15**	*Centropus sinensis*	Greater Coucal	1				LC
STRIGIFORMES	**STRIGIDAE**	**16**	*Otus lettia*	Collared Scops-Owl	1				LC
STRIGIFORMES	**STRIGIDAE**	**17**	*Ketupa zeylonesis*	Brown Fish-Owl			1		LC
STRIGIFORMES	**STRIGIDAE**	**18**	*Glaucidium cuculoides*	Asian Barred Owlet	1				LC
APODIFORMES	**APODIDAE**	**19**	*Apus affinis*	House Swft		23			LC
APODIFORMES	**APODIDAE**	**20**	*Hemiprocne coronate*	Crested Treeswift	4				LC
CORACIIFORMES	**CORACIIDAE**	**21**	*Coracias benghalensis*	Indian Roller	2	2			LC
CORACIIFORMES	**ALCEDINIDAE**	**22**	*Halcyon smyrnensis*	White-throated Kingfisher				1	LC
CORACIIFORMES	**MEROPIDAE**	**23**	*Merops orientalis*	Little Green Bee-eater		6			LC
PICIFORMES	**RAMPHASTIDAE**	**24**	*Megalaima virens*	Great Barbet			1		LC

APPENDIX 1: CONTINUED

ORDER	FAMILY	NO	SCIENTIFIC NAME	COMMON NAME	SITE I	SITE II	SITE III	SITE IV	IUCN STATUS
PICIFORMES	**RAMPHASTIDAE**	**25**	*Megalaima lineata*	Lineated Barbet			2		LC
PICIFORMES	**RAMPHASTIDAE**	**26**	*Megalaima haemaccephala*	Coppersmith Barbet			1		LC
PICIFORMES	**PICIDAE**	**27**	*Dendrocopos canicapillus*	Gery-capped Pygmy Woodpecker		1			LC
PICIFORMES	**PICIDAE**	**28**	*Chrysocolaptes lucidus*	Greater Flameback		2	2		LC
PASSERIFORMES	**CAMPEPHAGIDAE**	**29**	*Coracina macei*	Large Cuckooshrike	2				LC
PASSERIFORMES	**CAMPEPHAGIDAE**	**30**	*Pericrocotus cinnamomeus*	Small Minivet	6				LC
PASSERIFORMES	**ORIOLIDAE**	**31**	*Oriolus chinensis*	Black-naped Oriole		2			LC
PASSERIFORMES	**PRIONPIDAE**	**32**	*Tephrodornis gularis*	Large Woodshrike	3				LC
PASSERIFORMES	**RHIPIDURIDAE**	**33**	*Rhipidura albicollis*	White-throated Fantail	1				LC
PASSERIFORMES	**DICRURIDAE**	**34**	*Dicrurus macrocercus*	Black Drongo	2	2	1	3	LC
PASSERIFORMES	**DICRURIDAE**	**35**	*Dicrurus leucophaeus*	Ashy Drongo	3	1	1	2	LC
PASSERIFORMES	**DICRURIDAE**	**36**	*Dicrurus paradiseus*	Greater Racket-tailed Drongo				1	LC
PASSERIFORMES	**CORVIDAE**	**37**	*Corvus japonensis*	Large-billed Crow		4			LC
PASSERIFORMES	**CORVIDAE**	**38**	*Dendrocitta vagabunda*	Rufous Treepie	3				LC
PASSERIFORMES	**LANIIDAE**	**39**	*Lanius cristatus*	Brown Shrike	2	1	1	1	LC
PASSERIFORMES	**LANIIDAE**	**40**	*Lanius tephronotus*	Grey-backed Shrike	1				LC
PASSERIFORMES	**NECTARINIIDAE**	**41**	*Cinnyris jugularis*	Olive-backed Sunbird	2			1	LC
PASSERIFORMES	**DICAEIDAE**	**42**	*Dicaeum cruentatum*	Scarlet-backed Flowerpecker	2				LC
PASSERIFORMES	**CHLOROPSEIDAE**	**43**	*Chloropsis aurifroms*	Goldren-fronted Leafbird	3				LC
PASSERIFORMES	**MOTACILLIDAE**	**44**	*Anthus hodgsoni*	Olive-backed Pipit	2				LC
PASSERIFORMES	**MOTACILLIDAE**	**45**	*Motacilla alba*	White Wagtail	2	1	1	2	LC
PASSERIFORMES	**FRINGILLIDAE**	**46**	*Carpodacus erythrinus*	Common Rosefinch	2				LC
PASSERIFORMES	**SITTIDAE**	**47**	*Sitta frontalis*	Velvet-fornted Nuthatch	4				LC
PASSERIFORMES	**STURNIDAE**	**48**	*Acridotheres burmannicus*	Vinous-breasted Myna	8	2	5		LC
PASSERIFORMES	**STURNIDAE**	**49**	*Gracula religiosa*	Common Hill-Myna			7		LC
PASSERIFORMES	**MUSCICAPIDAE**	**50**	*Chaimarrornis leucocephalus*	White-capped Water-Redstart	1				LC

APPENDIX 1: CONTINUED

ORDER	FAMILY	NO	SCIENTIFIC NAME	COMMON NAME	SITE I	SITE II	SITE III	SITE IV	IUCN STATUS
PASSERIFORMES	**MUSCICAPIDAE**	**51**	*Phoenicurus auroreus*	Daurian Redstart		2			LC
PASSERIFORMES	**MUSCICAPIDAE**	**52**	*Monticola solitaries*	Blue Rock-Thrush	2				LC
PASSERIFORMES	**MUSCICAPIDAE**	**53**	*Saxicola maurus*	Eastern Stonechat	3	2	2	1	LC
PASSERIFORMES	**MUSCICAPIDAE**	**54**	*Saxicola caprata*	Pied Bushchat	1		1	1	LC
PASSERIFORMES	**MUSCICAPIDAE**	**55**	*Ficedula albicilla*	Taiga Flycatcher	2				LC
PASSERIFORMES	**MUSCICAPIDAE**	**56**	*Copsychus saularis*	Oriental Magpie-Robin	2	1	2	1	LC
PASSERIFORMES	**STENOSTIRIDAE**	**57**	*Culicicapa ceylonensis*	Grey-headed Canary-Flycatcher		2			LC
PASSERIFORMES	**PYCNONOTIDAE**	**58**	*Pycnonotus flaviventris*	Black-crested Bulbul	6	4	2	2	LC
PASSERIFORMES	**PYCNONOTIDAE**	**59**	*Pycnonotus jocosus*	Red-whiskered Bulbul	4	4			LC
PASSERIFORMES	**PYCNONOTIDAE**	**60**	*Pycnonotus cafer*	Red-vented Bulbul	8	5	4	5	LC
PASSERIFORMES	**TAMALIIDAE**	**61**	*Pellorneum ruficeps*	Puff-throated Babbler		2			LC
PASSERIFORMES	**CISTICOLIDAE**	**62**	*Orthotomus sutorius*	Common Tailordbird	2	1			LC

KEY

NT Near Threatened

LC Least Concern

APPENDIX 2: HABITAT TYPE OF BIRD SPECIES IN FOUR SURVEY SITES

NO	SCIENTIFIC NAME	COMMON NAME	HABITATS
1	*Gallus gallus*	Red Junglefowl	Bamboo forest
2	*Lophura leucomelanos*	Kalij Pheasant	Bamboo forest
3	*Microhierax caerulescens*	Collared Falconet	Forest
4	*Falco tinnunculus*	Common Kestrel	Soaring
5	*Pernis ptilorhynchus*	Oriental Honey-Buzzard	Soaring
6	*Elanus caeruleus*	Black-shouldered Kite	Forest
7	*Butastur teesa*	White-eyesd Buzzard	Soaring
8	*Vanellus duvaucelii*	River Lapwing	River side
9	*Streptopelia orientalis*	Oriental Turtle-Dove	Forest
10	*Streptopelia chinensis*	Spotted Dove	Forest
11	*Psittacula finschii*	Grey-headed Parakeet	Forest
12	*Psittacula alexandri*	Red-breasted Parakeet	Forest
13	*Psittacula longicauda*	Long-tailed Parakeet	Forest
14	*Rhopodytes tristis*	Green-billed Malkoha	Forest
15	*Centropus sinensis*	Greater Coucal	Reed bed
16	*Otus lettia*	Collared Scops-Owl	Forest
17	*Ketupa zeylonesis*	Brown Fish-Owl	Forest
18	*Glaucidium cuculoides*	Asian Barred Owlet	Forest
19	*Apus affinis*	House Swft	Soaring
20	*Hemiprocne coronate*	Crested Treeswift	Soaring
21	*Coracias benghalensis*	Indian Roller	Forest
22	*Halcyon smyrnensis*	White-throated Kingfisher	River side
23	*Merops orientalis*	Little Green Bee-eater	Forest
24	*Megalaima virens*	Great Barbet	Forest
25	*Megalaima lineata*	Lineated Barbet	Forest
26	*Megalaima haemaccephala*	Coppersmith Barbet	Forest
27	*Dendrocopos canicapillus*	Gery-capped Pygmy Woodpecker	Forest
28	*Chrysocolaptes lucidus*	Greater Flameback	Forest
29	*Coracina macei*	Large Cuckooshrike	Forest
30	*Pericrocotus cinnamomeus*	Small Minivet	Forest
31	*Oriolus chinensis*	Black-naped Oriole	Forest
32	*Tephrodornis gularis*	Large Woodshrike	Forest
33	*Rhipidura albicollis*	White-throated Fantail	Forest
34	*Dicrurus macrocercus*	Black Drongo	Forest
35	*Dicrurus leucophaeus*	Ashy Drongo	Forest
36	*Dicrurus paradiseus*	Greater Racket-tailed Drongo	Forest
37	*Corvus japonensis*	Large-billed Crow	River side
38	*Dendrocitta vagabunda*	Rufous Treepie	Forest
39	*Lanius cristatus*	Brown Shrike	Forest/Forest edge
40	*Lanius tephronotus*	Grey-backed Shrike	Forest
41	*Cinnyris jugularis*	Olive-backed Sunbird	Forest
42	*Dicaeum cruentatum*	Scarlet-backed Flowerpecker	Forest
43	*Chloropsis aurifroms*	Goldren-fronted Leafbird	Forest
44	*Anthus hodgsoni*	Olive-backed Pipit	Forest

APPENDIX 2: CONTINUED

NO	SCIENTIFIC NAME	COMMON NAME	HABITATS
45	*Motacilla alba*	White Wagtail	River side
46	*Carpodacus erythrinus*	Common Rosefinch	Bamboo forest
47	*Sitta frontalis*	Velvet-fornted Nuthatch	Forest
48	*Acridotheres burmannicus*	Vinous-breasted Myna	Forest
49	*Gracula religiosa*	Common Hill-Myna	Forest
50	*Chaimarrornis leucocephalus*	White-capped Water-Redstart	Forest
51	*Phoenicurus auroreus*	Daurian Redstart	River side
52	*Monticola solitaries*	Blue Rock-Thrush	Cliff
53	*Saxicola maurus*	Eastern Stonechat	River side
54	*Saxicola caprata*	Pied Bushchat	Reed bed
55	*Ficedula albicilla*	Taiga Flycatcher	Forest
56	*Copsychus saularis*	Oriental Magpie-Robin	Forest/Forest edge
57	*Culicicapa ceylonensis*	Grey-headed Canary-Flycatcher	Forest
58	*Pycnonotus flaviventris*	Black-crested Bulbul	Forest/Forest edge
59	*Pycnonotus jocosus*	Red-whiskered Bulbul	Forest/Forest edge
60	*Pycnonotus cafer*	Red-vented Bulbul	Forest/Forest edge
61	*Pellorneum ruficeps*	Puff-throated Babbler	Bamboo forest
62	*Orthotomus sutorius*	Common Tailordbird	Bush

APPENDIX 3: RECORDED MAMMAL SPECIES IN FOUR SURVEY SITES, MIDDLE YEYWA HYDRPOWER PROJECT

ORDER	FAMILY	NO	SCIENTIFIC NAME	COMMON NAME	SITE I	SITE II	SITE III	SITE IV	IUCN STATUS
SCANDENTIA	**TUPAIIDAE**	**1**	*Tupaia belangeri*	Nothern Treeshrew	✓	✓			LC
PHOLIDOTA	**MANIDAE**	**2**	*Manis pentadactyla*	Chinese Pangolin	✓		✓	✓	CR
DERMOPTERA	**LORISIDAE**	**3**	*Nycticebus bengalensis*	Asian Slow Loris				✓	VU
DERMOPTERA	**CERCOPITHECIDAE**	**4**	*Trachypithecus phayrei*	Phayre's Langur	✓		✓		EN
DERMOPTERA	**CERCOPITHECIDAE**	**5**	*Macaca mulatta*	Rhesus Macaque	✓		✓	✓	LC
DERMOPTERA	**CERCOPITHECIDAE**	**6**	*Macaca arctoides*	Stump-tailed Macaque	✓		✓	✓	VU
CARNIVORA	**CANIDAE**	**7**	*Cuon alpinus*	Dhole	✓		✓	✓	EN
CARNIVORA	**URSIDAE**	**8**	*Ursus thibetanus*	Asian Black Bear	✓		✓	✓	VU
CARNIVORA	**URSIDAE**	**9**	*Helartos malayanus*	Sun Bear	✓		✓	✓	VU
CARNIVORA	**MUSTELIDAE**	**10**	*Martes flavigula*	Yellow-throated Marten			✓		LC
CARNIVORA	**VIVERRIDAE**	**11**	*Viverra zibetha*	Large Indian Civet	✓	✓			LC
CARNIVORA	**VIVERRIDAE**	**12**	*Paradoxurus hermaphroditus*	Common Palm Civet	✓	✓			LC
CARNIVORA	**VIVERRIDAE**	**13**	*Arctictis binturong*	Binturong	✓				VU
CARNIVORA	**HERPESTIDAE**	**14**	*Herpestes javanicus*	Small Asian Mongoose	✓				LC
CARNIVORA	**FELIDAE**	**15**	*Neofelis nebulosa*	Clouded Leopard	✓	✓	✓	✓	VU
CARNIVORA	**FELIDAE**	**16**	*Felis chaus*	Jungle Cat		✓			LC
ARTIODACTYLA	**SUIAE**	**17**	*Sus scrofa*	Eurasian Wild Pig	✓	✓	✓	✓	LC
ARTIODACTYLA	**TRAGULIDAE**	**18**	*Muntiacus muntjak*	Red Muntjac	✓	✓	✓	✓	LC
ARTIODACTYLA	**BOVIDAE**	**19**	*Capricornis milneedwardsi*	Chinese Serow	✓	✓	✓	✓	NT
RODENTIA	**SCIURIDAE**	**20**	*Callosciurus finlaysonii*	Variable Squirrel	✓	✓			LC
RODENTIA	**SCIURIDAE**	**21**	*Menetes berdmorei*	Indochinese Ground Squirrel	✓	✓			LC
RODENTIA	**HYSTRUIDAE**	**22**	*Hystrix brachyuran*	Malayan Porcupine	✓	✓	✓	✓	LC
RODENTIA	**HYSTRUIDAE**	**23**	*Atherurus macrourus*	Brush-tailed Porcupine	✓	✓	✓	✓	LC

KEY

CR-Critically Endangered, **EN**-Endangered, **VU**-Vulnerable, **NT**-Near Threatened, **LC**-Least Concern

APPENDIX 4: EVIDENCE MAMMAL SPECIES IN FOUR SURVEY SITES, MIDDLE YEYWA HYDRPOWER PROJECT

NO	SCIENTIFIC NAME	COMMON NAME	Evidence					
			Visual	Aural	Faeces	Track/Sign	Trophy	Interview
1	*Tupaia belangeri*	Nothern Treeshrew	✓					
2	*Manis pentadactyla*	Chinese Pangolin						✓
3	*Nycticebus bengalensis*	Asian Slow Loris						✓
4	*Trachypithecus phayrei*	Phayre's Langur	✓					
5	*Macaca mulatta*	Rhesus Macaque	✓					✓
6	*Macaca arctoides*	Stump-tailed Macaque						✓
7	*Cuon alpinus*	Dhole	✓					
8	*Ursus thibetanus*	Asian Black Bear				✓		✓
9	*Helartos malayanus*	Sun Bear						✓
10	*Martes flavigula*	Yellow-throated Marten				✓		✓
11	*Viverra zibetha*	Large Indian Civet						✓
12	*Paradoxurus hermaphrodites*	Common Palm Civet						✓
13	*Arctictis binturong*	Binturong						✓
14	*Herpestes javanicus*	Small Asian Mongoose						✓
15	*Neofelis nebulosa*	Clouded Leopard				✓		✓
16	*Felis chaus*	Jungle Cat						✓
17	*Sus scrofa*	Eurasian Wild Pig				✓		✓
18	*Muntiacus muntjak*	Red Muntjac				✓	✓	✓
19	*Capricornis milneedwardsi*	Chinese Serow				✓	✓	✓
20	*Callosciurus finlaysonii*	Variable Squirrel	✓					
21	*Menetes berdmorei*	Indochinese Ground Squirrel	✓					
22	*Hystrix brachyuran*	Malayan Porcupine				✓		✓
23	*Atherurus macrourus*	Brush-tailed Porcupine						✓

APPENDIX 5: EVIDENCE MAMMAL SPECIES IN FOUR SURVEY SITES, MIDDLE YEYWA HYDRPOWER PROJECT

NO	SCIENTIFIC NAME	COMMON NAME	HABITATS
1	*Tupaia belangeri*	Nothern Treeshrew	Bush
2	*Manis pentadactyla*	Chinese Pangolin	Forest
3	*Nycticebus bengalensis*	Asian Slow Loris	Forest
4	*Trachypithecus phayrei*	Phayre's Langur	Cliff
5	*Macaca mulatta*	Rhesus Macaque	Cliff
6	*Macaca arctoides*	Stump-tailed Macaque	Forest
7	*Cuon alpinus*	Dhole	River side
8	*Ursus thibetanus*	Asian Black Bear	Forest
9	*Helartos malayanus*	Sun Bear	Forest
10	*Martes flavigula*	Yellow-throated Marten	River side
11	*Viverra zibetha*	Large Indian Civet	Forest
12	*Paradoxurus hermaphrodites*	Common Palm Civet	Forest
13	*Arctictis binturong*	Binturong	Forest
14	*Herpestes javanicus*	Small Asian Mongoose	Forest
15	*Neofelis nebulosa*	Clouded Leopard	River side
16	*Felis chaus*	Jungle Cat	Forest
17	*Sus scrofa*	Eurasian Wild Pig	Forest
18	*Muntiacus muntjak*	Red Muntjac	Forest
19	*Capricornis milneedwardsi*	Chinese Serow	Forest
20	*Callosciurus finlaysonii*	Variable Squirrel	Forest
21	*Menetes berdmorei*	Indochinese Ground Squirrel	Bush
22	*Hystrix brachyuran*	Malayan Porcupine	Forest
23	*Atherurus macrourus*	Brush-tailed Porcupine	Forest

APPENDIX 6: RECPRDED AMPHIBIANS AND REPTILES SPECIES IN FOUR SURVEY SITES, MIDDLE YEYWA HYDRPOWER PROJECT

ORDER	FAMILY	NO	SCIENTIFIC NAME	COMMON NAME	SITE I	SITE II	SITE III	SITE IV	IUCN STATUS
ANURA	**BUFONIDAE**	1	*Duttaphrynus melanostictus*	Common Toad	1		2	1	-
ANURA	**DICROGLOSSIDAE**	2	*Fejervarya limnocharis*	Paddy Frog	3	2			LC
ANURA	**MICROHYLIDAE**	3	*Kaloula pulchra*	Asian Painted Frog	1	2		1	LC
ANURA	**MICROHYLIDAE**	4	*Microhyla ornate*	Ornate Narrow-mouthed Frog	2	1			-
ANURA	**MICROHYLIDAE**	5	*Microhyla fissipes*	Marbled Narrow-mouthed Frog	1	2		1	LC
ANURA	**RANIDAE**	6	*Sylvirana nigrovittata*	Dark-sided Frog	1	1			LC
SQUAMATA	**AGAMIDAE**	7	*Calotes veriscolor*	Garden Fence Lizard	1		2	1	-
SQUAMATA	**AGAMIDAE**	8	*Calotes mystaceus*	Blue Forest Lizard			2	2	-
SQUAMATA	**GEKKONIDAE**	9	*Cyrtodacctylus brevidactylus*	Short-toed Bent-toed Gecko	1	1			-
SQUAMATA	**GEKKONIDAE**	10	*Gekko gecko*	Tokay Gecko	1		1		-
SQUAMATA	**GEKKONIDAE**	11	*Hemidactylus frenatus*	Spiney-tailed House Gecko			1	1	-
SQUAMATA	**GEKKONIDAE**	12	*Hemidactylus garnotii*	Garnot's House Gecko	1		1		-
SQUAMATA	**SCINCIDAE**	13	*Eutropis macularia*	Little Ground Skink		1		1	-
SQUAMATA	**VIPERIDAE**	14	*Cryptelytrops albolabris*	White-lipped Pit Viper			1		LC
SQUAMATA	**PYTHONIDAE**	15	*Python reticulatus*	Reticulated Python			1		-
SQUAMATA	**COLUBRIDAE**	16	*Ptyas korros*	Indo-Chinese Rat Snake	1				-
SQUAMATA	**TESTUDINIDAE**	17	*Indotestudo elongate*	Elongated Tortoise	1				EN

KEY

EN Endangered

LC Least Concern

APPENDIX 7: HABITAT TYPES OF AMPHIANS AND REPTILES IN FOUR SURVEY SITES, MIDDLE YEYWA HYDRPOWER PROJECT

NO.	SCIENTIFIC NAME	COMMON NAME	HABITATS
1	*Duttaphrynus melanostictus*	Common Toad	Path
2	*Fejervarya limnocharis*	Paddy Frog	Pond
3	*Kaloula pulchra*	Asian Painted Frog	Leaf litter
4	*Microhyla ornate*	Ornate Narrow-mouthed Frog	Leaf litter
5	*Microhyla fissipes*	Marbled Narrow-mouthed Frog	Leaf litter
6	*Sylvirana nigrovittata*	Dark-sided Frog	Under the stone
7	*Calotes veriscolor*	Garden Fence Lizard	Bush
8	*Calotes mystaceus*	Blue Forest Lizard	Forest
9	*Cyrtodacctylus brevidactylus*	Short-toed Bent-toed Gecko	Hut
10	*Gekko gecko*	Tokay Gecko	Hut
11	*Hemidactylus frenatus*	Spiney-tailed House Gecko	Hut
12	*Hemidactylus garnotii*	Garnot's House Gecko	Hut
13	*Eutropis macularia*	Little Ground Skink	Beside the stream
14	*Cryptelytrops albolabris*	White-lipped Pit Viper	Bush
15	*Python reticulatus*	Reticulated Python	Cave
16	*Ptyas korros*	Indo-Chinese Rat Snake	Path
17	*Indotestudo elongate*	Elongated Tortoise	Forest

APPENDIX 8: RECORDED INSECTS AND OTHER INVERTEBRATES IN FOUR SURVEY SITES, MIDDLE YEYWA HYDRPOWER PROJECT

ORDER	FAMILY	NO	SCIENTIFIC NAME	COMMON NAME	SITE I	SITE II	SITE III	SITE IV
LEPIDOPTERA	**PAPILIONIDAE**	1	*Pachliopta aristolochiae*	Common Rose	4	3	3	1
LEPIDOPTERA	**PIERIDAE**	2	*Catopsilia pyranthe*	Mottled Emigrant	3		4	
LEPIDOPTERA	**PIERIDAE**	3	*Delias descombi*	Common Jezebel	1	2	2	2
LEPIDOPTERA	**PIERIDAE**	4	*Pieris canidia*	Indian cabbage white	1			2
LEPIDOPTERA	**PIERIDAE**	5	*Eurema ada*	Talbot’s Grass Yellow		2		
LEPIDOPTERA	**PIERIDAE**	6	*Eurema sari*	Chocolate grass Yellow		1		5
LEPIDOPTERA	**NYMPHALIDAE**	7	*Parantica aglea*	Glassy Tiger	3		2	2
LEPIDOPTERA	**NYMPHALIDAE**	8	*Phalanta phalanta*	Common Leopard	3	4		1
LEPIDOPTERA	**NYMPHALIDAE**	9	*Mycalesis visala*	Long-brand bushbrown		1	1	
LEPIDOPTERA	**NYMPHALIDAE**	10	*Melanitis phedima*	Dark evening brown	5		2	1
LEPIDOPTERA	**NYMPHALIDAE**	11	*Melanitis zitenius*	Great evening brown	4	1		1
LEPIDOPTERA	**NYMPHALIDAE**	12	*Orsotriaena medus*	Nigger		1	5	
LEPIDOPTERA	**NYMPHALIDAE**	13	*Ariadne Ariadne*	Angled Caster	1		5	
LEPIDOPTERA	**NYMPHALIDAE**	14	*Moduza procis*	Commander		2		3
LEPIDOPTERA	**NYMPHALIDAE**	15	*Neptis hylas*	Common Sailer	1		4	
LEPIDOPTERA	**NYMPHALIDAE**	16	*Junonia hierta*	Yellow Pansy	2	5	2	
LEPIDOPTERA	**NYMPHALIDAE**	17	*Junonia lemonias*	Lemon Pansy		1	2	3
LEPIDOPTERA	**NYMPHALIDAE**	18	*Junonia atlites*	Gray Pansy	4		1	1
LEPIDOPTERA	**LYCAENIDAE**	19	*Jamides celeno*	The common cerulean	1		1	1
LEPIDOPTERA	**LYCAENIDAE**	20	*Euchrysops cnejus*	Gram Blue			1	2
LEPIDOPTERA	**HESPERIIDAE**	21	*Celaenorrhinus asmara*	White-banded Flat	1	1		
COLEOPTERA	**COCINELLIDAE**	22	*Cycloneda munda*	Lady bug beetle	3			
COLEOPTERA	**CRIOCERINAE**	23	*Neolema sexpunctata*	Shining Leaf Beetle	1		4	
COLEOPTERA	**MELYRIDAE**	24	*Hypebaeus spp*	Soft-wing flower Beetle		1		
COLEOPTERA	**GALERUCIDAE**	25	*Parchicola spp*	Flea Beetle	2			

APPENDIX 8: CONTINUED

ORDER	FAMILY	NO	SCIENTIFIC NAME	COMMON NAME	SITE I	SITE II	SITE III	SITE IV
COLEOPTERA	**CERAMBYCIDAE**	26	*Anoplophora glabripennis*	Asian Long horn Bettle			2	
COLEOPTERA	**ELATERIDAE**	27	*Ctenicera divaricate*	Click Beetle		2		
COLEOPTERA	**CARABIDAE**	28	*Carabus violaecus*	Violet Ground Beetle		1		
COLEOPTERA	**CARABIDAE**	29	*Amora oulica*	Ground Beetle		1	1	
COLEOPTERA	**SCARABAEIDAE**	30	*Scarabaeus viettei*	Dung Beetle	2			
COLEOPTERA	**LUCANIDAE**	31	*Lucanus cervus*	Stag Beetle(caterpillar)	1			1
ODONATA	**LIBELLULIDAE**	32	*Diplacodes nebulosa*	Black-tipped Percher	2	1	3	3
ODONATA	**LIBELLULIDAE**	33	*Neurothemis tulipa*		1			
ODONATA	**LIBELLULIDAE**	34	*Orthetrum triangulare*	Blue-tailed Forest Hawk	2	4		
ODONATA	**LIBELLULIDAE**	35	*Tholymis tillarga*	Coral-tailed Cloudwing		1		
ODONATA	**PETALURIDAE**	36	*Calicnemia imitans*		1	4	1	2

APPENDIX 9: HABITAT TYPES OF INSECTS AND OTHER INVERTEBRATES IN FOUR SURVEY SITES, MIDDLE YEYWA HYDRPOWER PROJECT

NO.	SCIENTIFIC NAME	COMMON NAME	HABITAT TYPE
1	*Pachliopta aristolochiae*	Common Rose	Shrub
2	*Catopsilia pyranthe*	Mottled Emigrant	Shrub
3	*Delias descombi*	Common Jezebel	Shrub
4	*Pieris canidia*	Indian cabbage white	Bush
5	*Eurema ada*	Talbot’s Grass Yellow	Shrub
6	*Eurema sari*	Chocolate grass Yellow	Shrub
7	*Parantica aglea*	Glassy Tiger	Shrub
8	*Phalanta phalanta*	Common Leopard	Shrub
9	*Mycalesis visala*	Long-brand bushbrown	Bush
10	*Melanitis phedima*	Dark evening brown	Bush
11	*Melanitis zitenius*	Great evening brown	Bush
12	*Orsotriaena medus*	Nigger	Bush
13	*Ariadne Ariadne*	Angled Caster	Trail
14	*Moduza procis*	Commander	Stream side
15	*Neptis hylas*	Common Sailer	Bush
16	*Junonia hierta*	Yellow Pansy	Trail
17	*Junonia lemonias*	Lemon Pansy	Trail
18	*Junonia atlites*	Gray Pansy	Bush
19	*Jamides celeno*	The common cerulean	Feaces
20	*Euchrysops cnejus*	Gram Blue	Feaces
21	*Celaenorrhinus asmara*	White-banded Flat	Bush
22	*Cycloneda munda*	Lady bug beetle	Bush
23	*Neolema sexpunctata*	Shining Leaf Beetle	Bush
24	*Hypebaeus spp*	Soft-wing flower Beetle	Trail
25	*Parchicola spp*	Flea beetle	Stream side
26	*Anoplophora glabripennis*	Asian Long horn Bettle	Bush
27	*Ctenicera divaricate*	Click Beetle	Trail
28	*Carabus violaecus*	Violet Ground Beetle	Trail
29	*Amora oulica*	Ground Beetle	Bush
30	*Scarabaeus viettei*	Dung Beetle	Bush
31	*Lucanus cervus*	Stag Beetle(caterpillar)	Trail
32	*Diplacodes nebulosa*		Stream side
33	*Neurothemis tulia*		Bush
34	*Orthetrum triangulare*		Trail
35	*Tholymis tillarga*		Trail
36	*Calicnemia imitans*		Trail

APPENDIX 10: SUMMARY OF GLOBAL THREATENED FAUNA SPECIES IN FOUR SURVEY SITES, MIDDLE YEYWA HYDRPOWER PROJECT

NO.	FAUNA	IUCN REDLIST CATEGORIES					TOTAL
		CR	EN	VU	NT	LC	
1	Birds	-	-	-	2	60	62
2	Mammals	1	2	6	1	13	23
3	Amphibians and Reptiles	-	1	-	-	5	6
4	Insects and other Invertebrates	-	-	-	-	-	-
	TOTAL	1	3	6	3	78	91

APPENDIX 11: SUMMARY OF GLOBAL THREATENED FAUNA SPECIES IN FOUR SURVEY SITES, MIDDLE YEYWSA HYDRPOWER PROJECT

NO.	FAUNA	ORDER	FAMILY	GENERA	SPECIES
1	Birds	11	32	14	62
2	Mammals	6	15	22	23
3	Amphibians and Reptiles	2	11	14	17
4	Insects and other Invertebrates	3	16	31	36
	TOTAL	22	74	81	138

IV.THREATS

The present survey focuses on the inundated areas due to dam. The previous surveys mostly focus on the catchment forests and the riverine area above the 320m asl. So the total plant species recorded in the previous surveys is 462 species that were identified areas the entire project area on both banks. Of these, 289 species can be found on the right bank and 383 species can be found on the left bank. But this does not mean that the left bank has more diversity than the right bank. The survey time on left bank consists of two times that is first time in dry season and the second time in wet season and also the survey area is rather. The wide survey time on the right bank consist of only one time that is in the period of at the end of raining season.

The present survey was the assessment in the direct impact zone that is the inundated area below 320m asl. The data was collected using the same methodology. So the previous finding and present findings should be used in environmental impact assessment (EIA) and environmental mangement plan of Middle Yeywa Hydropower project report to be a complete and sufficient report.

The forest ecosystem and species diversity of both flora and fauna in the area may be complete only if the datas of previous findings and present findings are analized together.

There are total of 131 plant species and 138 animal species are recorded in present survey. In the 11 aquatic plant species are recorded. Since the river is flowing in the V-shape Vally and at high flowing rate, the floating aquatic plants cannot survive. Only the submerged floating aquatic algae *Spirogyra* sp. can survive in the ponds between the stones on ths bank and *Potamogeton crispus* in the elbow bend of the river. In the spray zone closed to the waterfall some amphibions aquatic plants like *Dumortiera* sp. and mosses are found on the rocks and lichens are also found on the rocks and cliffs.

In the second research area around the confluence of the Dokhtawaddy River and Gohteik Stream, the elevation is above 320m asl. So the area is not included in the impact zone. But some aquatic bryophytes are collected and recorded and riverine plants are also recorded.

A total of 138 fauna species were conducted in four representative areas (inundated area closed to dam site (Site I), the downstream confluence Dokhtawaddy River and Gohteik Stream (Site II), the Namkam waterfall area and the inundated area of the confluence of Namkam stream and Dokhtawaddy River (Site III) and the previously used as boat jetty on the left bank of the river near Kyauk Sone village (Site IV)). All of them, 62 bird species, 23 mammal species, 17 species (6 amphibians and 11 reptiles) and 36 species (21 butterflies, 10 beetle and 5 dragonflies species) were respectively collected in four survey sites by fauna survey team. Among them, 13 species were observed as globally threatened and near threatened using with The IUCN Red List of Threatened Species. Version 3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**. Base on IUCN Red List of Threatened Species status, one Critically Endangered (CR), three Endangered (EN), six Vulnerable (VU), three Near Threatened (NT) were conducted in four survey sites during the survey period.

Base on current field survey result, the major threats to biodiversity of this survey area are: illegal logging, fuel wood harvesting and the timber trade and poaching. These threats lead to habitat degradation, decline of species population and disruption of ecological processes—all contributing to the overall loss of biodiversity.

4.1 Habitat degradation and destruction of fauna species

Villages near the survey areas rely on forests beside of the river for their livelihood. Although illegal logging, fuel wood harvesting and the timber trade, the forests are still decent in survey area.

4.2 Poaching

Hunting pressure is also serious threats on fauna species and local people were hunting after harvesting season (November-December). In the present time Eurasian Wildboar, Civet, Chinese Serow and Red Muntjac were main target species for the local hunters. The local hunters trap or shoot them for their meat, skin, bones and canines, which are in high demand as bush meat, status symbols and for use in traditional medicine.

The threats to biodiversity in the area are

1. Expansion of farmland in the forest.
2. Loss of fresh water supply due to loss of spring.
3. Habitat loss of fauna species due to deforestration.
4. Food scarcity for fauna species due to forest degradation and deforestration.

The wild game hunting is still in practic in the area. So fauna species are facing extinction.

V.DISCUSSION AND CONCLUSION

As mention in threat, the analysis of impacts of the middle Yeywa Hydropower Dam should base on the finding of both previous findings and present findings to get a complete picture.

5.1. Potential impacts matrix and mitigation measure

Source	Potential Impact to Biodiversity	Extinct			Duration			Probility			Magnitude			Significane			Recommended Measure
		L	M	H	L	M	H	L	M	H	L	M	H	L	M	H	
FLORA	**1.1** Existing Indaing Forest on riverine will be clean up.			√			√			√			√			√	The remaining Indaing forest above the 320 meter should be protected from ilegal logging.
	1.2. Existing Teak forest on riverine will be cleaned up and if not conserve the Teak in the cathment area, it will be degarated soon.			√			√			√			√			√	Reforestaion of teak plantaion should be done.
	1.3 Loss of nutrient regime eroded from catchment forest and transported from upstream to downstream			√		√			√		√				√		Reforestration of catchment forest must be carried out. The reforestration and conservation fund should be esterblished and implemented.
	1.4 Effect of decrease oxygen concentration in water due to the change of runing water to stagnant water in storaged dam.	√				√			√			√			√		To restore the DOC in the reservour man-made falls and rapid should be constructed to get stable oxygen concentration in the inundated area along the river
FAUNA	**1.1** Habitat loss due to clean up of the riverine forest	√				√			√			√			√		Restoration of remaining riverine forests and catchment forests to restore the lost habitat.
	1.2 Food scarcity due to decrease nutrient transport for aquatic fauna and decrease tree species population		√			√			√			√			√		Reforestration of catchment forest so that the nutrition regime can be maintained
	1.3 The storage dam may block the fish migration up and down the river		√				√		√				√			√	To built fish ladder so that fish can migrate to and from the up and down stream
	1.4 Effect on fish, habitat and food chain and food web			√			√			√			√			√	Construction should be included fish ladder, for migration for fish; there is no special habitat for specific species in Dodtawaddy River

The priority measure should be carried out in addition or as a focal of environmental management plan (EMP). The main measures that should be considered are mention below.

1. Change to land cover
   (a) Preserve the existing riverine Indaing forest, which had been above the 320 meter of inundated water level.
   (b) Esterblish the plan to reforest the forests in the catchment of the river

2. Change to aquatic biota
   (a) To restore the nutrient transport for fauna species and fertility of river bank agriculture, the reforestration of catchment forests must be carried out by any mean.
   (b) To restore the DOC in the inundaled area along the river, man-made water falls and rapid should be constructed.

It is also important to make provision from an early stage of project planning for the conduct of and environmental audit shortly after completion of project. The environmental auditors must identify the environmental changes and cumulative impacts caused by series of dam on the river and assess the effectiveness of mitigation measure adopled and suggest additional measure where appropriate.

For restoration of catchment forests, the "conservation fund" must be esterblished. This fund will come from CSR fund paid by the investor of the "Middle Ye Ywar Hydropower".

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ANNEX 2D

Report on Camera Trapping Result in the Middle Yeywa Hydropower Project Area

REPORT ON CAMERA TRAPPING RESULT
IN
MIDDLE YEYWA HYDROPOWER PROJECT AREA

TIN AUNG TUN (KO LAY), KYAW NAING OO AND MIN THEIN HTET
YANGON
JANUARY, 2018

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1. INTRODUCTION

A river with three names, Nam Tu River, Dodtawaddy River and Mytinge River, originating from the northern Shan State mountain ranges, flows from east to west in Kyaukme Township (Nam Tu River), continues to flow from north to south and then turns from east to west in Naung-cho Township where it becomes Dodtawaddy River. Before flowing into the Ayerawaddy River in Amayapura Township, the river (Mytinge River) flows from north east to south west in the low land area of Mandalay Division. The study area is located about 55 km east of Pyin Oo Lwin town and situated along the central part of Nam Tu River.

At the upstream end of the 70 km length of river, below the Upper Yeywa HPP, the Nam Tu River generally flows through deep gorges with an average valley width at river level of around 70 m. The minimum width of the valley at river level is approximately 25 m and the maximum width approaches 160 m. The topography in the river valley is generally characterized by deeply incised V-shape gorges with steep slopes in the range of 30_o to 60_o and no significant widening, which will result in a narrow reservoir with only a limited storage capacity when compared to the mean yearly inflow.

2. SURVEY PARTICIPANTS

Survey team was comprised by the following members:

Biodiversity experts: Tin Aung Tun (Ko Lay) (Researcher and Team Leader), Kyaw Naing Oo and Min Thein Htet

Local Guide: Sein Win, Soe Lwin, Tun Shwe and Phoe Zaw from Kyauk Sone village, Zaw Min Htwe, Zaw Min Oo, Zaw Phyo and Thar Gyi from Ye Twin Gyi village and Win Ngwe and Thar Gyi from Naung Hkioi Gyi village as local guide

3. ITINERARY

Survey was carried out four survey sites includes the inundated closed to the dam site, southern part of Yetwingyi village on the right bank of the river (Site I). Two camera traps were installed in the second survey area includes the downstream confluence Dodtawady River and Gohteik stream (Site II). Two camera traps were set up in the third survey area includes the Nan Kun waterfall area and the inundated area of the confluence of Nan Kun stream and Dodtawady River (Site III). Two camera traps were installed in the fourth survey area include the previously used as boat jetty on the left bank of the river near Kyauk Sone village (Site IV). The following table provides a daily detail description of itinerary and activities performed during the survey.

Table 1. Date activities description

DATE	ACTIVITIES DESCRIPTION
14/01/2018	Yangon-Yawk Sawk
15/01/2018	Yawk Sawk-Kyauk Sone (Preparation)
16/01/2018	Survey (Site III and Site IV)
17/01/2018	Kyauk Sone-Naung Hkio (Preparation)
18/01/2018	Survey (Site I)
19/01/2018	Survey (Site II)
20/01/2018	Naung Hkio-Mandalay
21/01/2018	Mandalay-Yangon

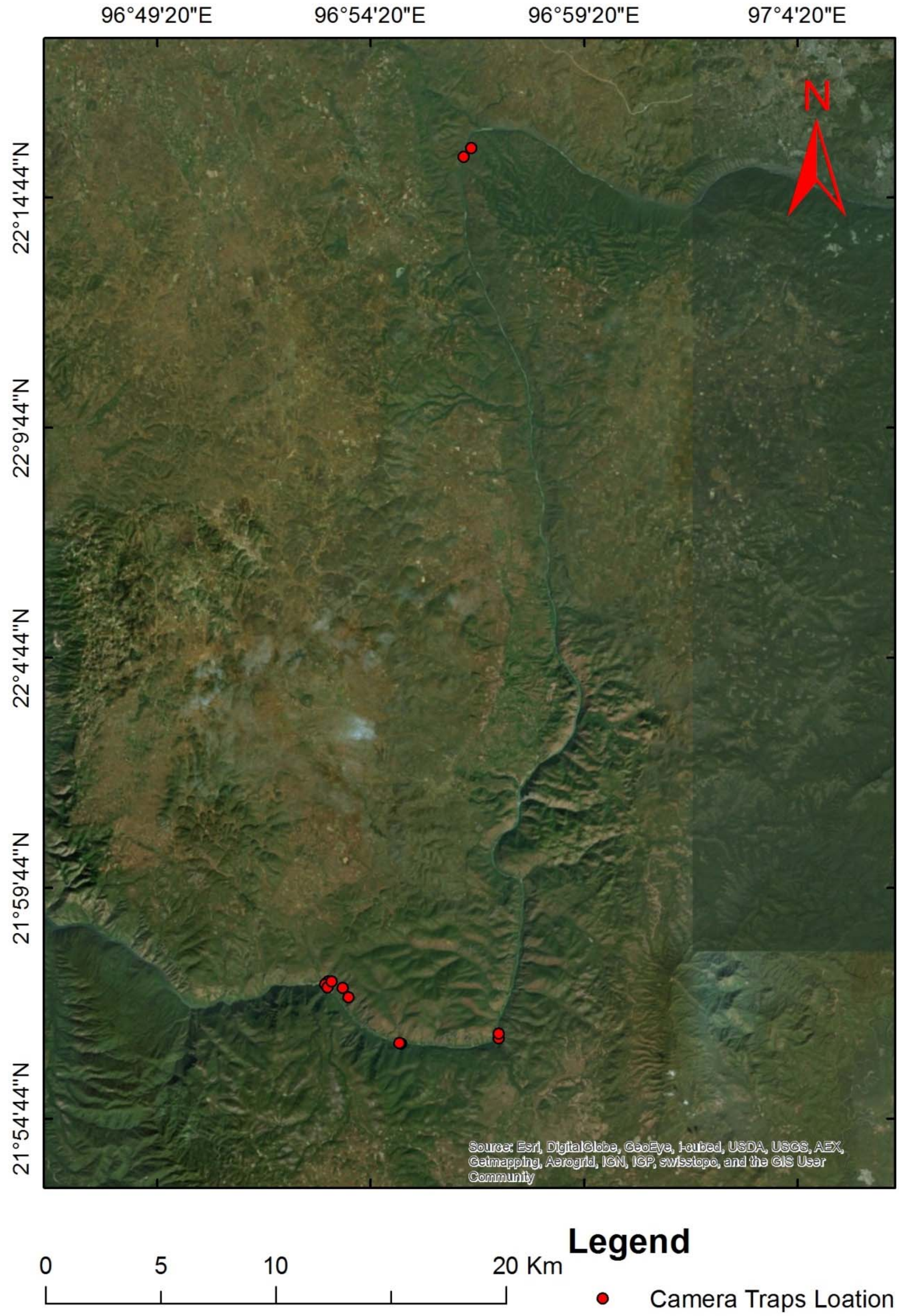

Figure 1. Camera Traps Location Map in Middle Yeywa Hydropower Project

4. MATERIALS AND METHODS

The survey was conducted from 14th to 21th of January, 2018. Globally threatened status of Fauna species were categorized using The IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.)., i.e Critically Endangered (CR), Endangerd (EN), Vulnerable (VU), Near threatened (NT) and Least Concern (LC). Geographic coordinates for each cameras location were recorded using GPS devices (Garmin etrex 10 receiver). Coordinates were recorded as latitude and longitude in decimal degrees, and referenced to the WGS84 (World Geodetic System of 1984) datum. Camera trap locations were selected based on where wild animal tracks were detected during the survey. A total of 12 cameras were operated in 12 locations in four study sites. Six camera traps were set up in the first survey area includes the inundated closed to the dam site, southern part of Yetwingyi village on the right bank of the river (Site I). Two camera traps were installed in the second survey area includes the downstream confluence Dodtawady River and Gohteik stream (Site II). Two camera traps were set up in the third survey area includes the Nan Kun waterfall area and the inundated area of the confluence of Nan Kun stream and Dodtawady River (Site III). Two camera traps were installed in the fourth survey area include the previously used as boat jetty on the left bank of the river near Kyauk Sone village (Site IV) for a minimum of 30 days. Cameras were placed beside of the animal trail and active 24.00 hrs with camera delay time of 10 second.

Table 2. The location of Cameras and target species

Camera Name	POINT_X	POINT_Y	Elev	Set up date	Take out date	Study site	Description
C1	96.916728	21.939457	237	2017-12-18	2018-01-16	Old boat jetty (Site IV)	Left bank
C2	96.917346	21.939329	232	2017-12-18	2018-01-16	Old boat jetty (Site IV)	Left bank
C3	96.955408	21.942878	275	2017-12-17	2018-01-16	Namkan water fall area (Site III)	Left bank
C4	96.955569	21.941311	266	2017-12-17	2018-01-16	Namkan water fall area (Site III)	Left bank
C5	96.941861	22.260119	323	2017-12-15	2018-01-19	Near Nawng Hkio Gyi area (Site II)	Left bank
C6	96.944720	22.263380	356	2017-12-15	2018-01-19	Near Nawng Hkio Gyi area (Site II)	Left bank
C7	96.894622	21.959463	526	2017-12-13	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank
C8	96.890132	21.961792	437	2017-12-12	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank
C9	96.888835	21.961750	382	2017-12-12	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank
C10	96.896853	21.956126	497	2017-12-13	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank
C11	96.888524	21.959651	246	2017-12-12	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank
C12	96.887728	21.960751	263	2017-12-12	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank

5. RESULTS

A total of 11 mammals and five bird species were recorded from 11 camera traps from 19 Dec 2017 to 18 Jan 2018. Base on camera trapping result, Camera 1 (C1) recorded the highest number of species and Camera 5 (C5) didn't record any species.

Camera 1 (C1)

A total of five mammal and five bird species were recorded in C1. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Green Peafol was recorded as Endangered (EN), Leopard was captured as Vulnerable (VU), River Lapwing was carried out as Near threatened (NT) and Rhesus Macaque, Leopard Cat, Red Juntjac, Blue-whisteling Thrush, Red Junglefowl and Ashy Woodpigeon were conducted as Least concern (LC).

Camera 2 (C2)

A total of four mammal and two bird species were recorded in C2. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Green Peafowl was recorded as Endangered (EN) and Rhesus Macaque, Leopard Cat, Red Muntjac and Red Junglefowl were conducted as Least concern (LC).

Camera 3 (C3)

A total of two mammal species were recorded in C3. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Red Muntjac was conducted as Least concern (LC).

Camera 4 (C4)

A total of five mammal species were recorded in C4. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Chinese Serow was carried out as Near threatened (NT) and Small Asian Mongoose and Leopard Cat as Least concern (LC).

Camera 5 (C5)

Camera 5 (C5) didn't recorded any species and the pictures colour were also uncorrected.

Camera 6 (C6)

A total of two mammal species were recorded in C6. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Small Indian Civet and Leopard Cat as Least concern (LC).

Camera 7 (C7)

A total of four mammal species were recorded in C7. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Chinese Serow was carried out as Near threatened (NT) and Rhesus Macaque, Leopard Cat and Malayan Porcupine were conducted as Least concern (LC).

Camera 8 (C8)

A total of two mammal species were recorded in C8. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Rhesus Macaque and Malayan Porcupine were conducted as Least concern (LC).

Camera 9 (C9)

A total of two mammal species were recorded in C9. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Rhesus Macaque and Red Muntjac were conducted as Least concern (LC).

Camera 10 (C10)

A total of two mammal and five bird species were recorded in C10. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Rhesus Macaque was conducted as Least concern (LC).

Camera 11 (C11)

A total of three mammal and one bird species were recorded in C11. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Rhesus Maacaque, Malayan Porcupine and Red Junglefowl were conducted as Least concern (LC).

Camera 12 (C12)

A total of four mammal species were recorded in C1. According to the IUCN Red List of Threatened Species. Version3.1. <www.iucnredlist.org>. Downloaded on **01 May 2017**.), Rhesus Macaque, Leopard Cat, Red Muntjac, and Malayan Porcupine were conducted as Least concern (LC).

Table 3. Recorded Mammal species in Camera trapping

Order	Family	No	Scientific name	Common name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	IUCN
DERMOPTERA	**CERCOPITHECIDAE**	**1**	*Macaca mulatta*	Rhesus Macaque	✓	✓					✓	✓	✓	✓	✓	✓	LC
CARNIVORA	**VIVERRIDAE**	**2**	*Viverricula indica*	Small Indian Civet						✓							LC
CARNIVORA	**HERPESTIDAE**	**3**	*Herpestes javanicus*	Small Asian Mongoose				✓									LC
CARNIVORA	**FELIDAE**	**4**	*Panthera paradus*	Leopard	✓												VU
CARNIVORA	**FELIDAE**	**5**	*Prionailurus bengalensis*	Leopard Cat	✓	✓		✓		✓	✓						LC
ARTIODACTYLA	**TRAGULIDAE**	**6**	*Muntiacus muntjak*	Red Muntjac	✓	✓	✓						✓			✓	LC
ARTIODACTYLA	**BOVIDAE**	**7**	*Capricornis milneedwardsi*	Chinese Serow				✓			✓						NT
RODENTIA	**HYSTRUIDAE**	**8**	*Hystrix brachyuran*	Malayan Porcupine							✓	✓			✓	✓	LC
		9		Bat spp	✓	✓		✓									-
		10		Langur spp										✓			-
		11		Rodent spp			✓	✓							✓	✓	-

Table 4. Recorded Bird species in Camera trapping

Order	Family	No	Scientific name	Common name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	IUCN
CHARADRIFORMES	**VANELLIDAE**	**1**	*Vanellus duvaucelii*	River Lapwing	✓												NT
PASSERIFORMES	**MUSCICAPIDAE**	**2**	*Myophonus caruleus*	Blue-whisteling Thrush	✓												
GALLIFOMES	**PHASIANIDAE**	**3**	*Gallus gallus*	Red Jungle Fowl	✓	✓									✓		
GALLIFOMES	**PHASIANIDAE**	**4**	*Pavo muticus*	Green Peafowl	✓	✓											EN
COLUMBIFORMES	**COLUMBIDAE**	**5**	*Columba pulchricollis*	Ashy Wood Pigeon	✓												

Some recorded photos in camera trap

Figure 2. Leopard

Figure 3. Leopard

Figure 4. Red Muntjac

Figure 5. Small Indian Civet

Figure 6. Leopard Cat

Figure 7. Chinese Serow

Figure 8. Langur spp

Figure 9. Rhesus Macaque

Figure 10. Malayan Porcupine

Figure 11. Red Muntjac

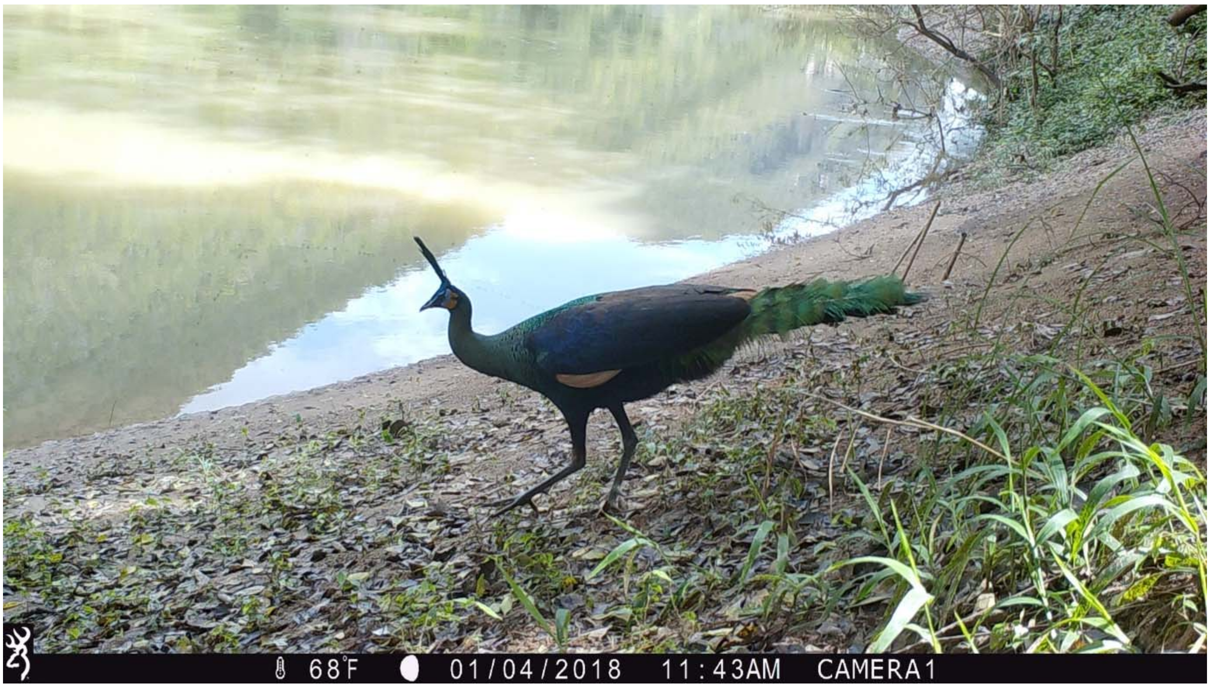

Figure 12. Green Peafowl

Figure 13. River Lapwing

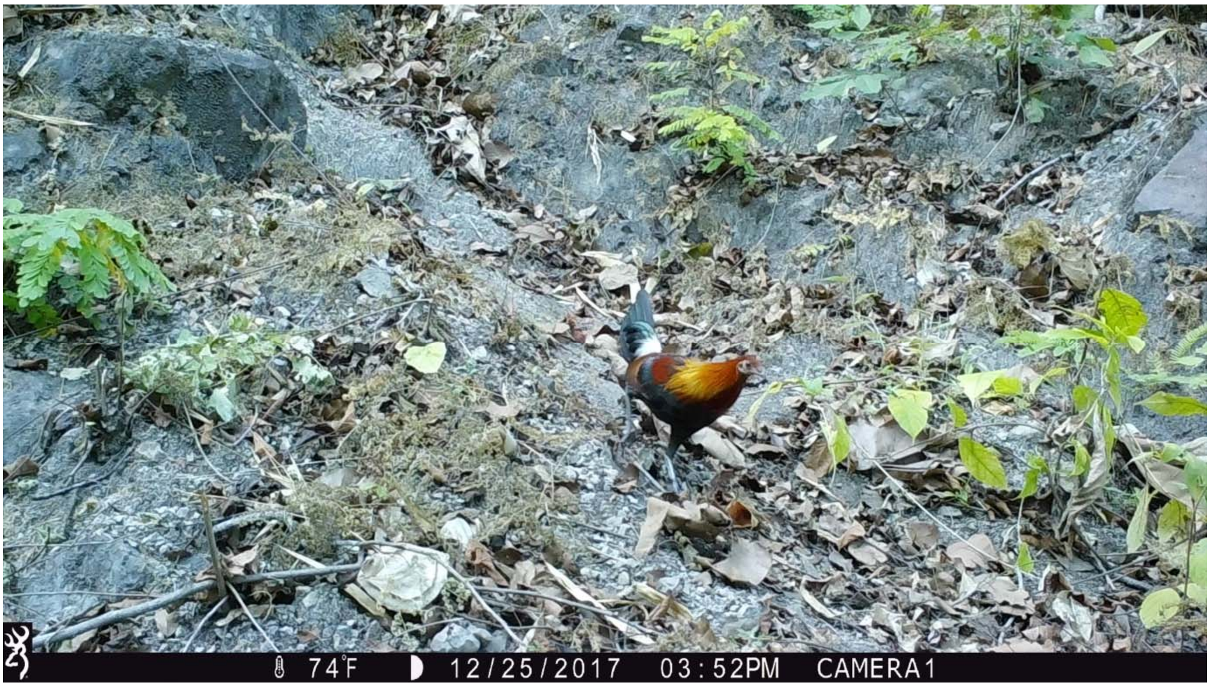

Figure 14. Red Junglefowl

Camera Name	POINT_X	POINT_Y	Elevation	Set up date	Take out date	Study site	Description	Total recorded species	
								Mammal	Bird
C1	96,916728	21,939457	237	2017-12-18	2018-01-16	Old boat jetty (Site IV)	Left bank	5	5
C2	96,917346	21,939329	232	2017-12-18	2018-01-16	Old boat jetty (Site IV)	Left bank	4	2
C3	96,955408	21,942878	275	2017-12-17	2018-01-16	Namkan water fall area (Site III)	Left bank	2	-
C4	96,955569	21,941311	266	2017-12-17	2018-01-16	Namkan water fall area (Site III)	Left bank	5	-
C5	96,941861	22,260119	323	2017-12-15	2018-01-19	Near Nawng Hkio Gyi area (Site II)	Left bank	-	-
C6	96,944720	22,263380	356	2017-12-15	2018-01-19	Near Nawng Hkio Gyi area (Site II)	Left bank	2	-
C7	96,894622	21,959463	526	2017-12-13	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank	4	-
C8	96,890132	21,961792	437	2017-12-12	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank	2	-
C9	96,888835	21,961750	382	2017-12-12	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank	2	-
C10	96,896853	21,956126	497	2017-12-13	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank	2	-
C11	96,888524	21,959651	246	2017-12-12	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank	3	1
C12	96,887728	21,960751	263	2017-12-12	2018-01-18	Near Ye Dwin Gyi area (Site I)	Right bank	3	-

Order	Family	No	Scientific name	Common name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	IUCN Status
CHARADRIFORMES	VANELLIDAE	1	*Vanellus duvaucelii*	River Lapwing	✓												NT
PASSERIFORMES	MUSCICAPIDAE	2	*Myophonus caruleus*	Blue-whisteling Thrush	✓												
GALLIFOMES	PHASIANIDAE	3	*Gallus gallus*	Red Jungle Fowl	✓	✓									✓		
GALLIFOMES	PHASIANIDAE	4	*Pavo muticus*	Green Peafowl	✓	✓											EN
COLUMBIFORMES	COLUMBIDAE	5	*Columba pulchricollis*	Ashy Wood Pigeon	✓												

Itinerary of Biodiversity Group, Camera Track Survey

Name : Biodiversity Group
Destination : Middle Yeywar Hydropower Project
Period : 14.01.2018 To 21.01.2018

Date	Location	Detail
January 14, 2018	Yangon to Kyaukgu Village	Go to Kyaukgu Village, by car
January 15, 2018	Kyaukgu Village	Discussion with village head and preparing site plan
January 16, 2018	Kyaukgu Village to Kyaukson Village	Divided by two groups, Go to Nankan water fall (C3, C4) and previous boat jetty area (C1, C2) and (C1) was changed its position.
January 17, 2018	Kyaukson Village to Naungcho	Go to Yetwingyi village and preparing camera track plan
January 18, 2018	Naungcho to Yetwingyi Village	Go to Yetwingyi site Area camera track point (C7, C8, C9, C10, C11, C12) and changed position of (C9, C10)
January 19, 2018	Naungcho to Naung cho gyi village	Go to Naung cho gyi village area camera track points (C5, C6) and changed position to right bank.
January 20, 2018	Naung cho Hotel	Data entry and analysis
January 21, 2018	Naung cho to Yangon	Reach Yangon, by car

ANNEX 3

INDIGENOUS PEOPLES REPORT

Contents

0. Introduction, Indigenous Peoples and IFC PS7

The presence of three ethnic minority groups in the vicinity of the project triggers IFC Performance Standard No. 7 on Indigenous Peoples. The three groups are Danu, Shan and Palaung (Ta-ang).

The indigenous peoples of the project area are all officially classed as ethnic minorities on the government list, and they meet all of the criteria set forth in PS7:

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
- Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture;
- A distinct language or dialect, often different from the official language or languages of the country or region in which they reside.

It will be seen that with reference to the intent of the PS as indicated in its introductory paragraph, all evidence indicates that these groups,

- are not “marginalized or vulnerable”
- their economic, social and legal status does not “limit their capacity to defend their rights to, and interest in, lands and natural and cultural resources,”
  - the groups are well-off economically, have very large tracts of land averaging, by villager estimates, a minimum of 10 acres per household. Cultural pride is evident in a wide array of popular media, and annual ethnic festivals in which all villagers participate
- and, “their ability to participate in and benefit from development,” is not restricted in any form as far as can be discerned from our investigations

Based upon information collecting visits to villages in the projects area, it is clear that they have not had their lands and resources “transformed, encroached upon, or significantly degraded.” Their languages, cultures, religions, spiritual beliefs, and institutions are intact and not under threat, and in fact appear to be growing stronger. It is highly unlikely, based upon our investigations, that they will suffer “adverse impacts associated with project development” more than non-indigenous communities (there are in fact no non-indigenous communities in the project area regardless of how it may be ultimately defined). The groups are not liable to lose their identity, culture, or the natural resource-based portion of their livelihoods, nor are they likely to be exposed to impoverishment and disease at any time in the foreseeable future.

1. Ethnic Minorities in Myanmar

The ethnic groups of Burma are usually divided into three main ethnolinguistic stocks: **Tibeto-Burman**, **Kra-Dai**, and **Austroasiatic**. In the far south among the islands of the Mergui Archipelago there are also a small number of **Austronesian** speaking Moken who traditionally live in boats, nomadic hunter-gatherers and whose livelihoods are based on the sea. The 800 or so islands of the archipelago are claimed by both Thailand and Myanmar, so their legal status and nationality in many cases remains undetermined. And in the far eastern portion of the Shan State there are several Yao (Iu Mien) villages indicating that the **Miao-Yao (Hmong-Mien)** family needs to be added to the list as well, bringing the total number of stocks to five. It has also been cited (Wikepedia – List of Ethnic Minorities of Myanmar) that Hmong Njua (Green Hmong) are present in the Keng Tung area as well, and if so then they would belong in the latter category as well.

1.1 Ethnic Groups

The official list of 135 ethnic groups is not well presented in government literature, particularly with regard to classification. Groups are lumped together based on geographical location and referred to as "national ethnic races," of which eight are recognized (Wikipedia-List of ethnic groups in Myanmar):

1. Bamar
2. Chin
3. Kachin
4. Kayin
5. Kayah
6. Mon
7. Rakhine
8. Shan

Thus the ***Shan*** category includes the Tibeto-Burman Lahu, Akha, Pa-O, and Danu; the Austroasiatic Palaung, Wa and Khmu; and the Hmong-Mien Yao. The Austronesian Moken mentioned above, also called Salone, is classed as Bama (i.e. Burmese).

For purposes of this report, and for coherence and clarity with respect to other Southeast Asian nations, the internationally accepted ethnolinguistic system of classification will be used.

The ethnolinguistic map below (Wikipedia commons, *ibid*) is a somewhat generalized but largely accurate rendering of the locations of ethnic groups in Myanmar, keeping in mind that broad categories such as Chin, Kachin, Karen, Palaung, Shan, etc. all have many subgroups whose languages are not necessarily mutually intelligible, and whose total numbers no doubt exceed the official list of 135.

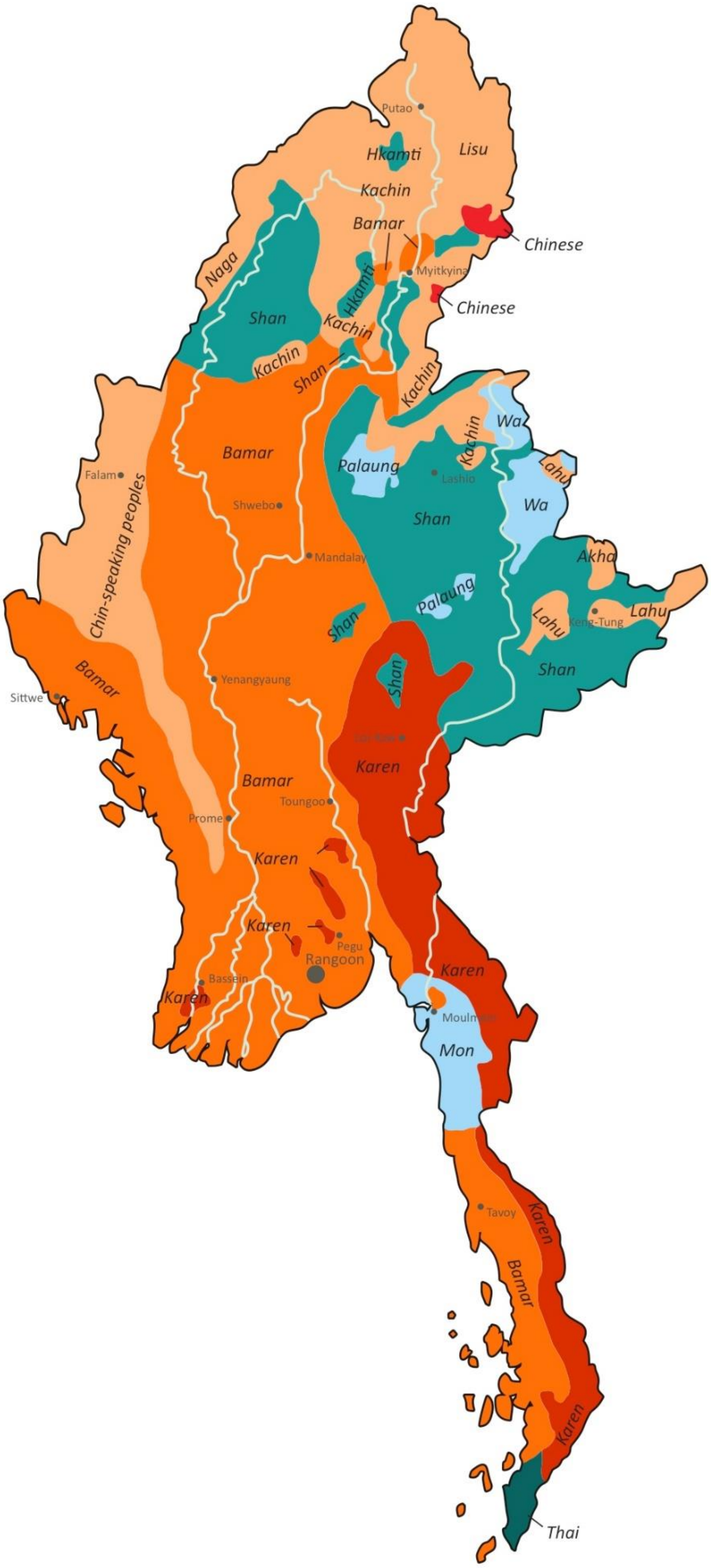

Figure 1: Map of Major Ethnic Groupings in Myanmar

1.2 Government Policy

Ethnic minorities re estimated to make up 30 - 40% of the country's total population, and so-called "ethnic states" occupy some 57% of the total land area along the international borders. Ethnic minorities are not recognized in the Constitution. Rather the term "national races" is used, though not defined by the Constitution, apparently arising from the application of the 1982 Myanmar Citizenship Law, listing 135 "national races" in its Procedures. The law includes include the Kachin, Kayah, Karen, Chin, Bamar, Mon, Rakhine and Shan ethnic groups that have settled in any of the territories included as part of the Burmese State as their permanent home from 1185 B.E or 1823 A.D. law. (Anonymous n.d.)

Political units in Myanmar are largely organised along ethnic lines. Seven states are named after the seven large ethnic groups, that is the Kachin, Kayah, Kayin, Chin, Mon, Rakhine, and Shan States. The Bamar do not have a specific state of that name, but they they remain the politically dominant ethnic group of the country, occupying especially the seven Regions (Sagaing, Magwe, Tanintharyi, Mandalay, Yangon, Ayeyarwady, and Bago). There are also six self-administered areas that are part of Regions or States, each named after the minority national race that forms the majority in the relevant area (Naga, Danu, Pa-O, Palaung, Kokang and Wa Self- Administered Areas). The rights of ethnic nationalities to representation in State parliaments is set forth in Myanmar national (*ibid*)

1.3 Self Administered Zones (SAZ)

Myanmar has a total of six Self Administered Zones (SAZs), all of which are located in the Shan State, including the disconnected portion of the State where the Khamti are dominant. One of these is allocated to the Danu, though the northern Danu who inhabit the project area are not included in the SAZ. The reasons for this are not immediately apparent other than the possibility that the northern Danu are considered to be more recent settlers and not a part of the Danu mainstream. The Danu maintain a political party but not a separatist army like the others. And although they consider themselves as separate and independent, linguistically and culturally they are closer te the ethnic Burmese than to any other ethnic group.

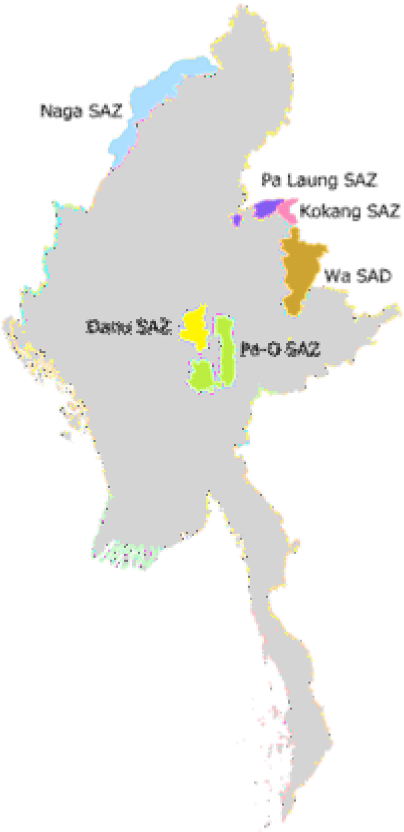

Figure 2: Map of Self Administered Zones

2. The Greater Project Area

2.1 History of the Shan State

The Shan State forms the eastern portion of the present Union of Myanmar and consists of 52 townships. The state is bounded by the Kachin State on the north, the People's Republic of China on the Northeast, Lao PDR and the Mekong River on the East, Thailand on the Southeast, Kayah State on the South, and the Mandalay Division to the west. The Salween River (Nam Khone in Shan), separates the Shan Plateau into two parts, flowing from North to South and emptying into the Gulf of Martaban, a part of the Indian Ocean. One of the notable features is Inle Lake (Nong Ang La in Shan) with its floating island gardens.

The name "Shan states" (plural) referred a group of some 46 states each with more-or less autonomous status, though some were more powerful than others. The feudal system acknowledged the rule of a "sao hpa" (Sawbwa in Burmese) in each state ("mong"), who was descended from the sky and who had the right to rule his farming subjects. The states are called "Mong" [actually /mɤŋ/ phonemically] and were organized into villages, *baan* or *maan*, as are other Tai speaking areas throughout Southeast Asia and Southern China.

The majority were ethnic Shan, with some notable exceptions such as Kokang (a small Chinese group), Pwo Karen (Pa-O), Nagas, Wa, Kachin, and Palaung (Ta-ang). The Danu-speaking area surrounding the MYW project and extending further south was never considered one of the states, though in part it was more recently granted status as an SAZ (Self-Administered Zone) in 2010.

Other ethnic groups found within the Shan states are Lahu, Akha, Lisu, Wa and many varieties of Ta-ang. The Tai-speaking Khamti in the extreme northwest of the country and the Kheun of Keng Tung (the eastern Shan State) are usually counted as types of Shan, with the exception of the Lue of Meuang Yong in Keng Tung State who are considered a separate group.

Following independence and the establishment of the Union of Burma all of these areas were grouped together under the singular designation of “Shan State.”

Historically, the most powerful Shan polities were located at Muang Mao in the north and at Ava in the south. The Ava Kingdom controlled upper Burma from 1364 until 1555 when it was conquered by the Burmese from Taungoo. It was located at the juncture where the Nam Tu (Myitnge) river flows into the Irrawaddy, just southeast of Mandalay, not far south of the proposed MYW dam site.

The Shan system of writing belongs to a class of Indic-based writing known as Lik scripts. The earliest example dates from the Tai polity of Meuang Mao in Yunnan in the 14^{th} century. Muang Mao had been in contact with the Burmese kingdom at Pagan since the 12^{th} century, so assuming a Mon or early Burmese prototype, the Lik script may have originated at that time (David Wharton p.c.). Note that the Burmese script has a separate origin, based upon the Old Mon system of writing.

As mentioned, Shan rulers of the states or fiefdoms were referred to as “Sao Pha” or “Chau Fa” (depending on the dialect). The literal translation is ‘sky-lord’, a reference to the belief that the original founders were heavenly beings who descended from the Buddhist heaven known as Tavatimsa. The elaborate clothing and regalia of the Shan princes, studded with gems and unearthly designs is a testament to that notion (Conway 2006). The idea of feudal lords being descended from heaven is not peculiar to the Shan however. Such ideas are found across a wide Tai-speaking area, beginning with the Tai Dam or Black Tai whose ruling nobility of the Lo lineage have their own separate heaven called Lian Phane to which they return after death. The “Chau Fa” title is found also among the Lue as well and in a continuum across northern Burma all the way to Assam.

In the MYW Project area, ruling Sao Phas of Lawksawk have been chronicled at least as far back as the 18th century:

Lawksawk Sabwas

- Hkun Sam Lik 1791–1811
- On Gaing 1812–1813
- Hkun Shwe Ek 1813–1850
- Vacant 1850–1854
- Sao Weng (first time) 1854–1881
- Occupied by Yawnghwe 1881–1886
- Sao Weng (second time) 1886–1887
- Bo Saing (regent) 1887
- Hkun Nu 1887–1900
- Sao Hkun Nsok 1900–1946
- Sao Hkun So 1946–1952

Chronicles of the Shan states are often fanciful and rife with mythological figures and dates that do not match with historical information that is available from other sources. For example, Mong Nai and Hsipaw claim their history begins in 519 BCE, and for Hsenwi it began in 441 BCE, and so on (Conway 2006:33). But in fact most of these feudal states can realistically date their origins to the 12th - 14th centuries, and have lists of their rulers that date from those periods. Many of the original rulers were in fact women. The genealogy of Yaungshwe, just to the south of the project area, begins in the 14th century with a prince named Si Hseng and continues without interruption until the last prince Sao Shwe Thaike whose reign ended in 1959 (Conway 2006:33).

Figure 3: Map of the Shan State

Apart from the Sao Pha who ruled a domain with absolute authority and power over life and death, there were deputies and minor princes with titles of their own. The senior consort of a prince was addressed as *chau/sao* or even *mahadewi* 'queen.' When townships began to appear under the British rule, the head of the township was given the title of *myosa* , a Burmese term translated literally as "eater of the town." (Conway 18). Shan administrators of non-Tai ethnic group areas were accorded the title of *Ngwegunhmus,* and in the Shan State Manual of 1925, eight such areas were recorded (Sao Saimong Mangrai 1965:xxv) and included such groups as Karen and Kachin.

It is generally believed that prior to the arrival of the Shan the plateau was occupied by the ancestors of Palaungic groups such as Wa and Ta-ang in the north and by various Karen peoples to the south.

In addition, the influence of the Austroasiatic Mon kingdom should not be overlooked. Having moved from what is now northern and central Thailand and establishing their first kingdom at Thaton in the 9th century, they are thought to have been the main source of culture for early Pagan, their artisans having constructed the temples and stupas there, and their orthography being the source for written Burmese. In 1752 the Mons of the briefly resurrected Hanthawaddy Kingdom captured Ava with the assistance of the French, and ended three centuries of the Burmese dynasty of Toungoo. But although there must have been considerable contact, little has been written on the relationship of the Mon and the Shan.

The Burmese king Bayinnaung conquered all of the Shan states in 1557. Although the Shan states would become a tributary to Irrawaddy valley based Burmese kingdoms from then on, the Shan Saophas retained a large degree of autonomy. Throughout the Burmese feudal era, Shan states supplied much manpower in the service of Burmese kings. Without Shan manpower, it would have been difficult, if not impossible, for the Burmans alone to achieve their much vaunted victories in Lower Burma, Siam, and elsewhere. Shans were a major part of Burmese forces in the First Anglo-Burmese War of 1824-1826, and fought valiantly—a fact even the British commanders acknowledged. (Sao Sai Mong).

After the Third Anglo-Burmese War in 1885, the British gained control of the Shan states. Under the British colonial administration, the Shan principalities were administered separately as British protectorates with limited monarchical powers invested in the Shan Saophas.

At the end of World War II, the Shan and other ethnic minority leaders negotiated with the majority Bamar leadership at the Panglong Conference, and agreed to gain independence from Britain as part of Union of Burma. The Shan states were given the option to secede after 10 years of independence. The Shan states (plural) became Shan State (singular) in 1948 as part of the newly independent Burma.

General Ne Win's coup d'état overthrew the democratically elected government in 1962, and abolished the Shan saopha system.

2.2 Population

As indicated, the Shan State itself is quite diverse including ethnic groups such as the Shan, Pa-O, Palaung, Kachin, Intha, Danu, Kokang, Wa, Lahu, Taungyo, Myoungzee, Lishaw, and Yinnet. Of these, the Shan are the largest, numbering an estimated six million (although not all live in Shan State). Estimates of the total population of Pa-O and Danu vary (due to the lack of reliable censuses), but the Danu population is usually cited as 220,000 and the Pa-O population as 600,000. There are seven SAZs in Shan

State, belonging to the Naga, Palaung, Kokang, Wa, Danu, and Pa-O. The Danu and Pa-O SAZs are located in southern Shan State and were focuses of this research. The Danu SAZ consists of two townships along the western edge of southern Shan State, with a total population of around 150,000, and the Pa-O SAZ consists of 3 non-contiguous townships with a total population of 400,000. Within both of these SAZs, the central government of Myanmar is present and performs all land management-related functions.

3. Ethnic Groups of the Project Area

3.1 Danu

3.1.1 Language and Culture

Danu belongs to Burmish branch of Lolo-Burmese, part of the greater Tibeto-Burman stock and ultimately the Sino-Tibetan superstock. It is quite close to Burmese, and is one of numerous dialects than includes Intha, Taung'yo, Tavoy (Dawei), Beik and Rakhaing (Arakan). Most of these dialects can be understood by Myanmar speakers after a few weeks exposure indicating their separation from the mainstream is not very old in linguistic terms. Danu is thought to have originated with a group of soldiers who were posted as a buffer between Pagan and the Shan States in the 18th century during the reign of King Alaungpaya, and whose territory stretches roughly from south to north between Taunggi and Mandalay. This was apparently a recognized practice. For example, when the Burmese capital was relocated from Ava to Mandalay in 1857, many troops and officials were stationed in the Shan States to monitor the goings on. And even as early as 1840 some 1,500 Burmese soldiers were posted to Mong Nai, a location just to the northeast of Inlay Lake (Conway: 37). Interestingly, this time period coincides with the dates of establishment provided by Danu villages in the project area.

In the period of 1970-72, and 1977-79, the Japanese linguist Shiro Yabu traveled to the Danu speaking areas and made some observations on their geographical distribution and language. Professor Yabu had the opportunity to work with the Danu dialect (as well as many other languages). The dialect recorded in this article is that of Pindaya, south of the MY project area.

Yabu (1981) describes Danu as a language spoken on the western edge of the Shan Plateau, in the administrative units of:

- Mogok
- Nawng Hkio [in Project Area]
- Maymyo (a hill station)
- Yassau (Lawksawk) [in Project Area]
- Ywagan

- Pintaya (Pangtara)
- Aung Ban
- Kalau

He notes that some of the areas inhabited by Danu have ruby mines, especially at Mong Long, to the north of Hsum-Hsai/Nawng Hkio.

The actual places he names as being Danu include:

- Nawng Hkio
- Hsum-Hsai (Note that this place is a district within the old Hsipaw principality, the district where Nawng Hkio is located – established in 1961)
- Mönglong (Ruby Mines)
- Lawksawk (Yassau)
- Kawng Bo
- Ye Ngan (Ywagan) (Yen Ngan)
- Ye U
- Maw (Bo)
- Pangtarn (Pintaya)
- Poila
- Aung Ban
- Maw Sön (Baw Saing)

This list is close to the Danu area defined by elders interviewed in Nawng Hkio, i.e.

- NW – Kyawk Se township
- NE – Yat Saut (Yassau) township
- W – Myot Thar township
- SW – Thar Se township
- SE – Pindaya township
- S – Aung Pan township and on to Taunggyi

Outside of the Shan State, Yabu furthermore notes areas in the Burmese lowlands where Danu people live, namely:

- Tha Ji (=Thar Se ?)
- Kyawk se

- Salaween Province (in Karen State)
- Kantarawadi (in Kayah State)
- And in the Southern Shan lowlands there are small populations at,
- He Pông
- Hsihseng
- Panglong (=Pinglong)

The Danu people themselves say there is not much variation among the dialects spoken in these areas. Most of these place names can be found on the attached Map of old Shan principalities (above). That the Danu distribution overlays the boundaries of the old principalities is good evidence of their relatively recent arrival, as historically they do not have a principality of their own as do the Shan, Wa, Palaung, Kachin, Kokang, etc.

In the well-known Gazetteer of Scott and Hardiman, it is noted that there are two kinds of Danu; Rhan Danu and Burman Danu, and speculates that the Shan Danu speak Shan as well as Danu. (Rhan = Shan). (note: This we did not find to be the case in any of the villages visited.)

He also notes two Burmese sources that claim the Danu are mentioned in Burmese "inscriptions," but no details are provided.

The two theories of origin Yabu heard, were

1. Related to Pa-O and /or Shan
2. Moved into the area from the Burmese lowlands

But whatever the case, he notes, Danu is definitely Burmese and the similarity of Danu, Taung'Yo and Intha dialects of Burmese is noted. But Although there may be some linguistic influence on Danu from Shan and Pa-O, Yabu notes that this cannot have been very big.

The findings of Yabu are consistent with those of our SIA research investigation. Caution is advised with place names, as there are often two names for the same location, at least in Romanized form. The total population of Danu at the time of Yabu's studies he estimates at between 70,000 and 100,000. In conclusion, Yabu notes that the northern and southern varieties of Danu differ slightly, but both are definitely Burmese and are closely related to Taung'yo and Intha. That is, they are not related to Shan or to Pa-o as some people used to believe. The tones are like Burmese.

In our brief interactions during the field trip, we noted that the Danu always take the one-down self-effacing position, claiming unsophistication, lack of education, honesty, hardworking, and peacefulness as their cultural traits. Their warrior past, if such turns out to be the case, comes to the surface when discussing hunting and stories pour forth with great animation. Guns used are all homemade.

With great community spirit and solidarity, the Danu make their own roads, do their own construction, collectively help each member of the community with their house building, and so on.

Ethnic pride and identity are in evidence everywhere. They have their own flag that flies in all important locations in the village. They remain in touch with the Danu further south, the Pindaya Danu, and have adopted their dress and festivities, and have begun their own, Northern Danu, celebration, just prior to the one in Pindaya.

The Danu perhaps preserve more of the old style SEA bilateralism with matrilocal residence. This seems very much in evidence in the villages visited

Relationships with Shan are said to be friendly and symmetrical, but this needs further investigation, since many of the villages have Shan names (eg Taung Kam) as if the original Shans were displaced.

The distribution of Danu roughly along the western border of the Shan State between Taunggyi and Mandalay supports the idea that the Danu are the descendants of soldiers placed here as a buffer between the Shan States and the Burmese King. (18^{th} c King Alaungpaya 1714-1760, founder of the Konbaung Dynasty). Since the Shans allegedly joined Alaungpaya in the retaking of Ava from the Mons this is a bit strange – although the Shans had controlled Ava at an earlier date.

It is also a possibility, hinted at by many of the Danu interviewed, that if indeed the king did order the soldiers to remain as a buffer, they would have sought wives from among local Shan women, and given the higher prestige of the Burmese language, the language gradually shifted to what was to become Danu, assisted perhaps by the bordering of that population with ethnic Burmese speakers. But this hypothesis does not fit the situation well, given the relative high status of Shan women and the fact that children tend to learn their mother’s language first. Also, as Yabu notes, there seems to be little or no influence from Shan on the Danu language. The Danu group must have been isolated to some degree from the Bama mainstream in order to develop separate dialectal features.

It does seem clear that the Northern Danu of the project area split off from the southern group approximately 150 years ago (mid-19^{th} c.), or four generations, the villagers queried provided much the same estimated age for their respective villages. Many also related that their grandparents or great grandparents were Shan, though oddly no linguistic traces of this remain.

At a meeting with Shan representatives in the Township Head of Nawng Hkio Attempts to speak with the Shan alone were thwarted, ostensibly by the Township administration, by inviting three senior level

Danu elders to the meeting which had the effect of inhibiting the Shan from speaking freely due to ethnicity and to age (*keng chay*). A Shan woman teacher who was part of the group observed wryly that the Danu version of history provided to us was an oral one without documentary evidence. Perhaps she was alluding to the lack of a written language or literature for Danu compared to the abundant wealth of Shan written historical and literary documents. But for our purposes, the Shan version of the area's history is still lacking.

The Danu at this meeting said the Danu settlement of the territory took place via migrations from the south (apparently Pindaya), and that the Danu gradually settled in Shan villages, intermarrying, until all of the Shan began speaking Danu, as evidenced by the fact that many Danu have Shan grandparents. This is apparently the myth that is being perpetuated and explains why so many villages have Shan names. But on the contrary, Danu speakers all claim, rather too gladly, that they do not speak a word of Shan, and there are indeed no traces of Shan sub-strata in the Danu language which would support their version of settlement.

For the time being this remains unresolved and more information is needed. The greater Project Area consists of the two townships of Nawng Hkio and Lawksawk – defined by nearest tracks. For Nawng Hkio we have no historical information on the Shan side, but for Lawksawk we have a list of Shan ruling princes since 1791 – see above.

Note: Danu the Burmish group, should not be confused with Danau, a Palaungic group.

The Danu Story of the Archer Prince

A prince of Yawng Shwe was out hunting in the forest nerar the entrance to Inle Lake, not far from Pindaya caves. There is another lake there called Poke Ta Loak. In this lake, seven angels from Kaw Loi (Kayah State – formerly Hwe Thar Li) liked to bathe there every day. One day they were having such a good time that it got to be too late, and they could not return home. Looking around, they discovered a large cave on the western side of the lake and decided to spend the night there.

At the time there was a giant spider that happened by, and spun a web that covered the entrance to the cave. When morning came, the angels found they were trapped in the cave by the spider's web and could not get out. They began to shout for help.

The prince heard the cries for help and went to see what was happening. Seeing the gigantic spider he shot it with an arrow and then proceeded to free the angels. In gratitude, the angels gave their youngest sister to the prince. They fell in love and he took her back to his kingdom where they lived together forever. His name was Thu Danu.

(NB: The name *Danu* is from Sanskrit ***dhanu***, the word for the long bow used in warfare and hunting and borrowed into many languages in Southeast Asia as a literary form.)

3.1.2 Status with respect to Performance Standard 7

The Danu people visited:

- Perceive themselves as honest, hardworking, farmers
- Are economically well-off and self-sufficient
- Language not the same as Bama, southern Danu is more different
- Have own traditional dress
- Have own singing, dances, music
- Have ethnic pride, belong to the Danu Political Democracy Party, but the northern Danu are not part of the Danu SAZ (established in 2010)
- Each village has its own cultural group with dancing competitions
- Have the same origin myth of the Archer Prince Thu Danu

The Danu are officially classed as an ethnic minority among the groups listed by the government, and they meet all of the criteria set forth in PS7:

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
- Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture;
- A distinct language or dialect, often different from the official language or languages of the country or region in which they reside.

However, with reference to the intent of the PS as indicated in the introductory paragraph, all evidence indicates that the Danu,

- are not “marginalized or vulnerable”
    - the Danu are the dominant ethnic group in the project area both numerically and due to their close ethnic and linguistic affiliation with the Myanmar majority of the country
- their economic, social and legal status does not “limit their capacity to defend their rights to, and interest in, lands and natural and cultural resources,”

  - the Danu are well-off economically, have very large tracts of land averaging, by villager estimates, a minimum of 10 acres per household. Cultural pride is evident in a wide array of popular media, and annual ethnic festivals in which all villagers participate
- and, "their ability to participate in and benefit from development," is not restricted in any form as far as can be discerned from our investigation

Based upon information collecting visits to a sample of seven widespread Danu villages in the projects area, it is clear that the Danu have not had their lands and resources "transformed, encroached upon, or significantly degraded." Their languages, cultures, religions, spiritual beliefs, and institutions are intact and not under threat, and in fact appear to be growing stronger. It is highly unlikely, based upon our investigations, that they will suffer "adverse impacts associated with project development" more than non-indigenous communities (there are in fact no non-indigenous communities in the project area regardless of how it may be ultimately defined). The Danu are not liable to lose their identity, culture, or natural resource-based livelihoods, nor are they likely to be exposed to impoverishment and disease at any time in the foreseeable future.

3.2 Shan

3.2.1 Language and Culture

Technically Shan belongs to the Be-Tai sub-family of Kam-Tai family under the Kra-Dai ethnolinguistic stock. Its contemporaneous sister states and statelets include the Ahom kingdom of Assam, the Lue Sip-Song Panna, the Black Tai Sip-Song Chu Tai, and more fully developed kingdoms of Laos and Siam. All of these belong to the Southwestern branch of Tai. Related languages often considered as Shan dialects include Khamti, Phakhe, Khamyang, Turung, Nora, and Aiton spoken in northwestern Burma and Assam respectively.

The Shan are an old and well-established ethnic group. Their current status as "minority" belies their historical position as a state nearly rivaling that of Burma itself. What is now called the Shan State was formerly a group of principalities ruled by Saophas (or Sawbwas) since the 13th century. Today that includes a territory covering nearly one-third of Myanmar. Shan is a written language with an old literature both religious and secular. It is worth mentioning that the Chinese invasion of 1765-9 used the Nam Tu river as their main route through the Shan States to attack Ava.

Despite being subjugated by the Burmese king Bayinnaung in 1557, the Shan saophas (or chau fa, depending on the dialect) remained largely autonomous. When, after the Third Anglo-Burmese War in 1885, the British gained control of the Shan states, Shan principalities were administered separately as British protectorates, but still with a degree of power accorded to the saophas.

After World War II, the Shan and other ethnic minority representatives negotiated with the majority Bamar and agreed to independence from Britain to become the Union of Burma in 1948. The first president of the Union, Sao Shwe Thaik, was in fact a Shan prince from Yawnghwe. The Shan states were given the option to secede after 10 years of independence which ultimately they did not exercise, and the Shan States [plural] became Shan State in 1948, a part of independent Burma. But the Shan Saopha system was not abolished until after Ne Win's coup d'état in 1962.

Thus while in microcosm Shan villages are few in relation to Danu in the greater project area, in the Shan state where the project is situated, the Shan are the overwhelming majority. In the one village visited where the Shan comprise a considerable percentage percent of the population, Nawng Hkio Gyi, the Shan appear to dominate the village administration. The village has a thriving and modern mechanized agricultural system with an advanced action program of conservation complete with protected forests and lakes where fishing and hunting are prohibited, and a reforestation program (the only village visited so far to have done this). They also have functioning schools, a health clinic, a large well-cared for temple, and a language preservation policy wherein all children learn how to read and write the Shan language in addition to Burmese. Indeed it would be hard to imagine how an outside development program could improve upon the existing system except perhaps providing a better road system.

3.2.2 Status with respect to Performance Standard 7

As with the Danu, the Shan people visited:

- Are economically well-off and self-sufficient
- Possess a distinct spoken and written Language distance from Bama
- Have their own traditional dress and material culture
- Have their own singing, dances, music and ceremonies
- Have ethnic pride, and are voice their opinions openly to the government
- Have a considerable historical and literary heritage dating from the 13th century

The Shan are officially classed as an ethnic minority among the groups listed by the government, and they meet all of the criteria set forth in PS7:

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;

- Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture;
- A distinct language or dialect, often different from the official language or languages of the country or region in which they reside.

However, with reference to the intent of the PS as indicated in the introductory paragraph, all evidence indicates that the Shan,

- are not "marginalized or vulnerable"
  - while the Shan are not the dominant ethnic group in the project area they do have considerable political and administrative authority in the villages shared with Danu
- their economic, social and legal status does not "limit their capacity to defend their rights to, and interest in, lands and natural and cultural resources,"
  - the Shan are well-off economically, have very large tracts of land averaging, by villager estimates, a minimum of 10 acres per household. Cultural pride is evident in a wide array of popular media, and ethnic festivals in which all villagers participate
- and, "their ability to participate in and benefit from development," is not restricted in any form as far as can be discerned from our investigation

Based upon information collecting visits to a sample of seven widespread Danu villages in the projects area, it is clear that the Shan have not had their lands and resources "transformed, encroached upon, or significantly degraded" within living memory. Their languages, cultures, religions, spiritual beliefs, and institutions are intact and not under threat. It is highly unlikely, based upon our investigations, that they will suffer "adverse impacts associated with project development" more than non-indigenous communities (there are in fact no non-indigenous communities in the project area regardless of how it may be ultimately defined). The Shan are not liable to lose their identity, culture, or natural resource-based livelihoods, nor are they likely to be exposed to impoverishment and disease at any time in the foreseeable future.

3.3 Palaung (Ta-ang)

3.3.1 Language and Culture

Palaung, is an exonym applied to this group by the Burmese, and the general term preferred by the groups themselves is Ta'ang. This is a recently adopted political term, as there are said to be between 13 and 17 subgroups, whose languages are not all mutually intelligible. They prefer politically to be seen as speaking with a single common voice. In fact Ta-ang is also the name of a specific subgroup of Palaung. In the northern Shan State the Ta-ang (Palaung) have their own SAZ (see map) and a liberation army.

Internal Ta'ang diversity has also caused problems in the adoption a written language that can be understood by all dialects. The Palaung are thought to have predated the Shan in much of the area of the Shan State.

Ethnolinguistically, Palaung belongs to the Palaungic Branch of Austroasiatic, considered by some to be related to the Khasian Branch of Megdalaya in northeastern India. Palaungic includes several main groups, including Danau, Palaung, Riang, Angkuic, Lamet (Ramet, Xmet), and Waic (Plang, Lawa, Wa).

A family tree showing the relationships of the various groups to each other is shown here:

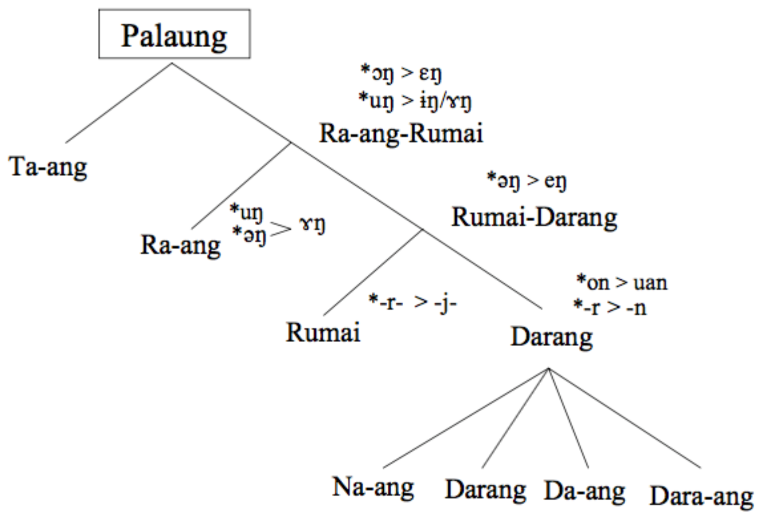

Figure 4 - Palaung Subgroups based on linguistic criteria (Ostapirat)

These groups are widely distributed around the Shan State, though their point of origin is thought to be in the north near the Chinese border. There are also Palaung languages spoken in Yunnan and Thailand. The Palaung in the vicinity of the project appear to belong to the Darang subgroup in the above phyletic tree.

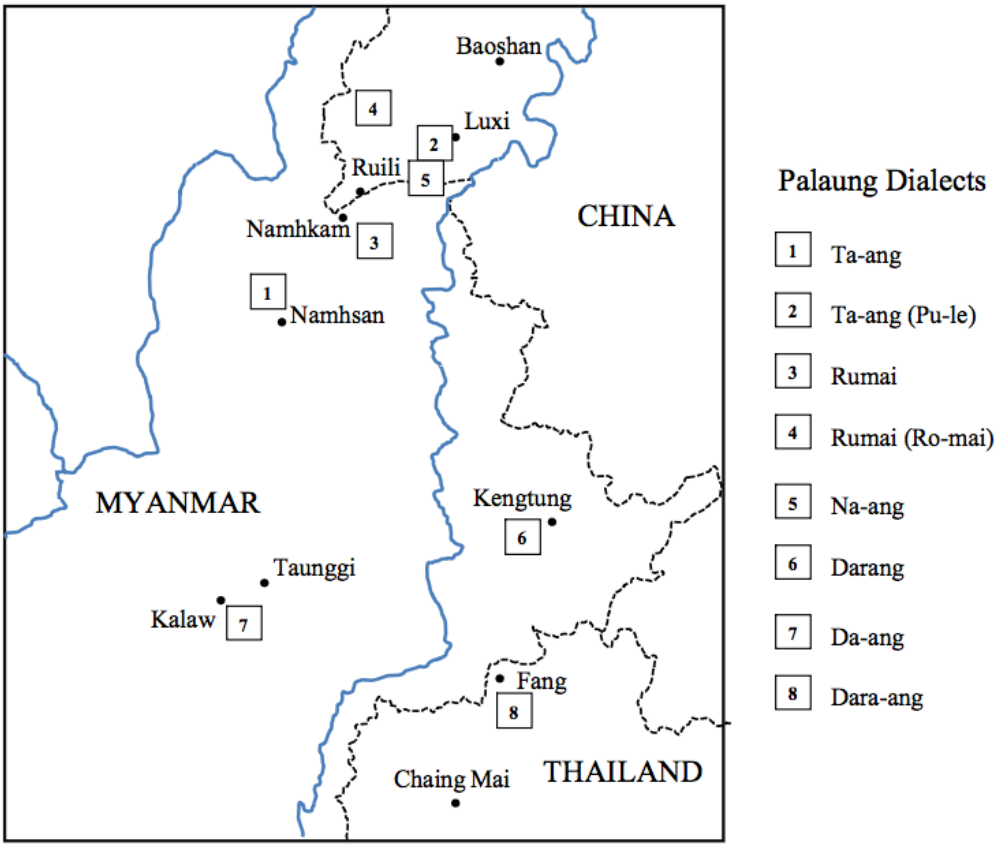

Figure 5 - Map of locations of Palaung groups (Ostapirat)

In the greater project area there are six Palaung villages in Kyawk Ku track of Lawksawk township on the left bank. These have so far not been included in the project preparation work. Another village, Nawng Yin, is located two kilometers southeast of Pin Ping and was said to have moved here from Yassau (Lawksawk) at the same time as the Danu in the mid-19th century. In addition to education in the government schools which is in Burmese, the Palaung villages visited have literacy programs in their own language, using a modified from of Shan or Lik alphabet.

There has been some involuntary relocations of this group from areas further north where armed resistance to the government was taking place until recently, but the villages in the project area were not a part of this process.

Long ago Leach (1960) noted the Palaung or Ta'ang represent an exception to long held theories regarding state development in Southeast Asia, and upland-lowland ethnic relationships. As noted in Takahiro and Badenoch (2013):

> *The lowland model is characterized as governed by hierarchical political structures, supported by high-productivity wet- rice cultivation, organized by non-unitary descent, dedicated to*

> *Buddhism, and displaying a modest level of bilingualism. The contrasting upland model has egalitarian governance, shifting cultivation, unitary descent, animism, and high levels of multilingualism as its defining characteristics.*

The Palaung break this pattern. They have been Buddhists for hundreds of years, are proficient in the use of written religious texts, and some observers have ventured they are even more devout than the Shan. Their prosperous economy is based on tea which is likened to the position of rice among the Shan, and has allowed them to interact with the Shan on more or less symmetrical terms. And according to their own legends their Buddhism came directly from India and is hence more pure than that of the lowlanders. But all indications are that in reality Buddhism was received by the Palaung in the 16th century at the same time as the Shan - not necessarily from the Shan although the two forms are very much alike.

Leach's characterizations have been shown over the years to be somewhat overly rigid, but he has been lauded for demonstrating that ethnicity is a highly flexible and ever changing type of social phenomena. However the Shan-Palaung relationship does not fit Leach's pattern of social oscillation between democratic and autocratic, but rather developed into something more stable.

This is made abundantly clear in one little known fact, that one of the principalities of the Shan States was in fact Palaung – that of Taung Peng. It was in fact a mountain kingdom, something that was not supposed to be possible. In all other respects, this state resembled the Shan model, and was ruled by a Palaung Sawbwa. At one point in history, Taung Peng paid its tribute directly to the Burmese court at Ava rather than via the Shan. In 1947, when the council was held to form the Union of Burma, alluded to above, the representative of the Shan states was indeed the Palaung prince Hkun Pan Tsing, the last Sawbwa of Taung Peng. (Takahiro and Badenoch 2013).

Although not many Palaung villages near the project area have been visited by the consultants, it is clear that the Palaung or Ta-ang do **NOT** fit the typical Mon-Khmer stereotype of remote upland minority dominated or enfeoffed by Tai overlords.

3.3.2 Status with respect to Performance Standard 7

No adverse impacts on land, traditional livelihoods, culture, or legal rights, were identified. The Palaung are on an equal status economically and socially with Shan and Danu.

4.0 Conclusions

In effect, no adverse impacts on Indigenous Peoples or their indigeneity have been identified. Households sampled in 7 villages have average estimated household incomes raging from 3,200,000 kyats (USD 2,005) to 7,750,000 kyats (USD 5,580), well above the national average which in 2011 was calculated by Harpers Index at $459. (Gross National Income (GNI) which is not completely comparable in 2015 was calculated by the World Bank at $1,270.)

4.1 General Requirements

The Indigenous Peoples identified in this report, as per PS7, refer to distinct social and cultural groups possessing the following characteristics:

- Self-identification as members of a distinct indigenous cultural group and recognition of this identity by others;
- Collective attachment to geographically distinct habitats or ancestral territories in the project area and to the natural resources in these habitats and territories;
- Customary cultural, economic, social, or political institutions that are separate from those of the mainstream society or culture; or
- Possess a distinct language or dialect, often different from the official language or languages of the country or region in which they reside.

In the cases of Shan and Palaung distinct written languages are used and taught in addition to the national language. IN the case of Danu, the language, though distinct, is considered by linguists to be a dialect of Burmese and as such, they do not possess a separate written language.

Villagers consulted in the locations visited by the team are willing participants in discussions of potential environmental and social impacts, and the dialog remains open to further consultations as needed. So far, impacts on natural resources and livelihoods are very minimal as villages are not located close to the river do not cultivate areas in the river valley due to the steepness of the slopes. No relocation of villages or village lands is envisioned, and critical cultural heritage is not effected. Archaeological sites are so far absent, but see Annex II for this potential.

The need for FPIC at this time is therefore minimal.

Probably the greatest social impacts will be felt in the villages that will host the construction camp(s) and this will need to be monitored carefully when plans become finalized.

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Annexes

Annex I – Villages Visited

The following locations were visited during a brief 5-day stay in the townships of Nawng Hkio and Lawksawk.

Village No 1 – Nawng Hkio Gyi

Belongs to the Nyan Taw Village Track, a cluster of 4 villages

Half Shan – Half Danu

Village No. 2 – Nawng Lin

Belong to the Me Pok Village Track

Danu

Village No. 3 – Me Poke

Head of the village track

Danu

Village No. 4 – Pin Ping

(Is Kyauk Ku the village track??)

Danu

Village No. 5 – Thar Si

(Also Kyauk Ku Track ?)

Danu

Village No. 6 – Phet Yin Gone

Kyauk Ku Village Track

Lawksawk Township

Danu

26 (24?) villages in this track

- including 12 Danu
- 6 Shan
- 6 Palaung

Village No. 7 – Yae Twin Gyi

Head of Village Track

Danu

No. 8 – Nawng Hkio Township

Meeting with Shan and Danu leaders

No. 9 – Inn Wine Village

Palaung sample village (not in project area)

Annex II – The likelihood of archeological remains in caves along the Myitnge River (Nam Tu River)

Burmese archaeologists look upon their prehistory as being composed of seven periods based upon remains found in various parts of the country, they include:

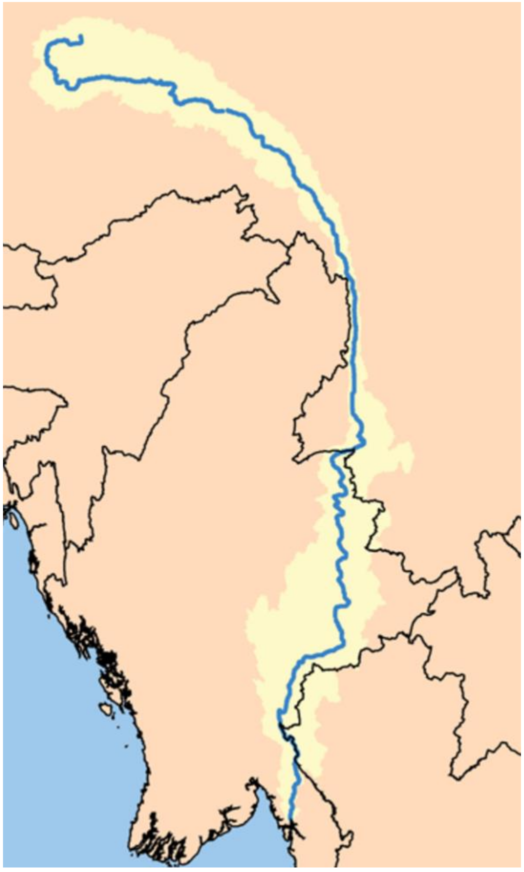
Dates	Description
750,000- 275,000 years BP	Lower Palaeolithic men of early Anyathian culture (*Homo erectus*) lived along the bank of the Ayeyawaddy river.
275,000-25,000 years BP	Lower Palaeolithic men of late Anyathian culture
11,000 BCE	Upper Palaeolithic men (*Homo Sapiens*) live in Badah-lin caves which situated in Ywagan township in southern Shan States.
7,000 - 2,000 BCE	Neolithic men live in central Burma, Kachin State, Shan States, Mon State, Taninthayi Region, and along the bank of the Chindwin and Ayeyarwaddy rivers.
1500 BCE	Earliest evidence of copper and bronze works, rice growing, domesticating chickens and pigs in Irrawaddy valley
500 BCE	Iron-working settlements south of present-day Mandalay
200 BCE	Pyu people enter the Irrawaddy valley from Yunnan

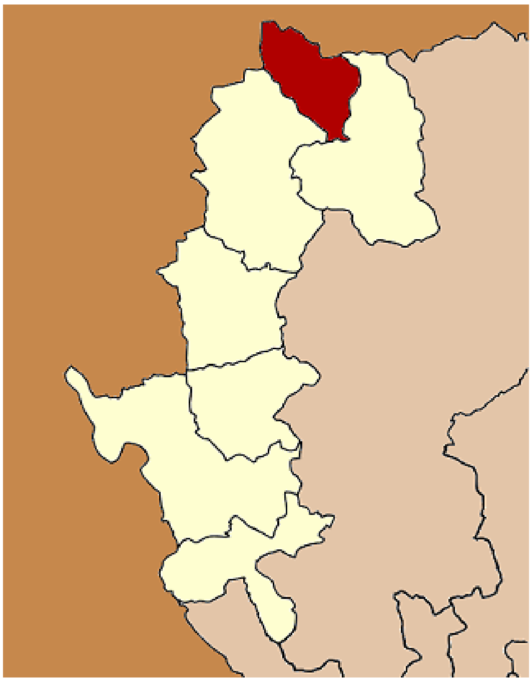
Figure 6: Prehistoric periods of Burma

(source: https://en.wikipedia.org/wiki/Prehistory_of_Myanmar#cite_note-rmc-1-1)

A number of the finds used for this classification are found in the Shan State. Note especially the third and fourth periods.

It is not known whether archaeological exploration has been carried out in the caves located inside the valley of the Nam Tu River. This is considered relevant because of the presence in adjacent areas of Laos and Thailand of extensive Hoabinhnian finds have been discovered in caves. The best known of these is the Spirit Caves located in Mae Hong Son Province, Thailand, excavated by by Chester Gorman (1970) immediately adjacent to the Shan State and falling within the watershed of the Salween. The project site on the Nam Tu is only a few miles from the watershed divide that separates the Salween from the Irrawaddy.





Figur7: Salween watershed and Spirit Cave location (Source: Wikipedia)

The Spirit Cave finds are dated at between 12,000 – 7,000 BP and may contain evidence of early domesticated agriculture although this claim is highly controversial. The distance between Mae Hong Son and the project area is approximately 150-170 miles. DNA from Hoabinhnian sites has recenly been shown to be identical to that of the nigrito Andaman islannders.

Although the link of Spirit Cave to the caves along the Nam Tu is purely speculative, substantial neolithic finds were discovered in the Padah-Lin caves near Taungyi only a short distance from the project area (Aung Thaw 1969). Furthermore, these finds share almost the same time depth as those in the Spirit Cave mentioned above, in this case 13,000 BP (compared to 12,000 BP for Spirit Cave). Both dates were based on radio-carbon methods using bone and charcoal. The assemblage includes over 1,600 stone artefacts as well as many pieces of bone and red ochre. The stone artefacts are clearly Hoabinhnian as well and include unifacial choppers, bifacial chopping tools, perforated stone rings, adzes and scrapers. That is, again, very similar or identical to the assemblage at Spirit Cave. The Padah-Lin caves are now tentatively approved as a UNESCO World Heritage site.

ANNEX 4

VILLAGE PROFILES

Table of Contents

Village Profile of Nawng Lin

Population

Based on the Household Baseline Survey, where 90 (33%) of the total of 273 households of Nawng Lin were included in survey, data shows the following:

- There are 415 Danu people with 201 (48%) female and 214 (52%) males with a lone Bama male
- 15.4% are children below the age of nine
- 18% are between 10-18 years old
- 55% are in the productive years between 19-54 years old. Of which, 89 females are in their reproductive years.
- 12% are 55 years old and above
- Average household size is five
- 72 (8%) of the surveyed population have no education and most of these are females with 10% while the males are 7%
- 293 (70%) of the surveyed population have attained primary education between Grades 1-5
- Where 33.4% are females
- Only 19 (4.6%) have reached middle school which is between Grade 6-9. Where 3.4% are females
- Only 3 (0.7%) have proceeded to high school and 3 (0.7%) have gone further to university studies.
- 25 (6%) have gone through monastic education where 22 are males.
- 310 (75%) of the surveyed population are farmers while 24.3 % are unemployed or dependent since most of them are students and children.
There are 5 persons with disabilities in this village

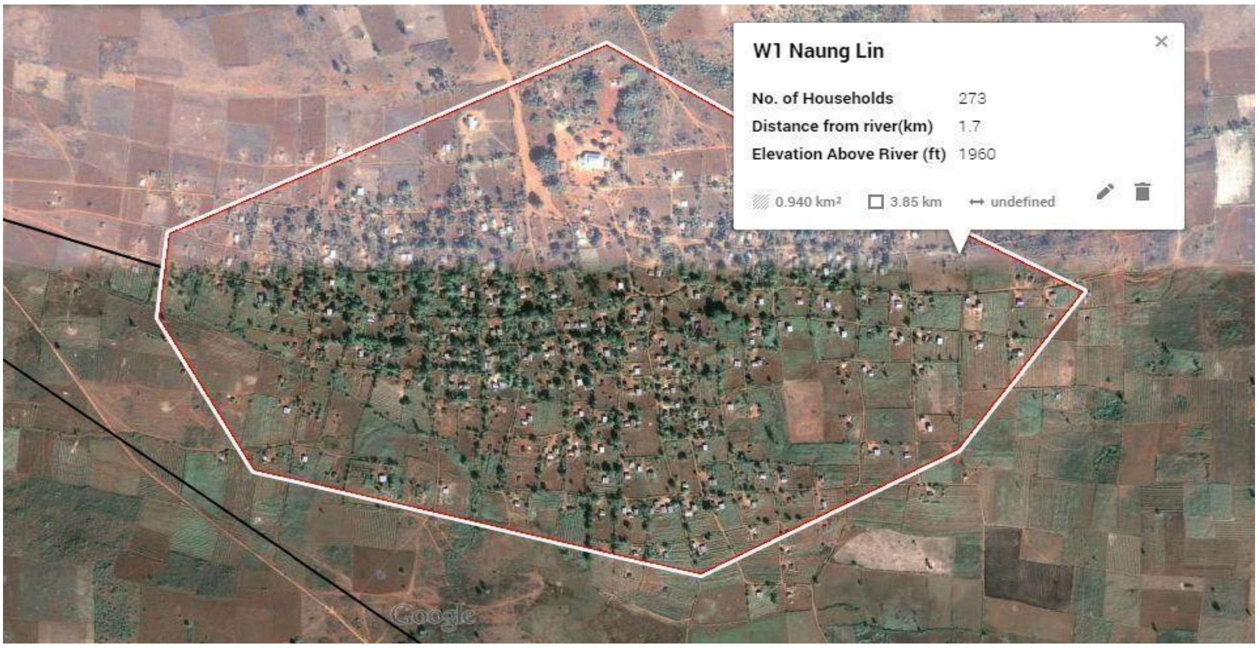


Figure 1: Satellite image of Nawng Lin Village

The population sample of Nawng Lin revealed only one person not belonging to the Danu group – he was Burmese or Bama. The population by age and household size are presented in the tables below.

Table 1: Population of Nawng Lin by age group

Age Group (years)	Female (number of persons)	Male (number of persons)
0-9	31	33
10-18	35	40
19-27	38	39
28-36	20	34
37-45	31	20
46-54	19	26
55-63	15	14
64 and above	12	9

Table 2: Population of Nawng Lin by household size

Age Range	Number of Persons
1-2	4
3-4	33
5-6	43
7-9	9
10+	1
Grand Total	**90**

Gender

Of the 90 household sample, only one household was reported to have a female household head. Other information regarding gender is presented in the tables below.

Table 3: Education levels by gender at Nawng Lin

Education Level	Female	Male	Grand Total
Child or no education	42	30	72
Primary (grade 1-5)	139	154	293
Middle School (grade 6-9)	14	5	19
High School (grade 10-11)	1	2	3
College/University	1	2	3
Monastic Education	3	22	25
Preschool	1	0	1
Grand Total	**201**	**215**	**416**

Table 4: Occupation of respondents by gender at Nawng Lin

Occupation	Female	Male	Grand Total
Child	13	13	26
Casual Labour	1	4	5
Farmer	145	165	310
Housewife	5	0	5
Student	28	22	50
Dependant	9	11	20
Grand Total	**201**	**215**	**416**

Vulnerability

The following information was recorded on vulnerability.

Table 5: Households with Disabled People at Nawng Lin

No. of Households with Disabilities	5
Type of Disability	**Total Number**
Dumb	1
Paralysis by Stroke	0
Deaf	0
Blind	0
Lame	5
Mentally Ill	0

Livelihood and Economic Activities of Households

Based on the result of the household survey, farming income shows that corn is planted by almost all (98.8%) of the sample households and the total estimated annual income is Kyats 109,158,700; the most important crop planted is upland rice wherein 63% of the sample households are planting providing them an estimated annual income of Kyats 19,030,328 and the third crop planted by 51% of the sample households is sugarcane where the estimated annual income is Kyats 243,368,500.

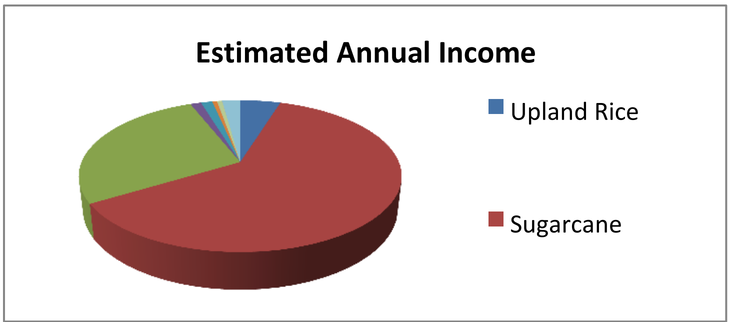


Figure 2: Annual Income for Nawng Lin

In terms of cash income, sugarcane provides the highest income however only half of the household samples plant sugarcane because it takes around 9-12 months to harvest the sugarcane. This means that the farmland cannot be used any longer for the production of other crops necessary for the households' food. Corn and rice are planted by most of the household because these provide the food and sustenance of the household. Rice and corn are planted once a year which takes an average of 4-6 months depending on the variety. The remaining 6 months is used to plant other cash and food crops such as vegetables, beans, peanuts, fruits such as watermelon and pineapple.

No household does mono-cropping. Most of the farming practice combines a number of crops that will provide the food for the household and also cash for their other needs. The average annual income from corn of a household is Kyat 1,226,502.25; average annual income from upland rice is kyats 333,865.40; and for sugarcane is Kyats 5,290,619.57. For the 46 households planting sugarcane their annual cash income is very high.

Another source of household income is timber and Non-Timber Forest Products (NTFPs) as shown in the Figure below, timber or wood is the highest cash income earner for the household. This data shows the economic significance of the forest area along the slope of the Yeywa River where these forest and non-timber forest products are taken from.

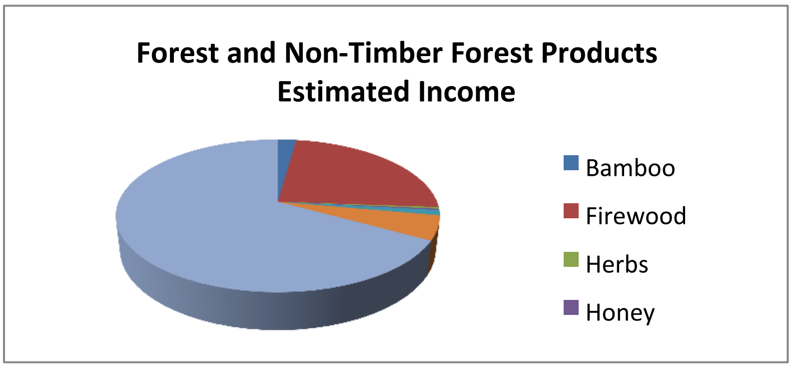


Figure 3: Timber and NTFP Income for Nawng Lin

Other sources of household income are shown in the Figure below. Labor services and livestock raising are the highest income earners other than farming. For livestock raising, where 36 households are engaged with this livelihood, a household earns an estimated annual income of Kyats 748,722 and for labor services, there are 64 households, usually the husband during off-farming season, work elsewhere usually in construction work providing an annual cash income of Kyats 568,906.25 for each of the 64 households engaged in this activity. This number of available manpower should be noted and may be tapped for the construction activities of the proposed dam project.

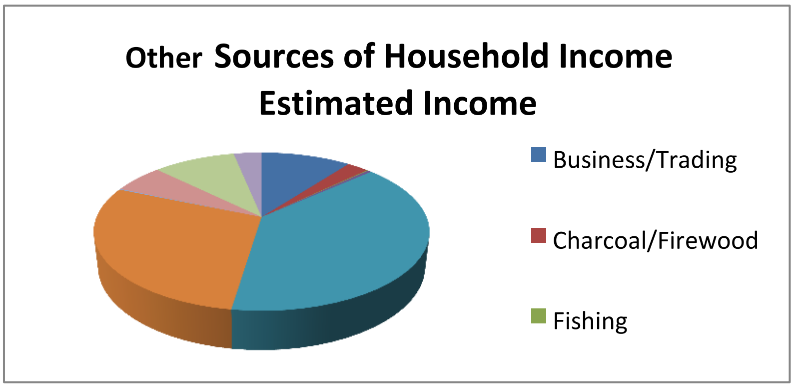


Figure 4: Other Sources of Income for Nawng Lin

Village Profile of Yae Maung Tan

Population

- Based on the Household Baseline Survey, where 26 (33%) of the total 80 households of Yae Maung Tan included in survey reveal the following:
- There are 109 Danu people in this village. Of which, 59 (55%) are females and 50 (45%) are males.
- 13.8% are children below 9 years old
- 17.4% are between 10-18 years old
- 56 (51.4%) are in the productive years between the ages 19-54 years old. Of this, 27 females are in their reproductive years.
- 18.3 % are 55 years old and above
- The average household size in this village is 4
- Only 11 (10%) of the surveyed population have no education or attended school. This may account for the children below the school age.
- 88 (80.7%) of the surveyed population have attended primary education between Grades 1-5
- 7 (6.4%) of the surveyed population have reached middle school between Grades 6-9
- Only 1 (0.9%) proceeded to study high school. This is the highest educational attainment reached among the surveyed population in this village
- Two(1.8%) males attended monastic education
- 79 (72.5%) are farmers and the rest of the surveyed population are children, students, and dependents.
- There are no disabled persons in this village

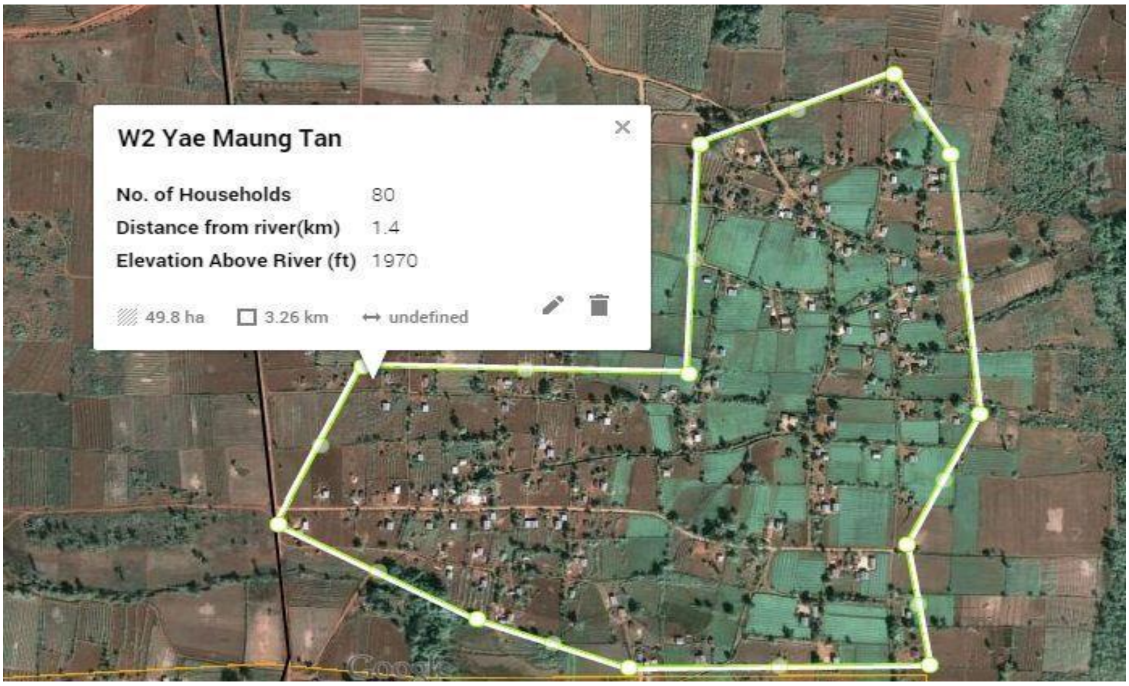


Figure 1: Image of Yae Maung Tan Village

The population sample of Yae Maung Tan revealed all sampled households belonging to the Danu group. The population by age and household size are presented in the tables below.

Table 1: Population of Yae Maung Tan by Age Group

Age Group (years)	Female (number of persons)	Male (number of persons)
0-9	5	9
10-18	12	7
19-27	11	7
28-36	5	7
37-45	11	10
46-54	4	1
55-63	7	8
64 and above	4	1

Table 2: Population of Yae Maung Tan by Household Size

Age Range	Number of Persons
1-2	1
3-4	14
5-6	11
7-9	0
10+	0
Grand Total	**26**

Gender

Of the 26 household sample only one household was reported to have a female household head. Other information regarding gender is presented in the tables below.

Table 3: Education Levels by Gender of Yae Maung Tan

Education Level	Female	Male	Grand Total
Child or no education	6	5	11
Primary (grade 1-5)	49	39	88
Middle School (grade 6-9)	4	3	7
High School (grade 10-11)	0	1	1
Monastic Education	0	2	2
Grand Total	**59**	**50**	**109**

Table 4: Occupation of Respondent by Gender of Yae Maung Tan

Occupation	Female	Male	Grand Total
Child	1	2	3
Casual Labour	0	1	1
Farmer	45	34	79
Housewife	3	0	3
Student	7	9	16
Dependent	3	4	7
Grand Total	**59**	**50**	**109**

Vulnerability

No vulnerable or disabled persons were reported for this village survey.

Livelihood and Economic Activities of Households

There are more than 10 varieties of cash crops planted by the villagers which contributes to the household source for food and cash, these are rice, corn, vegetables, beans, wheat, tomato, root crops, peanuts and fruits. Based on the result of the household survey, where 26 sample households were interviewed, corn (30%), upland rice (17.5%) and vegetables (15%) are the cash crops planted most by the households in the village. But in terms of the village total cash income per cash crop, the highest is corn (60.82%); sugarcane is second (8.43%) with only three households and upland rice is third (8.07%) with 14 households planting this crop. Corn provides an estimated annual income of Kyat 969,916.67 to a household.

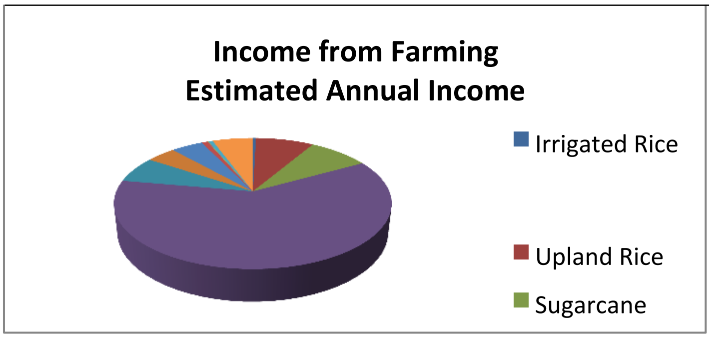


Figure 2: Annual Farming Income for Yae Maung Tan

The pie below shows the significant use of the forest to households as source for cash income, mostly from wood/timber and bamboo and firewood and some non-timber forest products such as wild vegetables, fruits and animal. The total income from Forest and NFTPs is Kyats 3,177,500. The loss of access to this natural resource because of inundation may impact the villagers in relation to their source of household firewood for cooking.

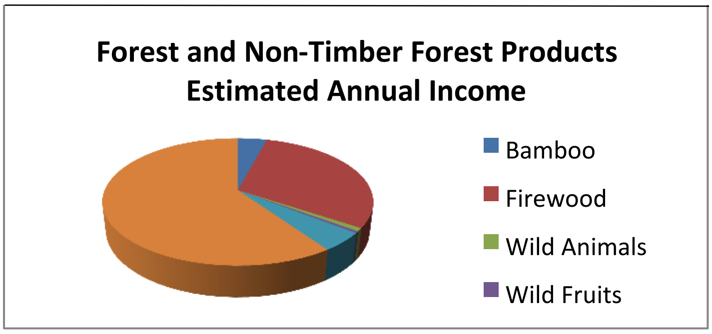


Figure 3: Annual Income from Timber and NTFPs for Yae Maung Tan

Other sources of household income are shown by the diagram below. Fifteen households (58%) are engaged in labour services.

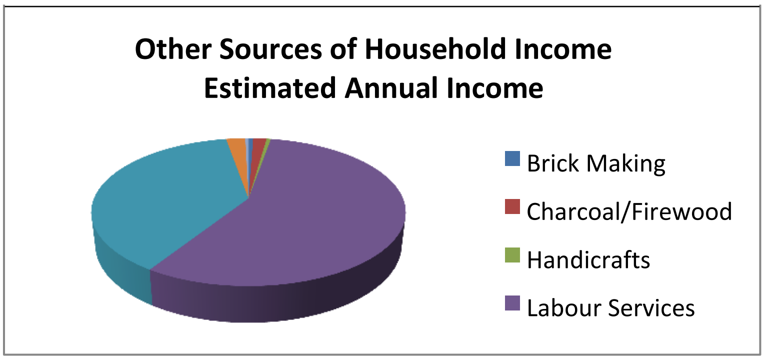


Figure 4.15: Other Sources of Income for Yae Maung Tan

Village Profile of Me Poke

Population

Based on the Household Baseline Survey, where 88 (33%) of the total 267 household of Me Poke were included in survey shows the following:

- 363 (99.7%) are Danu people with one Bama male. Of which, 186 (51%) are female and 177 (49%) are male.
- 57 (15.7%) are children below 9 years old.
- 60 (16.5%) belong to the ages 10-18 years old,
- 190 (52.2%) are in the productive years between the ages 19-54 years old. Of this group, 86 females are in their reproductive years.
- 57 (15.7%) are 55 years old and above.
- The average household size of this village is 4.
- 59 (16.2%) have not attended school. This number also includes children who have not reached school age yet.
- 240 (66%) of the surveyed population have attended primary education between Grades 1-5.
- 48 (13%) of the surveyed population have reached middle school between Grades 6-9.
- 7 (2%) have proceeded to attend high school
- Only 2 (0.5%) males have proceeded to attend university level education.
- 7 (2%) attended monastic education. Two are females and 5 are males.
- 242 (66%) are farmers; 118 are female-farmers. The rest of the surveyed population are children, students, and dependents.
- There are 5 persons with disabilities in this village.

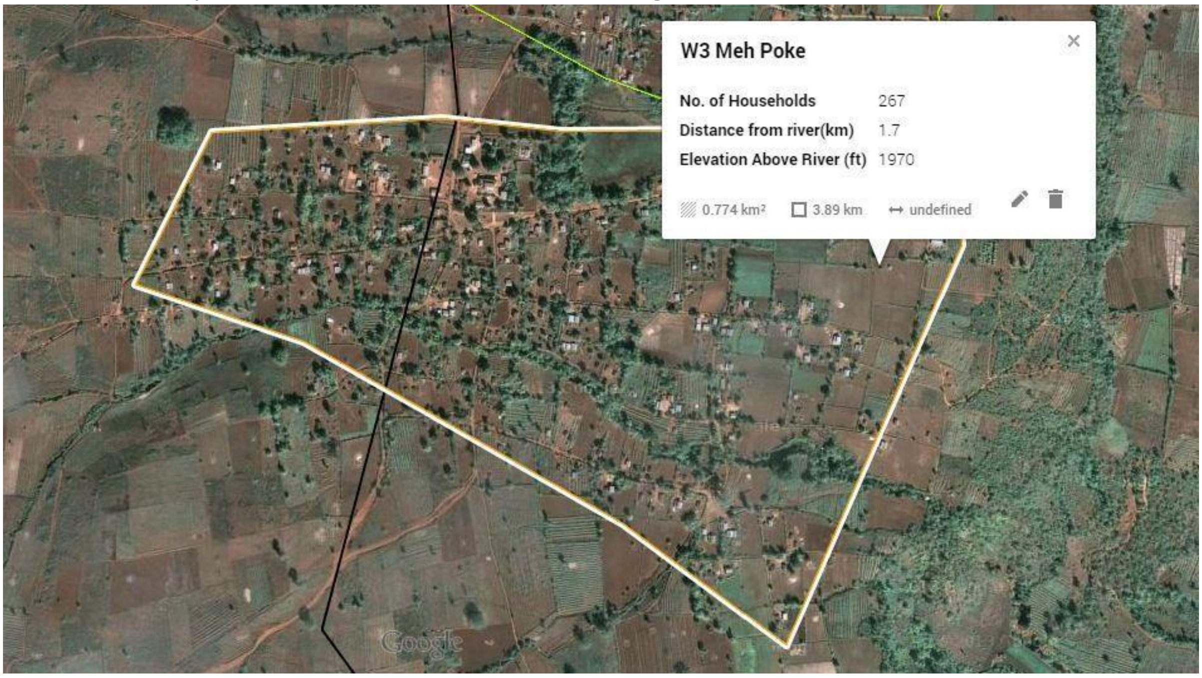


Figure 1: Image of Me Poke Village

The population sample of Me Poke revealed only one person not belonging to the Danu group – he was Burmese or Bama. The population by age and household size are presented in the tables below.

Table 1: Population of Me Poke by Age Group

Age Group (years)	Female (number of persons)	Male (number of persons)
0-9	24	33
10-18	37	23
19-27	33	28
28-36	26	27
37-45	27	27
46-54	10	12
55-63	11	16
64 and above	18	12

Table 2: Population of Me Poke by Household Size

Age Range	Number of Persons
1-2	13
3-4	42
5-6	26
7-9	7
10+	0
Grand Total	**88**

Gender

Of the 88 household sample eight households were reported to have a female household head. Other information regarding gender is presented in the tables below.

Table 3: Education Levels by Gender of Me Poke

Education Level	Female	Male	Grand Total
Child or no education	37	22	59
Primary (grade 1-5)	124	116	240
Middle School (grade 6-9)	19	29	48
High School (grade 10-11)	4	3	7
College/University	0	2	2
Monastic Education	2	5	7
Preschool	0	1	1
Grand Total	**186**	**178**	**364**

Table 4: Occupation of Respondent by Gender of Me Poke

Occupation	Female	Male	Grand Total
Child	9	13	22
Casual Labour	4	3	7
Farmer	118	124	242
Housewife	6	1	7
Student	31	29	60
Dependant	18	8	26
Grand Total	**186**	**178**	**364**

Vulnerability

The following information was recorded on vulnerability.

Table 5: Households with Disabled People at Me Poke

No. of Households with Disabilities	5
Type of Disability	**Total Number**
Dumb	0
Paralysis by Stroke	0
Deaf	1
Blind	0
Lame	2
Mentally Ill	2

Livelihood and Economic Activities of Households

Based on the results of the household survey, where 88 household samples were taken in Meh Poke, farming income reveals that corn is the most planted cash crop by 82 households (93%). Income from corn is 53% of the total income generated from all crops produced. Rice is the second most planted crop and vegetable is the third. However, for cash income, sugarcane is the second highest cash income earner.

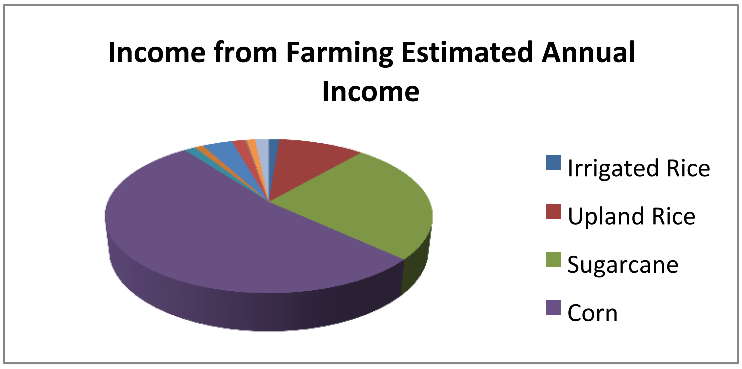


Figure 2: Annual Farming Income for Mae Poke

Income from forest and non-timber forest products is shown in the pie below that timber/wood generates Kyats 2924000 (45%) income and firewood generates Kyats 2,757,000 (42.6%) income. Sixty-seven percent (67%) of the households generate Kyats 48,368.42 cash income and household fuel from firewood. Loss of access to the forest will impact not only the 57 households but also those households buying their firewood from the households gathering firewood.

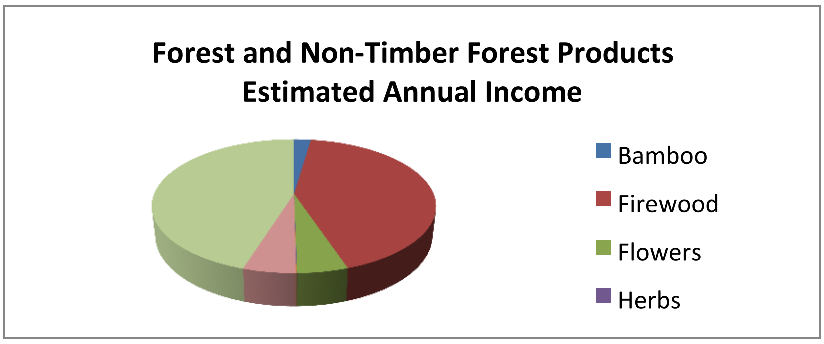


Figure 3: Annual Income from Timber and NTFPs for Me Poke

Other sources of household income that are non-agricultural based are shown in the pie chart below. Labour services are the highest income earner.

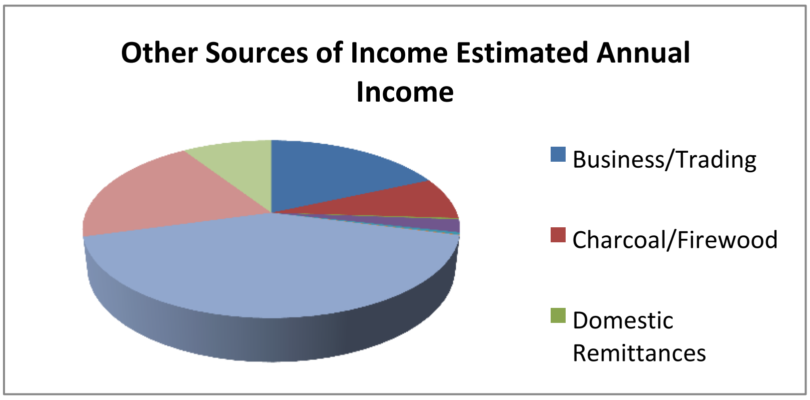


Figure 4: Other Sources of Income for Me Poke

Village Profile of Nawnghkio Kone

Population

Based on the Household Baseline Survey, where 19 (33%) of the total 55 households of Nawnghkio Kone were included in survey shows the following:

- 86 (100%) are Danu people in this village. Of which 40 (47%) are female AND 46 (53%) are male
- 21 (24%) are children below 9 years old
- 11 (12.7%) belong to the ages 10-18 years old
- 42 (49%) are in the productive years between the ages 19-54 years old. Of this group, 19 females are in their reproductive years.
- 12(14%) are 55 years old and above
- Average household size is 4
- 10 (11.6%) have not attended school. This could be attributed to children who have not reached school age
- 64 (74%) of the surveyed population have attended primary education between Grades 1-5. Of this number, 31 are female and 33 are male.
- 5 (5.8%) of the surveyed population have reached middle school between Grades 6-9
- 4 (4.7%) have reached high school. Of this number, 2 are females and 2 are males.
- 3 (3.5%) have attended monastic education, where 2 are females.
- 52 (60%) are farmers and the rest are children students and dependents. There are 24 female farmers and 28 male-farmers.
- There are 3 disabled persons in this village

Figure 1: Image of Nawnghkio Kone Village

The population sample of Nawnghkio Kone revealed all sampled households belonging to the Danu group. The population by age and household size are presented in the tables below.

Table 1: Population of Nawnghkio Kone by Age Group

Age Group (years)	Female (number of persons)	Male (number of persons)
0-9	8	13
10-18	5	6
19-27	9	4
28-36	8	9
37-45	2	4
46-54	3	3
55-63	3	4
64 and above	2	3

Table 2: Population of Nawnghkio Kone by Household Size

Age Range	Number of Persons
1-2	0
3-4	11
5-6	3
7-9	3
10+	1
Grand Total	**18**

Gender

Of the 18 household sample one household was reported to have a female household head. Other information regarding gender is presented in the tables below.

Table 3: Education Levels by Gender of Nawnghkio Kone

Education Level	Female	Male	Grand Total
Child or no education	2	8	10
Primary (grade 1-5)	31	33	64
Middle School (grade 6-9)	3	2	5
High School (grade 10-11)	2	2	4
Monastic Education	2	1	3

Grand Total	**40**	**46**	**86**

Table 4: Occupation of Respondent by Gender of Nawnghkio Kone

Occupation	Female	Male	Grand Total
Child	1	1	2
Farmer	24	28	52
Housewife	1	0	1
Student	9	9	18
Dependant	5	8	13
Grand Total	**40**	**46**	**86**

Vulnerability

The following information was recorded on vulnerability.

Table 5: Households with Disabled People at Nawnghkio Kone

No. of Households with Disabilities	3
Type of Disability	**Total Number**
Dumb	0
Paralysis by Stroke	1
Deaf	1
Blind	0
Lame	0
Mentally Ill	1

Livelihood and Economic Activities of Households

Just like the other 3 villages, Nawnghkio Kone households have the same ranking for the top two crops: corn, rice and the third highest income earner are peanuts. Based on the 19 (33%) household survey samples, no household among the surveyed are planting sugarcane. Of the 19 households, 18 households are planting corn and 16 households are planting rice. Corn provides an annual average income per household of Kyats 814,055.56 and rice provides an annual average income of Kyats 275,750 per household. Both rice and corn are staple food of the households.

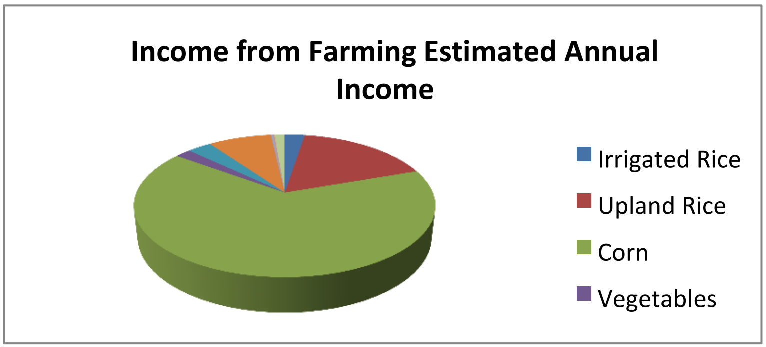


Figure 2: Annual Farming Income for Nawnghkio Kone

From the forests, timber, bamboo and other NTFPs are harvested. Around 7 households are exploiting the forest for its bamboo, firewood, flowers, fruits and vegetables. Three households mentioned that they get timber but for household use not for selling, hence no cash income is reflected in their data. Other households gather fruits also for consumption. Cash income from the forest comes from bamboo and firewood.

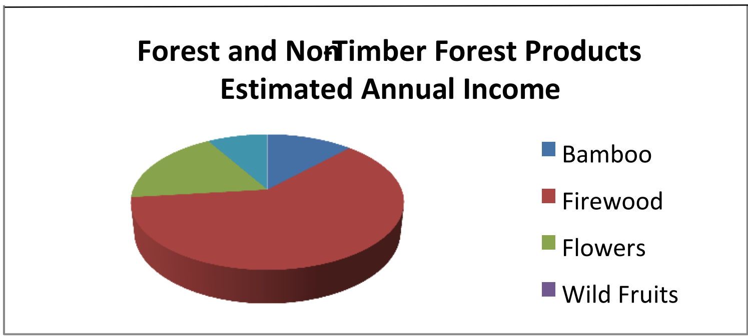


Figure 3: Annual Income from Timber and NTFPs for Nawnghkio Kone

Other sources of income are shown on the pie below. Livestock is the most interesting income earner for this village since 42% of the surveyed households are engaged in this activity. The total income earned from livestock raising is estimated at Kyats 3,195,000. Most of these are poultry/chicken. There are very few cattle among the survey household.

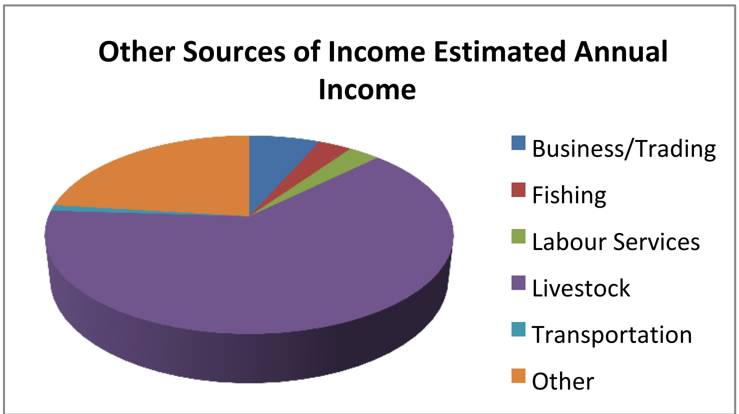


Figure 4: Other Sources of Income for Nawnghkio Kone

Village Profile of Ma Gyi Yae

Population

Based on the Household Baseline Survey, where 11 (41%) of the total 27 households of Ma Gyi Yae were included in survey shows the following:

- 47 (82.5%) are Danu; 4 are Shan and 1 female Palaung are the ethnic composition in this village.
- 12 (23%) are children below 9 years old .
- 11 (21%) belong to the ages 10-18 years old.
- 24 (46%) are in the productive years between the ages 19-54 years old. Of this group, 10 females are in their reproductive years.
- 5 (9.6%) are 55 years old and above.
- Average household size in this village is 5.
- Seven people have not attended school.
- 42 (80.7%) have attended primary education Grade 1-5. Of this number, 19 are female and 23 are male.
- Only 2 females have proceeded to Middle School, which is the highest educational attainment in this village and 1 female attended monastic education.
- The main occupation in this village is farming. There are 28 farmers with 17 are female-farmers. The rest of the village population are children, students and dependents.
- There are no disabled persons in this village.

Figure 1: Image of Ma Gyi Yae Village

The population sample of Ma Gyi Yae revealed five persons not belonging to the Danu group – two Shan and one Palaung. The population by age and household size are presented in the tables below.

Table 1: Population of Mae Gyi Yae by Age Group

Age Group (years)	Female (number of persons)	Male (number of persons)
0-9	8	4
10-18	3	8
19-27	4	3
28-36	4	5
37-45	2	2
46-54	2	2
55-63	2	0

64 and above	1	2

Table 2: Population of Ma Gyi Yae by Household Size

Age Range	Number of Persons
1-2	0
3-4	5
5-6	5
7-9	1
10+	0
Grand Total	**11**

Gender

Of the 11 household sample no household was reported to have a female household head. Other information regarding gender is presented in the tables below.

Table 3: Education Levels by Gender of Ma Gyi Yae

Education Level	Female	Male	Grand Total
Child or no education	4	3	7
Primary (grade 1-5)	19	23	42
Middle School (grade 6-9)	2	0	2
Monastic Education	1	0	1
Grand Total	**26**	**26**	**52**

Table 4: Occupation of Respondent by Gender of Ma Gyi Yae

Occupation	Female	Male	Grand Total
Child	1	2	3
Farmer	17	21	38
Student	8	3	11
Grand Total	**26**	**26**	**52**

Vulnerability

No vulnerable or disabled persons were reported for this village survey.

Livelihood and Economic Activities of Households

Ma Gyi Yae is, in terms of population and number of household, the smallest village of the 6 villages. Only 11 (41%) household samples were included in the household survey.

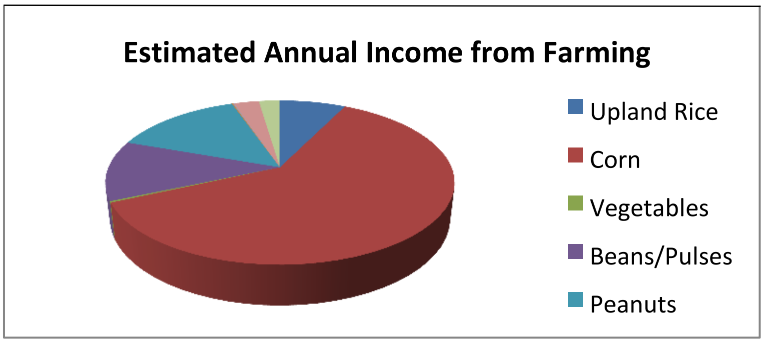


Figure 2: Annual Farming Income for Ma Gyi Yae

Consistent with the other villages, corn and rice are the crops most favoured to be planted being a staple food of the households. But in terms of income generation, corn (61%), pulses/beans (14.3% and peanuts (11.8%) are the top income earners. Also, more households (81.8%) are engaged in corn farming.

Exploitation of timber and non-timber forest product seems low in this village. Activities are focused mainly on firewood gathering wherein 54.5% of the households engage in this activity. Timber seems to be a high income earner but only 2 households (18%) are doing this activity.

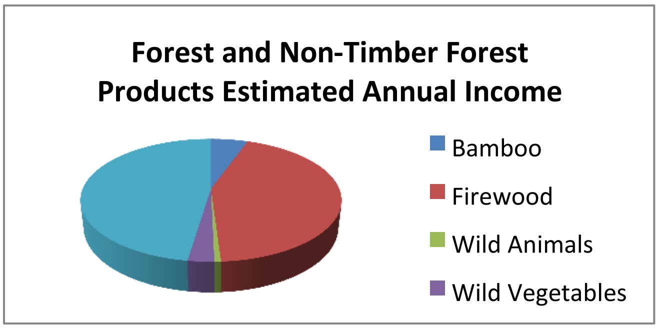


Figure 3: Annual Income from Timber and NTFPs for Ma Gyi Yae

Other sources of income outside farming are focused mainly on 3 activities: livestock raising, charcoal production, and provision of labour services.

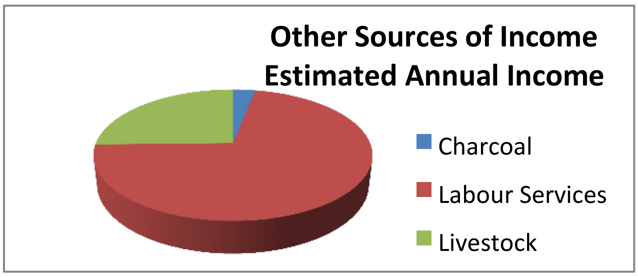


Figure 4: Other Sources of Income for Ma Gyi Yae

Village Profile of Yae Twi Gyi

Population

Based on the Household Baseline Survey, where 66 (33%) of the total 200 households of Yae Twi Gyi were included in survey shows the following:

- 334 (99%) are Danu, one female Shan and 1 male Bama are the ethnic composition in this village. Of this number, 174 are female Danu.
- 84 (25%) are children below 9 years old.
- 60 (17.9%) belong to ages 10-18 years old
- 160 (47.6%) are in the productive years between the ages 19-54 years old. Of this group, 85 females are in their reproductive years.
- 35 (10.4%) are 55 years old and above.
- Average household size in this village is 5.5
- 74 (22%) have not attended school and some are children who have not reached school age
- 238 (71%) have attended primary school. Of this number, both females and males share 50% each.
- Only 8 have reached middle school and 7 of these are females.
- Two males have reached high school.
- 1 female attended college education
- 3 attended vocational/technical school 9 attended monastic education.
- There are 216 (64%)farmers; 2 fishermen; 5 are working as casual labourer and 113(33.6%) are students, children and dependents
- There are 6 disabled persons in this village

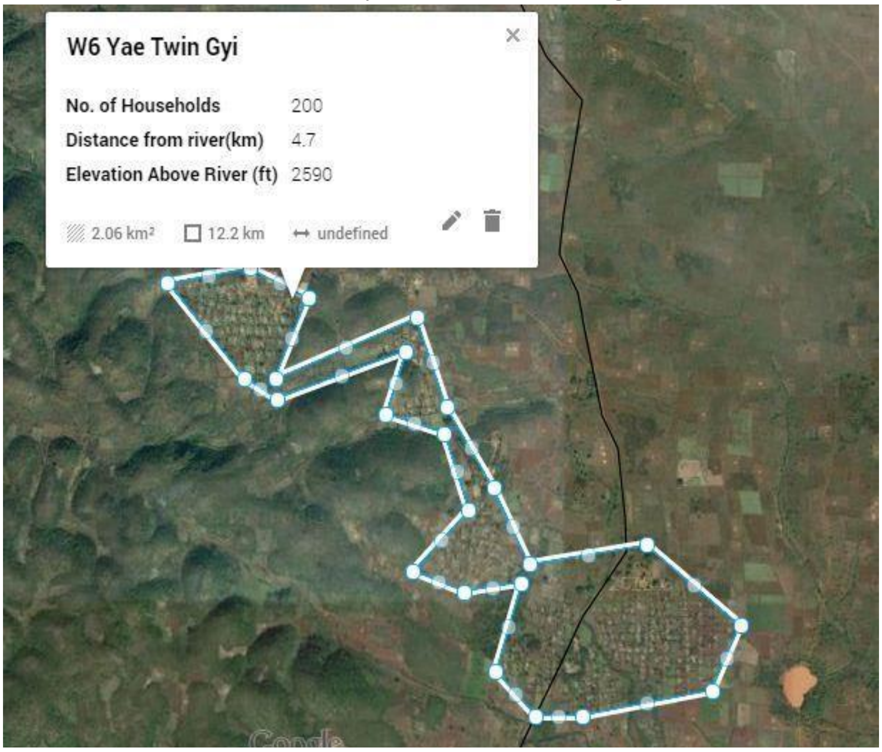


Figure 1: Image of Yae Twin Gyi Village

The population sample of Mae Poke revealed two persons not belonging to the Danu group – one Shan and one Burmese (Bama). The population by age and household size are presented in the tables below.

Table 1: Population of Yae Twin Gyi by Age Group

Age Group (years)	Female (number of persons)	Male (number of persons)
0-9	46	38
10-18	27	33
19-27	26	29
28-36	30	20
37-45	17	15
46-54	12	11
55-63	10	7
64 and above	8	10

Table 2: Population of Yae Twin Gyi by Household Size

Age Range	Number of Persons
1-2	2
3-4	20
5-6	36
7-9	6
10+	2
Grand Total	**66**

Gender

Of the 63 household sample, three households were reported to have a female household head. Other information regarding gender is presented in the tables below.

Table 3: Education Levels by Gender of Yae Twin Gyi

Education Level	Female	Male	Grand Total
Child or no education	44	30	74
Primary (grade 1-5)	119	119	238
Middle School (grade 6-9)	7	1	8
High School (grade 10-11)	0	2	2
Vocational/Technical School	1	2	3
College/University	1	0	1
Monastic Education	3	6	9
Preschool	0	1	1
Grand Total	**175**	**161**	**336**

Table 4: Occupation of Respondent by Gender of Yae Twin Gyi

Occupation	Female	Male	Grand Total
Child	22	17	39
Casual Labor	4	1	5
Fisherman	0	2	2
Housewife	6	0	6
Student	28	26	54
Dependant	9	5	14
Grand Total	**175**	**161**	**336**

Vulnerability

Table 5: Households with Disabled People at Yae Twin Gyi

No. of Households with Disabilities	**5**
Type of Disability	**Total Number**
Dumb	0
Paralysis by Stroke	1
Deaf	2
Blind	1
Lame	1

Livelihood and Economic Activities of Households

Based on the results of the household survey in Yae Twi Gyi, of which 66 sample households were interviewed, the top three income earners from farming are corn (53%), rice (26.3%) and sugarcane (7.7%). But in terms of number of households planting cash crops, corn (100%), rice (87.8%) and fruits (70%) have the most number of households planting these crops.

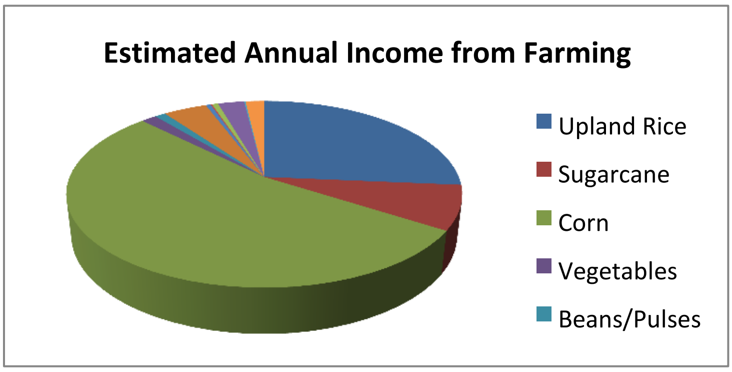


Figure 2: Annual Farming Income for Yae Twi Gyi

Income from forests comes from bamboo, firewood, timber/wood, wild vegetables, fruits, honey and other things as shown in the pie below. Income from wood/timber of 18 households is estimated at Kyats 3,781,000; from firewood of 40 households is estimated at Kyats 2,185,000 and from bamboo of 19 households is estimated at Kyats 607,000. Inundation of the side slopes of the river where most of the forest area are located will impact the villagers for their source of firewood, bamboo and wood whether for household consumption and/or for cash income.

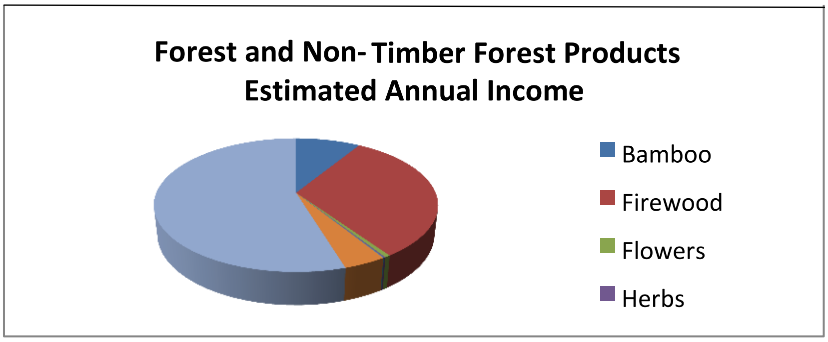


Figure 3: Annual Income from Timber and NTFPs for Yae Twi Gyi

Other sources of income which are non-farming activities are labour services, charcoal making and livestock raising. Charcoal making may be affected most because the source of wood for charcoal is from the forests. However, with 72.7% of the village households engaged in providing labour services, the households will gain cash income during construction of the dam and facilities and the access road. This benefit from the project will be experienced by all of the six villages.

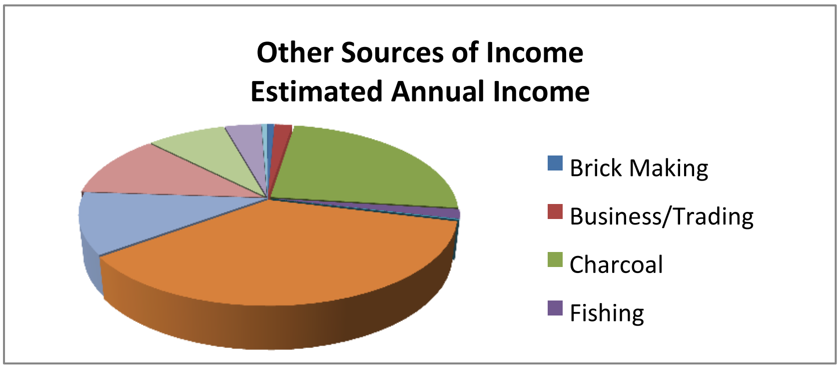


Figure 4: Other Sources of Income for Yae Twi Gyi

Village profile of Hpet Yin Kone:

Village Overview

Hpet Yin Kone is a village of approximately 180 households located on the left bank of the Mytinge River in the 'Lower Left' quadrant for Middle Yeywa EIA analysis. The SIA survey for Hpet Yin Kone was conducted in 2017. The village has medium road access via an unpaved but relatively low incline branch road that meets route 41 in the village tract village Kyauk Ku (also the market centre). Travel time from Hpet Yin Kone to Kyauk Ku by motorbike is 30-45 minutes; travel time to Nawnghkio town is approximately 3 hours.

The village was founded in 1885 as part of an expansion from a nearby community (possibly Tawng Kham, unclear). Hpet Yin Kone is almost entirely Danu and has been like that for since its founding. There were four founding households. There is a Palaung village nearby (60 minutes by motorbike) and the two communities get along well, attending each other's religious and cultural ceremonies. On the day of the visit for qualitative research, there was a Danu ceremony and several Palaung people in attendance. Over the last 10-15 years, road access has improved allowing the community to more easily reach health and education services. Previously, their village was located in a 'black' area (i.e. controlled by non-state actors) but now conflict problems do not exist. Over 10-15 years has doubled in size from 90 households.

Livelihoods in the village revolve around farming with paddy and peanut as the most traditional crops, the former for consumption and the latter for both consumption and market. In the last 10 years, farmers have also begun to grow sesame, soybean, and corn for market. Farmland in the village is not registered with government (i.e. no formal tenure) but all households have traditional control over at least a small amount of land. Approximately 25 households are large farmers with 15+ acres, 50-80 are small farmers with 3-5 acres, and the rest have between 8 and 10 acres. There is no irrigated farmland. Farming practices include the use of fertilizer and pesticides, though this has only become common in the last few years. Mechanization is limited to hand tractors, of which there are approximately 100 in the village. No livestock is raised for market, but most households have chickens and about half also raise pigs. Livestock face health problems, the villagers reported that every few years a disease would wipe out livestock.

Market access is primarily to Nawnghkio. Farmers group together to finance a large truck to ship their harvest to a broker.

Forest and river use is limited. Forest is an income supplement for a few households, generally via honey and hunting, the product of which is sold in the village. The river is rarely used and then only for a small amount of supplementary fishing.

There is a school in the village but only at a post-primary level, for further education children must travel to Kyauk Ku and beyond. Healthcare is accessed in Kyauk Ku.

Demographics

Hpet Yin Kone is a Danu village with 259 of the 261 members of interviewed households being Danu.

Table 1: Sample population of Hpet Yin Kone by Ethnicity

Ethnic Group	Female	Male	(blank)	Total
Bamar		1		1
Danu	131	127	1*	259
Shan	1			1
Total	**132**	**128**	**1**	**261**

*One Danu child's gender was not recorded,

Age figures for Hpet Yin Kone indicate that well over half of the population is under 27 (60%) and just 11 % above 55. There was little difference by gender across age groups.

Table 2: Sample population of Hpet Yin Kone by Age Group

Age Group	Female	% of Female	Male	% of Male	(blank)	Total	% of Total
0-9	20	15%	28	22%	1	49	19%
10-18	28	21%	23	18%		51	20%
19-27	27	20%	27	21%		54	21%
28-36	21	16%	16	13%		37	14%
37-45	9	7%	7	6%		16	6%
46-54	15	11%	8	6%		23	9%
55-63	11	8%	13	10%		24	9%
64 >	1	1%	5	4%		6	2%
Total*	**132**		**127**		**1**	**260**	

*One male individual's age was not recorded

Table 3: Sample Households of Hpet Yin Kone by Household Size

Number of Household Members	Number of Households
1-2	3
3-4	25
5-6	23
7-9	7
10+	1
Total	**59**

Education

Well over half of the members of respondents' households have a primary education. There is no middle school in the village and the number of students who are able to go to middle school in Kyauk Ku or beyond is determined by their family's ability to pay for room and board.

Table 4: Education levels of sample population of Hpet Yin Kone by Gender

Education Level	Female	Male	Blank	Total
Child/No education/Other	17	15	1	33
Kindergarten	1	2		3
Monastic Education	6	18		24
Primary School	92	76		168
Middle School	13	9		22
High School	2	7		9
Graduate/University	1	1		2
Total	**132**	**128**		**261**

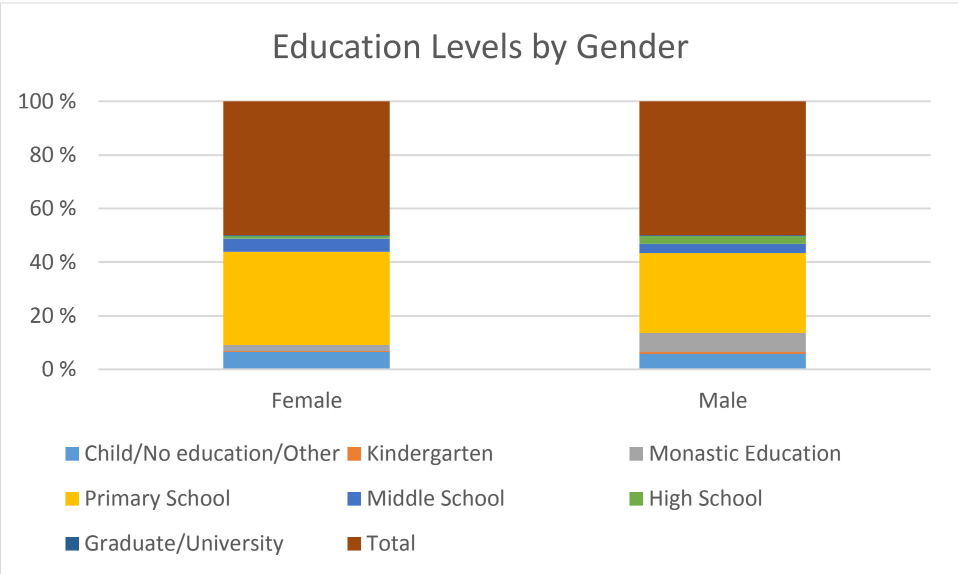


Figure 1: Education levels by gender of Hpet Yin Kone

Table 5: Occupation of Respondents by Gender of Hpet Yin Kone sample population

Occupation	Female	Male	Blank	Total
Child	2	8	1	11
Dependent	4	2		6
Farmer	96	87		183
Mason		1		1
Monk		1		1
Other	1	1		2
Student	27	27		54
Government staff/ Formal Employment	2	1		3
Total	**132**	**128**	**1**	**261**

Vulnerability

Of the 54 households interviewed as part of the survey, three were reported as having a female household head.

Table 6: Households with Disabled People in Hpet Yin Kone Sample

Type of disability	Number of afflicted individuals
Mute	1

Livelihoods

As with most of the impact zone's villages, the majority of income comes from the sale of agricultural crops. Hpet Yin Kone's position in the lower left quadrant means it relies primarily on corn as the major crop, but with other crops playing important roles, including rice, as well as sesame and groundnut.

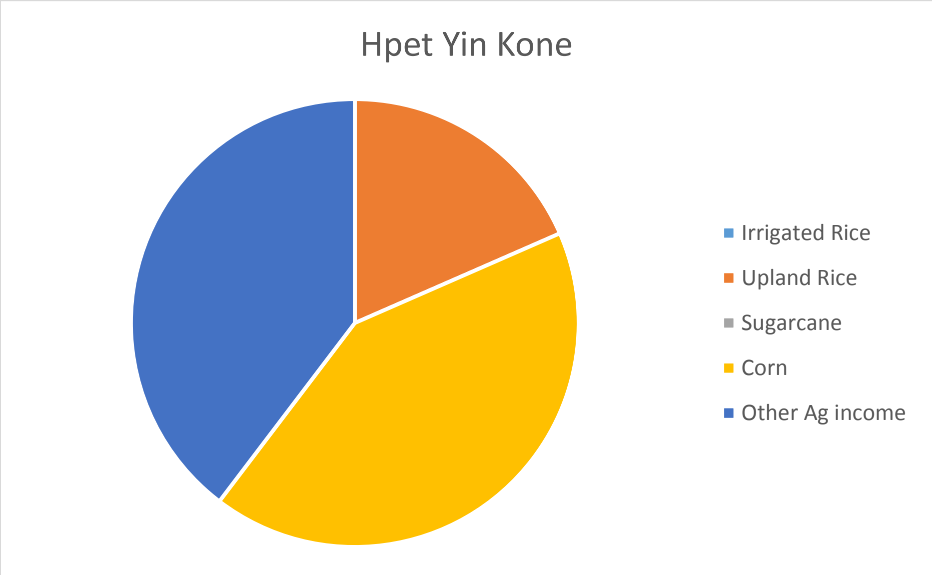


Figure 2: Estimated annual income from major crops

Income from forest sources makes up a very small proportion of the average income in Hpet Yin Kone.

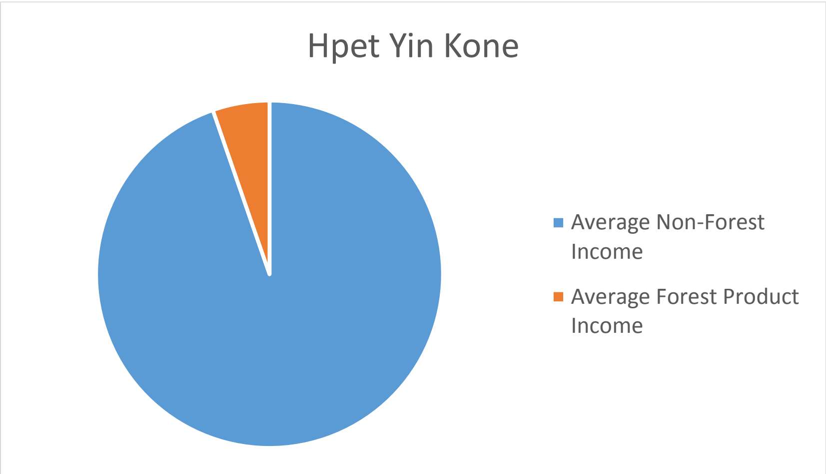


Figure 3: Forest income vs. Non-forest income

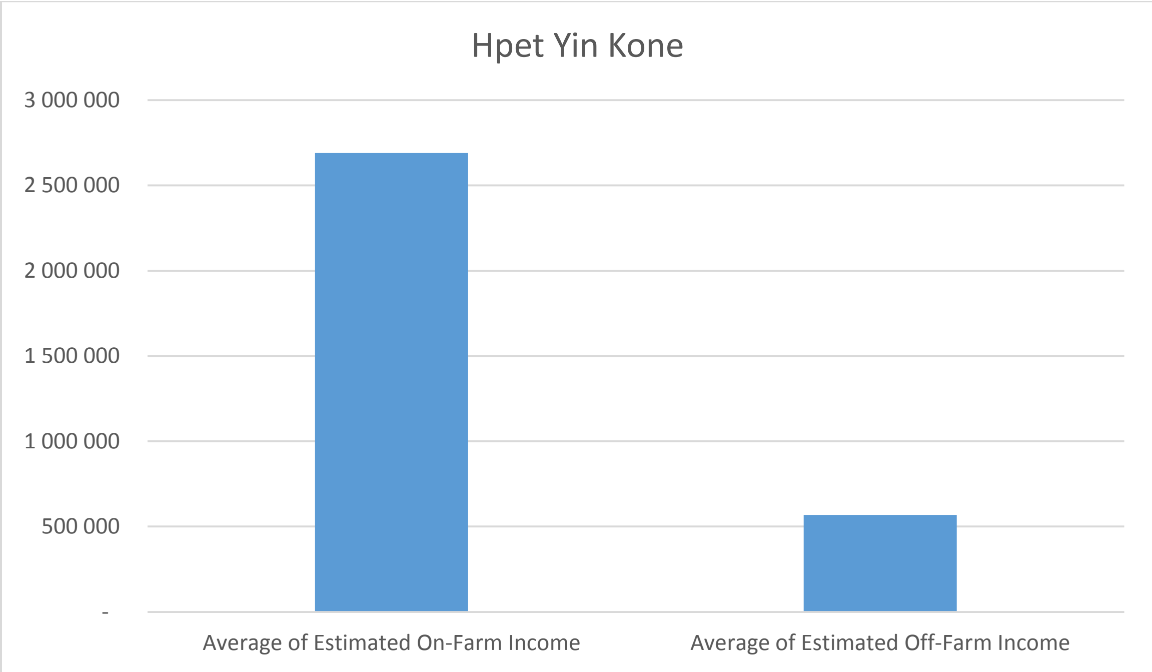


Figure 4: Agriculture income vs. Non-Agricultural income

Village profile of Kone Nyaung

Village Overview

Kone Nyaung is a village of approximately 250 households located on the Left Bank of the Myitnge River in the 'Upper Left' quadrant for EIA analysis. The SIA survey was conducted in 2017. Historically, the village had extremely poor road access being located even further from the main than the other impact zone villages of Thar Si and Pin Ping. These traditional routes meant a travel time to Kyauk Ku of some 3 hours in good weather by 4x4. However, villages reported that a new bridge has been constructed over the Myitnge River that connects them to Kyaukme Township, reportedly as part of the Upper Yeywa hydropower project, This bridge was reported to have cut down travel time to markets and services dramatically.

The main agricultural crops in Kone Nyaung is corn and groundnut and most farmers also grow some paddy for consumption. The entire corn harvest is sold while some groundnut is sold and some processed into oil for village consumption. Every household in the village has access to at least some land and all farmland is taunggya (upland fields). However, the increase in population has meant that over time average farm sizes are decreasing. Unlike other villages, 1/3 of farmers have been able to register their land and hold a formal Land Use Certificate and the rest of the farmers are waiting eagerly to get their own documents, which they expect will happen within 12 months. While they were initially skeptical of the process, the benefits of land registration are now clear to them. A small number of households (4-5) have large holdings of between 50 and 100 acres; 1/3 of the village are small holders with less than 10 acres and practice shifting cultivation, planting approximately two acres each year. The remainder are medium sized farmers with between 20 and 30 acres. Market access is to a village called Nyaung Pine, outside the impact zone.

There is very little forest use in Kone Nyaung apart from hunting for 'fun'. Over time they have had problems with deforestation as land was cleared to create more taunggya fields.

Kone Nyaung has a primary school but it has only recently been recognized by government and will only receive government funding for teachers from next year. At the time of interview, the community pays for teachers who provide education up to the 6^{th} grade. Beyond that, families who are able to pay send their children further afield to Lashio or Namlan. There is no rural health center in the village; for healthcare they go to Nyaung Pine or Kyaukme. Two young women have been selected from within the community to receive nursing training but this has not yet occurred.

Water access comes from several springs north of the village and tube wells. There are more than 60 tube wells in the village. The political party USDP provided cash to support the purchase of solar panels for 50% of the village shortly before the 2015 election; the rest of the village shares these panels.

Demographics

Unlike other villages in the impact zone, Kone Nyaung is a very much a mixed village with a large Shan minority population. As a result, the largest ethnic grouping is actually mixed Danu/Shan individuals.

Table 1: Kone Nyaung demographics by ethnic group

Ethnic Groups	Female	Male	Total
Bamar		2	2
Danu	71	70	141
Danu/Shan	92	85	177
Shan	38	30	68
Total	**201**	**187**	**388**

Age figures for Kone Nyaung indicate that over 55% of the population is under 27, with just 12% over 55.

Table 2: Population of Kone Nyaung by age group

Age Group	Female	% Female	Male	% Male	Total	% of Total
0-9	**48**	**23%**	**43**	**23%**	**91**	23%
10-18	**37**	**18%**	**36**	**19%**	**73**	18%
19-27	**32**	**15%**	**29**	**15%**	**61**	15%
28-36	**25**	**12%**	**28**	**15%**	**53**	13%
37-45	**26**	**13%**	**16**	**8%**	**42**	11%
46-54	**14**	**7%**	**17**	**9%**	**31**	8%
55-63	**11**	**5%**	**9**	**5%**	**20**	5%
over 64	**15**	**7%**	**12**	**6%**	**27**	7%
Total	**208**		**190**		**398**	

Table 3: Population of Kone Nyaung by household size

Number of Household Members	Number of Households
1-2	5
3-4	29
5-6	34
7-9	13
Total	**81**

Education

The lack of government recognized schools has driven up the proportion of villagers in Kone Nyaung who lack an education, particularly among women. Men have disproportionate access to monastic education to replace government schools but women are much less likely (12 women with monastic education compared to 66 men) to be educated by religious institutions.

Table 4: Education Levels by Gender of Kone Nyaung

Education Level	Female	Male	Total
Not known		1	1
Middle School	4	5	9
Monastic Education	12	66	78
Primary School	97	77	174
No Education	88	37	125
Unknown/Other	6	4	10
Graduate	1		1
Grand Total	**208**	**190**	**398**

Table 5: Occupation of respondents by gender of Kone Nyaung

Occupation	Female	Male	Total
Dependent	27	21	48
Farmer	151	135	286
Novice		5	5
Student	29	29	58
Other	1		1
Grand Total	**208**	**190**	**398**

Vulnerability

Of the 81 households interviewed as part of the survey, seven were reported as having a female household head.

Table 6: Households with Disabled People in Kone Nyaung

Type of disability	Number of afflicted individuals
Deaf	2
Lame	1
Other	1

Livelihoods

As with other zone 4C (left bank) villages, Kone Nyaung is heavily reliant on corn as a source of income, with it accounting for just under half of the average households annual income.

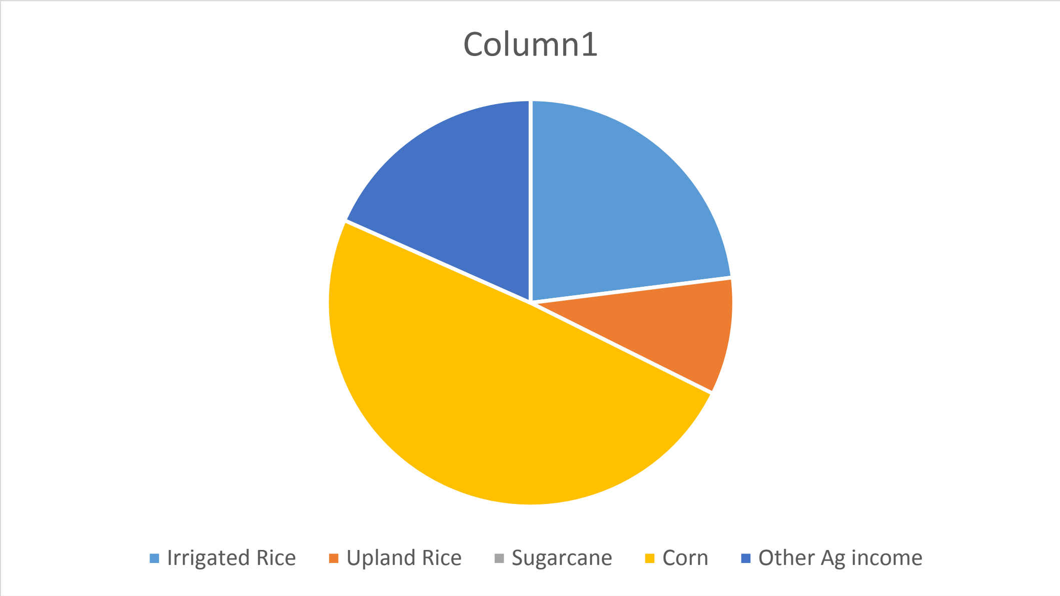


Figure 1: Estimated annual income from major crops

Given the levels of deforestation that surround Kone Nyaung, it is unsurprising that levels of forest income are very low. Just 3% of income for most households comes from forest-related sources.

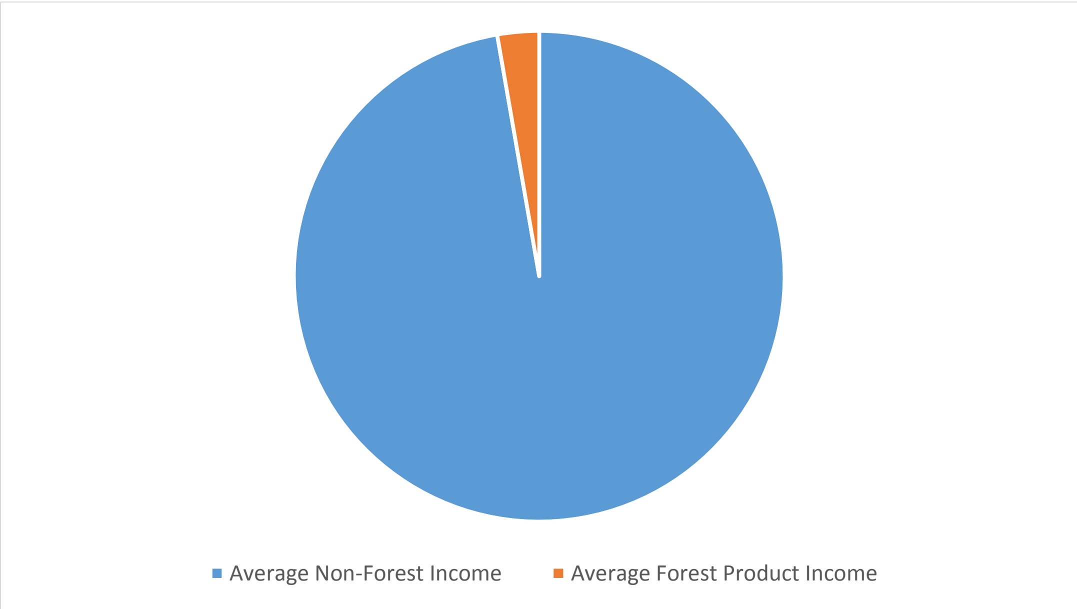


Figure 2: Forest income against non-forest income

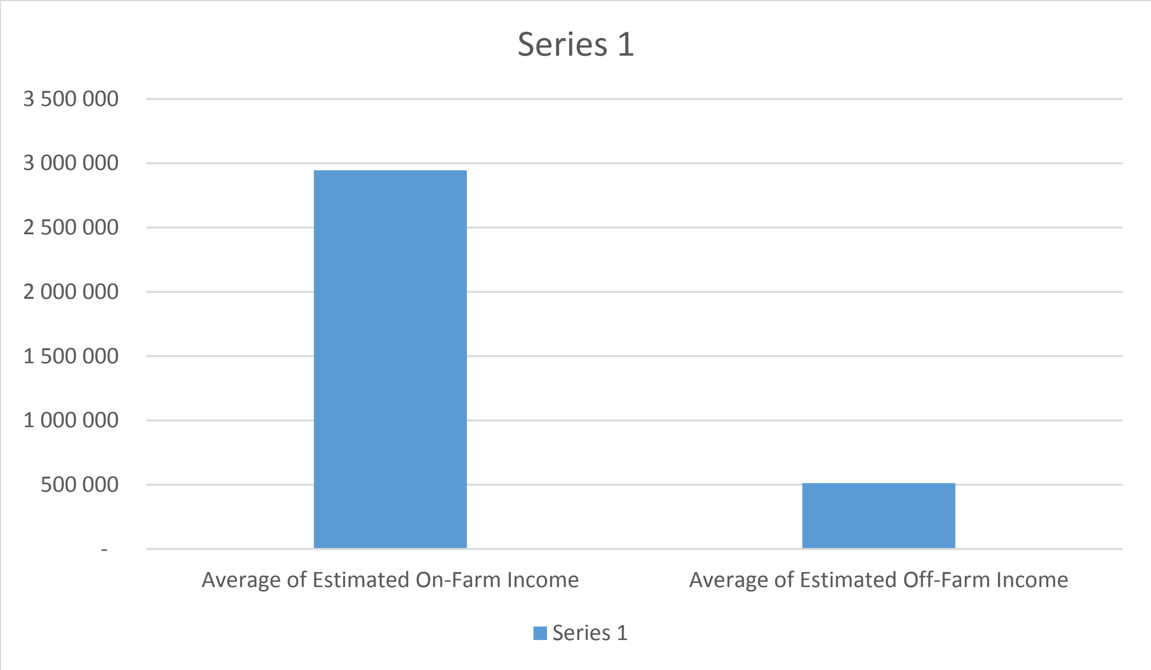


Figure 3: Agriculture income against non-agricultural income

Village profile of Kyauk Hson:

Village Overview

Kyauk Hson is a village of approximately 200 households located on the left bank of the Myitnge River in the 'Lower Left' quadrant for the Middle Yeywa EIA analysis. The SIA survey was conducted in 2017. The village has very good road access as route 41 passes through the village approximately halfway between the village of Kyauk Ku and the Myitnge river. Kyauk Ku is approximately 30 minutes by car and Nawnghkio town is approximately 2 hours by car.

The village was founded over 200 years ago, but has only grown to its current size in recent decades. For example, 70 years ago there were only 30 households. Over the last 10-15 years, the village has experienced significant improvements in transportation access accompanied by better education and healthcare resources. The main road through their village was constructed in 2000 (approx.) and paved between 10 and 12 years ago.

Kyauk Hson's inhabitants primarily rely on agriculture and their primary grips is corn. However, they also grow ground nut, soybean and also a small amount of sugarcane as well as paddy for consumption.

All households have access to their own land, and there are some significant land holdings. Approximately 30% of the village are larger land-owners, having between 30 and 50 acres. A further 20% have between five and ten acres while half of the households farm smaller plots generally between three and five. All land was traditionally taungya, but in recent years expansion of the village has reduced shifting cultivation and meant some farmers even plant a second winter crop. However, they have sought to replace shifting cultivation with crop rotation—the only village in the impact zone which reported considering this as a step. There is limited mechanization compared to other villages with only some households using small machines and a continued reliance on buffalos and cows by many households.

The village has faced land challenges as 1500 acres were seized in 2004 by politically connected individuals. Some has been planted with mango trees and is an active plantation while the remaining 800 continue to be farmed by the original users. The villagers have initiated the process of petitioning for the return of their land.

Every household raises chickens and approximately 2/3 has pigs raised for their own consumption.

The nearest market to purchase goods is Kyauk Ku, but for selling their harvest most households transport it to Nawnghkio. For groundnut, however, they grind and sell the oil themselves directly to Mandalay.

Forest use is limited to hunting trips for personal use or to be shared with others in the village. There is no market for hunted meat.

There is a school that goes up to 7th grade in the village, two years ago they received additional resource which brought it up from 5th grade. There are now six government teachers and three teachers paid for by the village, but this is not enough: in total the school has 200 students. They have requested additional teaching resources from the township government. There is a small health clinic in the village and one resident government staff nurse/midwife.

Electricity is provided for some households by small hydro-generators, each of which power between four and five households. There are seven of these turbines across the village while the rest of the community relies on solar panels. There is good water access from several springs and a pond.

Demographics

Kyauk Hson is a Danu majority village with a small number of members from other ethnic groups. Of the interviewed households' 260 members, 252 were Danu.

Table 1: Sample population of Kyauk Hson by Ethnicity

Ethnic Group	Female	Male	Grand Total
Bamar		4	4
Danu	130	122	252
Other	1	2	3
Shan	1		1
Grand Total	**132**	**128**	**260**

Age figures for the members of sampled households indicate that 55% of the population is under 27. There was little difference by gender across age groups.

Table 2: Sample population of Kyauk Hson by Age Group

Age Group	Female	% of Female	Male	% of Male	Total	% of Total
0-9	22	17%	28	22%	50	19%
10-18	26	20%	25	20%	51	20%
19-27	20	15%	21	16%	41	16%
28-36	25	19%	19	15%	44	17%
37-45	17	13%	12	9%	29	11%
46-54	11	8%	7	5%	18	7%
55-63	6	5%	14	11%	20	8%
64 and above	5	4%	2	2%	7	3%

Table 3: Sample households of Kyauk Hson by Household Size

Number of Household Members	Number of Households in Kyauk Hson Sample
1-2	2
3-4	26
5-6	18
7-9	8
10+	0

Education

147 of the 260 respondent household members have a primary education. There is now a middle school in the village which has improved education access. This was stressed as a recent and significant improvement for village conditions by community members. High school access is to Kyauk Ku or Nawnghkio.

Table 4: Sample population of Kyauk Hson by Gender

Education	Female	Male	Grand Total
Child	3	11	14
Don't Know	6	10	16
High School	9	4	13
Kindergarten	5	1	6
Middle School	14	13	27
Monastic Education	2	19	21
No Education	14		14
Other	1		1
Primary School	78	69	147
University		1	1
Grand Total	**132**	**128**	**260**

Table 5: Occupation of Respondents by Gender of Kyauk Hson sample population

Occupation	Female	Male	Total
Child	3	9	12
Dependent	5	6	11
Farmer	89	88	177
Government Staff	1		1
Other	2	5	7
Student	29	17	46
(blank)	3	3	6
Grand Total	**132**	**128**	**260**

Vulnerability

Of the 55 households interviewed as part of the survey, five were reported as having a female household head.

Table 5: Households with Disabled People in Kyauk Hson Sample

Type of disability	Number of afflicted individuals
Blind	1

Livelihoods

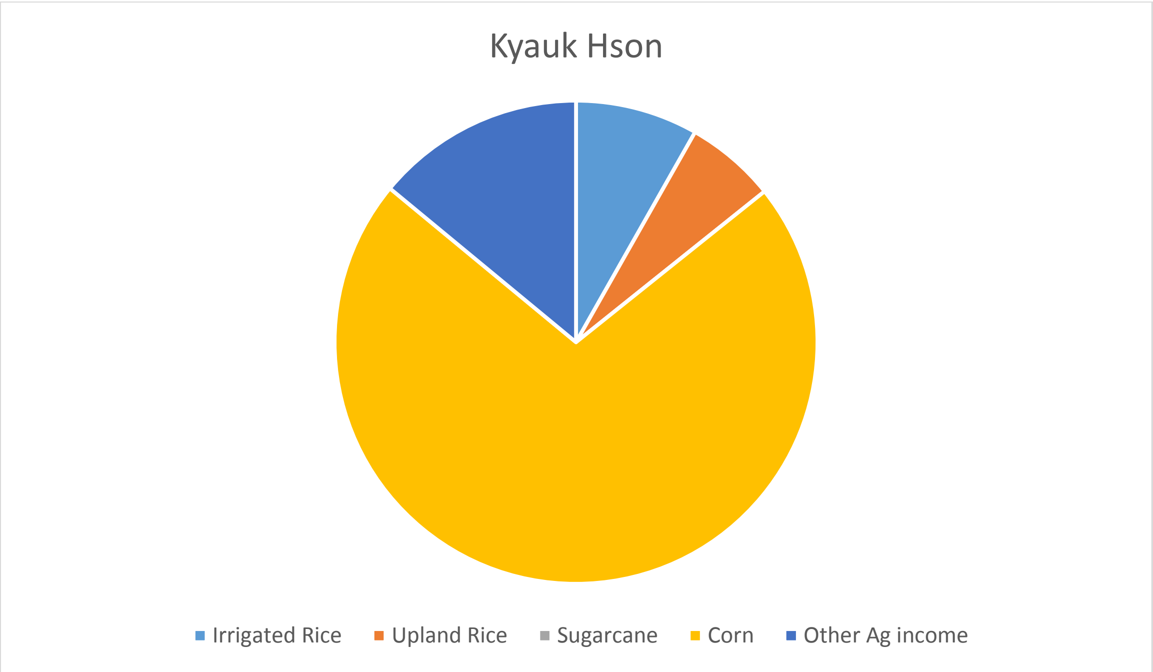


Figure 1: Estimated annual income from major crops

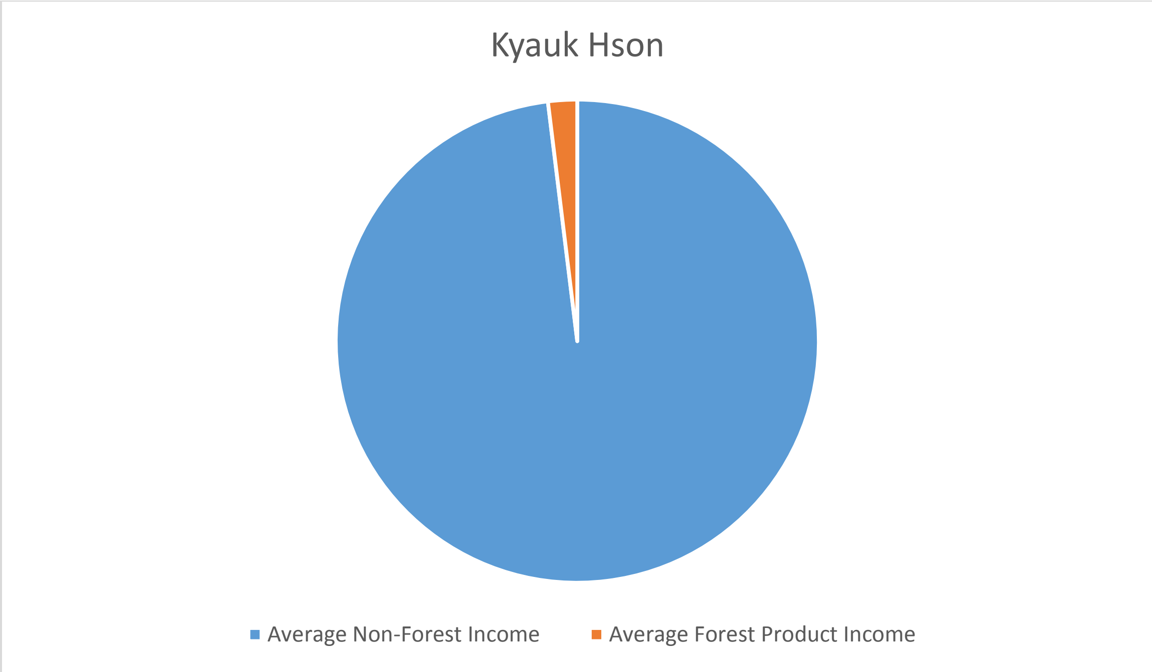


Figure 2: Forest income vs. Non-forest income

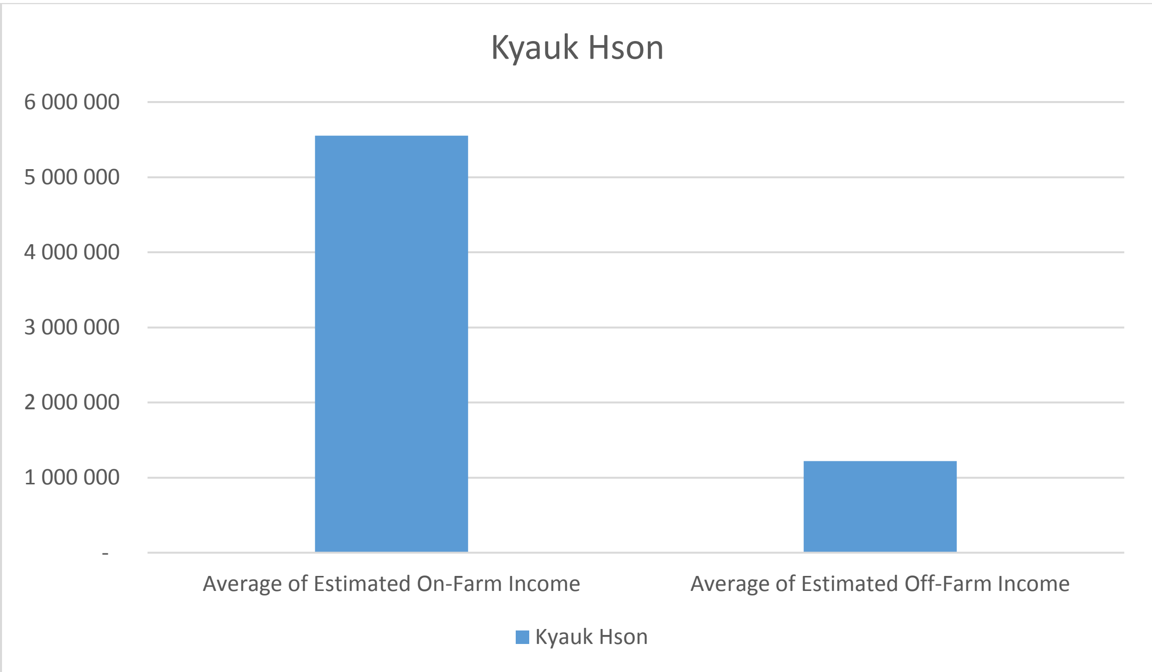


Figure 3: Agriculture income vs. Non-Agricultural income

Village profile of Nawnghkio Gyi:

Village Overview

Nawnghkio Gyi is a village of 288 households located on the right bank of the Mytinge River in the 'Upper Right' quadrant for EIA analysis. The survey was conducted in 2017. The village has good road access via an improved but unpaved branch road that meets with route 41 outside of Nawnghkio. Travel time by motorbike to Nawnghkio Gyi from Nawnghkio is approximately 40 minutes.

The village was founded in 1878 and village elders reported it was well known across Shan because the colonial leader Saya San sought refuge from British forces for several days before moving north and his eventual arrest in Hsipaw.

Livelihoods in the village revolve around agriculture, predominantly growing sugar cane, all of which is sold to the factory at Nawnghkio. In the focus group discussion, village leaders reported that there are now more than 80 agricultural machines in the village, including more than 40 large trucks used to transport cut sugar cane. The village does also grow corn which is sold to Nawnghkio for eventual shipment to China. There are no landless households in the village and as the village still has room to expand, those with less land can fell trees and create more taungyya land if they choose.

However, over time the village has become more aware of the environmental risks cutting down forests cause and so have designated certain areas (including nearer the river) as village forests to be preserved. However, they have no official community forestry paperwork or documentation.

Market access is to Kan Gyi, which hosts a 5-day rotating market. Most agricultural sales (apart from sugarcane) happen at Nawnghkio.

The village has good drinking and household use water access thanks to several in-village bore wells and two large ponds near the village that are piped into the community. There are a small number of agricultural areas that are irrigated, but as with most villages in the impact zones, most agricultural land is unirrigated, upland cropland.

All households in the village have access to solar panel, with sizes varying based on household wealth; there is no grid electricity. There is good mobile connectivity with 3G in the village.

Nawnghkio Gyi is not the village tract village, but is where the village tract administrator lived (at the time of research; there has since been a local election the results of which are unknown) and has a small office building. There is a middle school within the village; for high school students must travel to Nawnghkio or the village tract village of Kan Gyi. The village has its own rural health center staffed with two junior midwives whose primary role is providing child and maternal health, including vaccinations. For additional health care and to access medication, villagers must travel to Nawnghkio or Kan Gyi

Demographics

Nawnghkio Gyi has a mixed ethnicity population, as shown in table below. Within the households interviewed, some 71% of household members are Danu while another 11% of Shan. The remaining population are primarily Shan-Danu mix, but there is a small population of Bamar villagers as well.

Table 1: Sample population of Nawnghkio Gyi by Ethnicity

Ethnic Group	Female	Male	Total
Danu	123	122	245
Other	32	29	61
Shan	14	23	37
Total	**169**	**174**	**343**

Age figures for Nawnghkio Gyi indicate that well over half the population is under 36 (56%) and just seven per cent above 64. There is little gender difference across age groups, with the exception of the 37-45 age bracket which has a notably smaller proportion of men than women.

Table 2: Sample population of Nawnghkio Gyi by Age Group

Age group	Female	% of Female	Male	% of Male	Total	% of total
0-9	17	10%	18	10%	35	10%
10-18	26	15%	31	18%	57	16%
19-27	28	16%	29	16%	57	16%
28-36	25	15%	25	14%	50	14%
37-45	24	14%	15	9%	39	11%
46-54	25	15%	26	15%	51	15%
55-63	15	9%	19	11%	34	10%
64 and above	10	6%	13	7%	23	7%

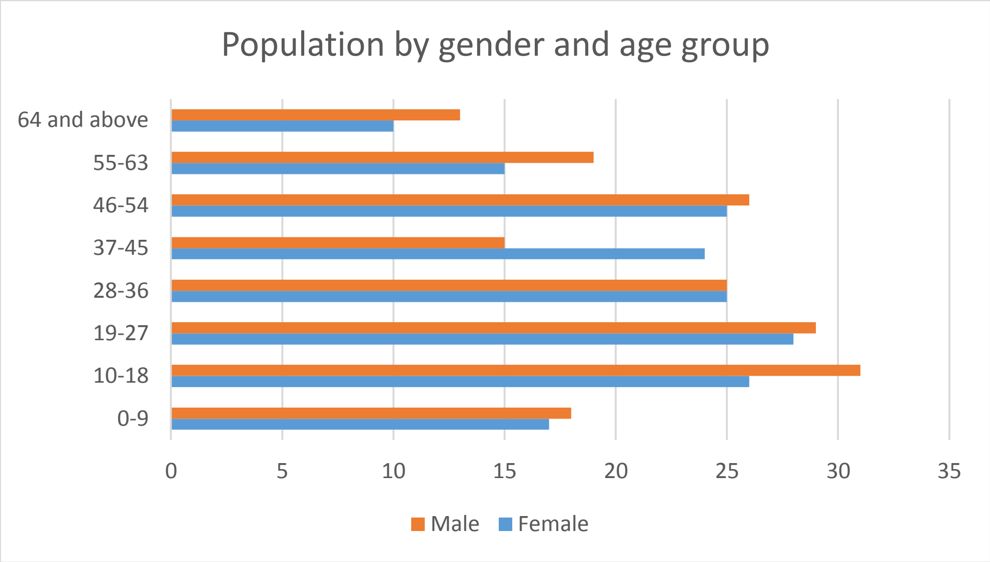


Figure 1: Population by gender and age group

Households in Nawnghkio Gyi tend to be between three and six people; 20, or 27%, of households interviewed consisted of four people.

Table 3: Sample households of Nawnghkio Gyi by Household Size

Number of Households Members	Number of Households
1-2	5
3-4	31
5-6	28
7-9	10
10+	0
Total	**74**

Education

Well over half of respondents' households have only a primary school education. The presence of a middle school in the village will likely see the proportion of residents with somewhat higher education increase, but it that is a slower process. The small number of high school students is unsurprising.

Table 4: Education levels of sample population of Nawnghkio Gyi by Gender

Education Level	Female	Male	Total
No Education/Child	11	4	15
Kindergarten	4	3	7
Monastic Education	2	9	11
Primary	99	102	201
Middle School	31	28	59
High School	9	19	28
Graduate	2		2
University	7	5	12

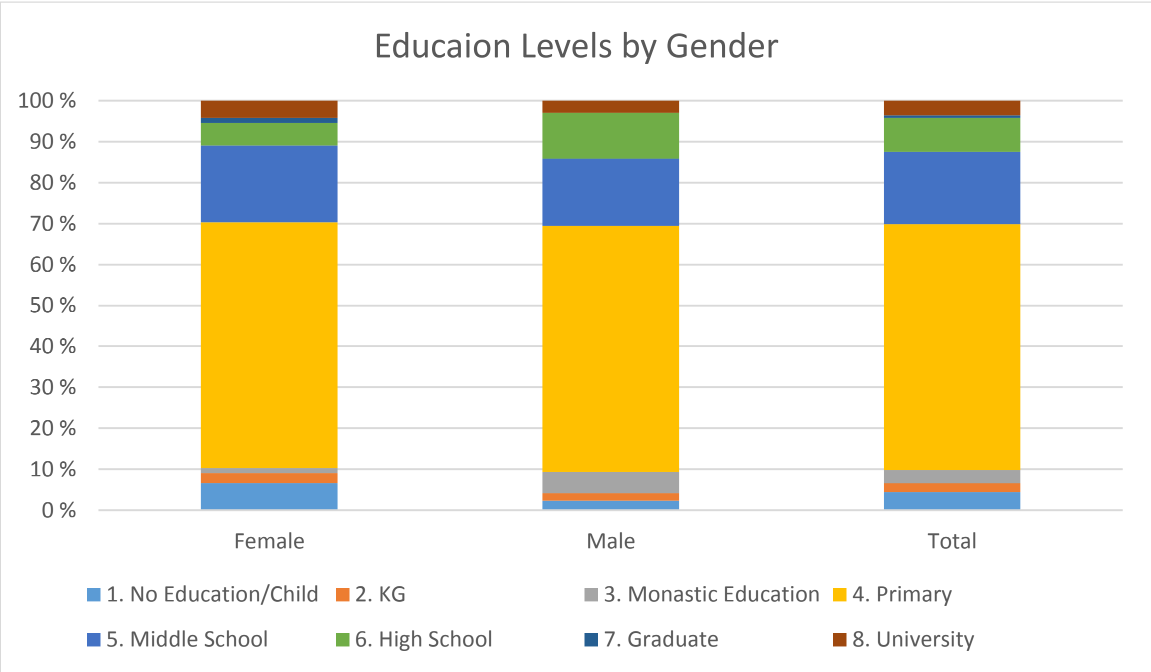


Figure 2: Education levels by gender

Occupations and Livelihoods

Table 5: Occupation of Respondents by Gender of Nawnghkio Gyi sample population

Occupation	Female	Male	Total
Farmer	122	130	252
Student	27	28	55
Dependent	12	9	21
Child	3	2	5
Driver	0	2	2
Government staff/Formal Employment	3	2	5
Other	2	0	2
Totals	**169**	**173**	**342**

Vulnerability

Of the 74 households interviewed as part of the survey, eight were reported as having a female household head.

Table 6: Households with Disabled People in Nawnghkio Gyi Sample

Type of disability	Number of afflicted individuals
Deafness	2
Mute	2
Other	2

Livelihoods

As with most of the impact zones' villages, the majority of income comes from the sale of agricultural crops. Nawnghkio Gyi's position in the upper right quadrant means it has ready access to the Nawnghkio sugar mill; as a result, the vast majority of it income from comes sugar cane. As noted in the baseline's main text, Nawnghkio Gyi has the highest estimated income of any village in the impact zone.

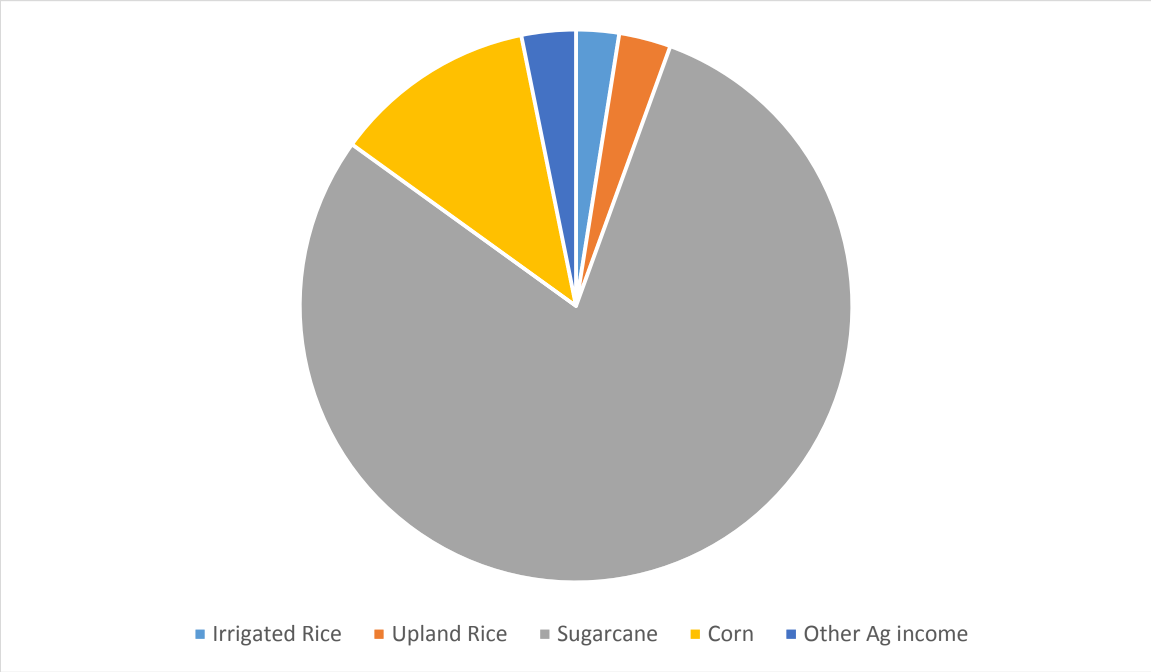


Figure 3: Estimated annual income from major crops

In keeping with the other villages in the impact zones, only a small proportion of income in Nawnghkio Gyi comes from forest products. Figure 2 shows the proportion of estimated average income received from forest products.

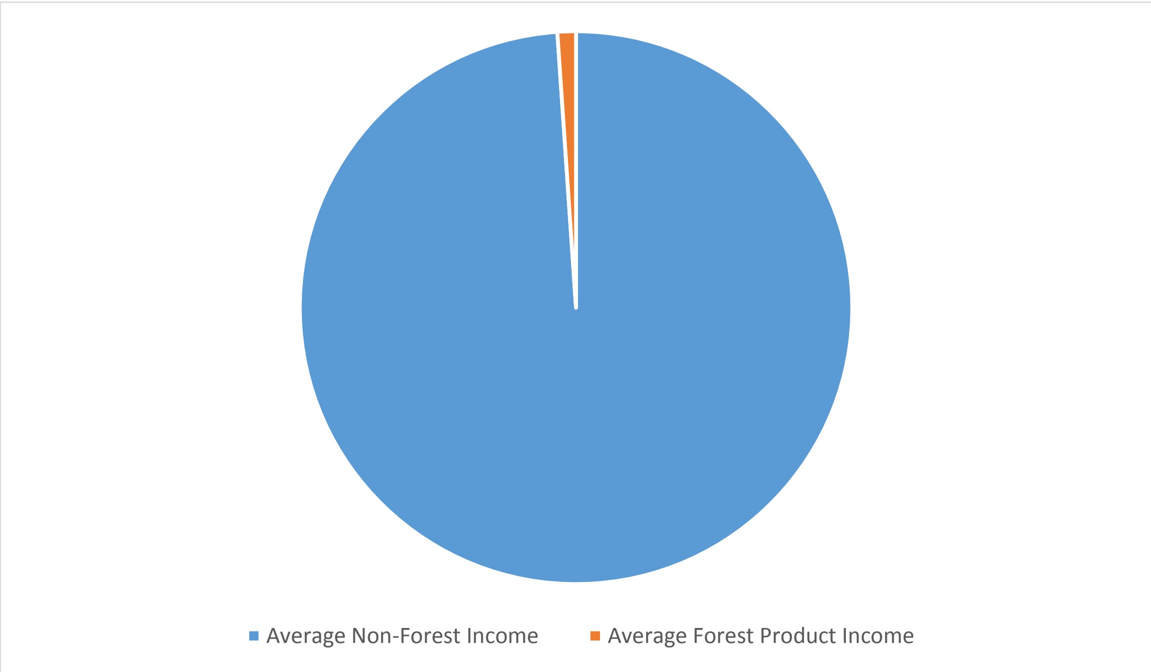


Figure 4: Forest income vs. Non-forest income

However, in order to understand the full importance of income forest products, it is necessary to evaluate its position among only households who receive income from these sources. Of the 85 total households interviewed, a total of 72 received at least some income from forest product, with the average income from forest products at MMK 104,153. Given incomes in Nawnghkio Gyi averaged over 6.5 million kyat, this remains an extremely small proportion of total income (approximately 1.5%).

Non-farm income makes up a somewhat larger proportion of income, but continues to account for less than 20%, despite the fact that Nawnghkio Gyi is perhaps the village with best access to the large market centers of Nawnghkio and Kan Gyi.

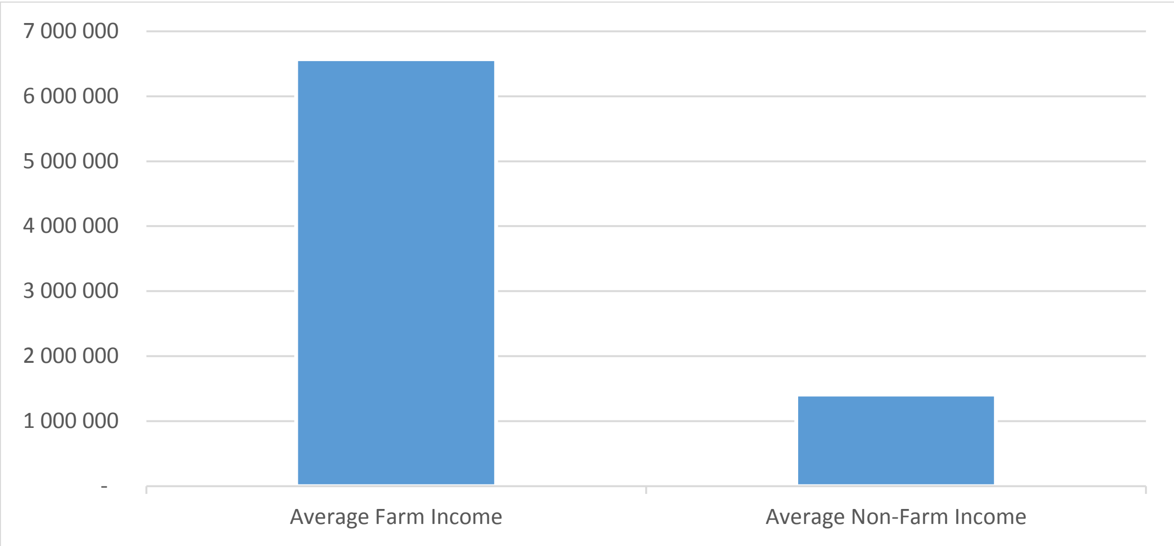


Figure 3: Farm income vs. Non-farm income

Village profile of Tawng Hkan:

Village Overview

Tawng Hkam is a village of 112 households located on the left bank of the Mytinge River in Zone 4D (lower left bank) within the indirect impact zone. The survey was conducted in 2017. The village has medium road access via an unpaved but relatively low incline branch road that meets route 41 in the village tract village of Kyauk Ku (also the market center). Travel time from Hpet Yin Kone to Kyauk Ku by motorbike is 20-25 minutes; travel time to Nawnghkio town is approximately 2.75 hours.

The eastern part of the village was founded in 1870, with the western portion springing up some 30 years later. As a result of this two-stage founding, the village has two of certain key infrastructure such two Nat shrines, two cemeteries etc. However, the founding story of the village is unclear.

Livelihoods in the village revolve around farming with paddy and peanut as the most traditional crops, the former for consumption and the latter for both consumption and market. In the last 10 years, farmers have also begun to grow sesame, soybean, and corn for market. Farmland in the village is not registered with government (i.e. no formal tenure) but all households have traditional use of at least a small amount of land. Most household have between 8 and 10 acres of land; a few larger farmers have 30-40 acres. As of the last 2-3 years, the village no longer is able to rest parts of upland farmland each year in a shifting pattern, instead planting their entire holding. Many households (100 or more) have and use hand tractors in agriculture; there are no large tractors used in the village.

Households raise livestock but only for their own consumption. All households have chickens and over half have a pig. In recent years households have sold their cows and buffaloes used to work the land and replaced them with hand tractors.

Market access is primarily to Kyauk Ku; the village jointly has a truck to take their agricultural products.

Forest use is limited, honey and other products are sometimes collected and sold within the village but this has limited contribution to incomes. There are local orchards within the village, primarily mango, totaling between 200 and 400 trees. Djenkol bean trees and avocado trees are common within the village.

Tawng Hkam has a primary school; middle school and high schools are located at Kyauk Ku. The village school has 7 staff (1 principal, 5 teachers, 1 clerk) and provides education for 55 students. There is no rural health center in the village and no government health staff. Several villagers received first aid/mid-wife trainings from the government.

Water access is a primary concern of the village as the nearest water supply is three miles from the village. It is a natural reservoir that is pumped to holding tanks in the village. Electricity is provided by household solar panels; 50% of households have them, the remainder cannot afford.

Demographics

Tawng Hkan is a Danu village with all but one of the 112 members of interviewed households reporting as ethnically Danu.

Table 1: Sample population of Tawng Hkan by ethnicity

Row Labels	Female	Male	Total
Bamar		1	1
Danu	54	57	111
Total	**54**	**58**	**112**

Age figures for Tawng Hkan indicate that just over half the population is under 27 with just 9% over 55. There was little difference by gender across age groups.

Table 2: Sample population of Tawng Hkam by age group

Age Group	Female	% Female	Male	% Male	Total	% of Total
0-9	12	22%	10	17%	22	20%
10-18	5	9%	9	16%	14	13%
19-27	14	26%	13	22%	27	24%
28-36	8	15%	6	10%	14	13%
37-45	6	11%	6	10%	12	11%
46-54	6	11%	6	10%	12	11%
55-63	2	4%	4	7%	6	5%
64 and above	1	2%	4	7%	5	4%
Total	54		58		112	

Table 3: Sample households of Tawng Hkam by household size

Household Members	Households in sample
1-2	2
3-4	18
5-6	6
7-9	2
10+	0

Education

Over half of the members of respondent households have a primary education. There is no middle school in the village and access to further education in Kyauk Ku and beyond is by motorbike and reflects ability of the household to pay for boarding and other school costs.

Table 4: Education levels of sample population of Tawng Hkam by Gender

Type of Education	Female	Male	Total
Child	1	2	3
High School		5	5
Middle School	8	6	14
Monastic Education	4	8	12
No Education	4	2	6
Pre School	1	1	2
Primary School	32	29	61
Unknown	4	5	9
Total	**54**	**58**	**112**

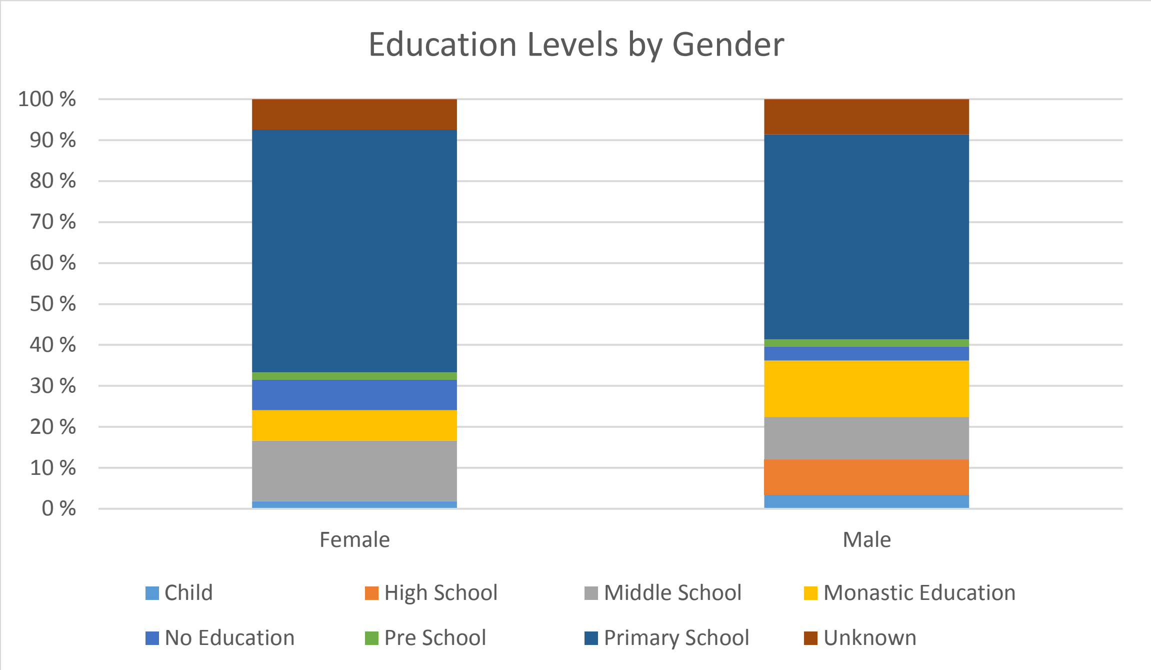


Figure 1: Education levels by gender

Table 5: Occupation of Respondents by Gender of Tawng Hkam sample population

Row Labels	Female	Male	Total
Child	4	6	10
Dependent	2	2	4
Farmer	36	40	76
Student	12	10	22
Total	**54**	**58**	**112**

Vulnerability

Of the 28 households interviewed as part of the survey, one was reported as having a female household head.

Table 5: Households with Disabled People in Tawng Hkam Sample

Type of disability	Number of afflicted individuals
Deaf	2
Mute	1
Deaf/Mute	1

Livelihoods

As with most of the impact zone's villages, the majority of income comes from the sale of agricultural crops. Tawng Hkan's position in Zone D means it relies primarily on corn as the major crop, but with other crops playing important roles, including rice, as well as sesame and groundnut.

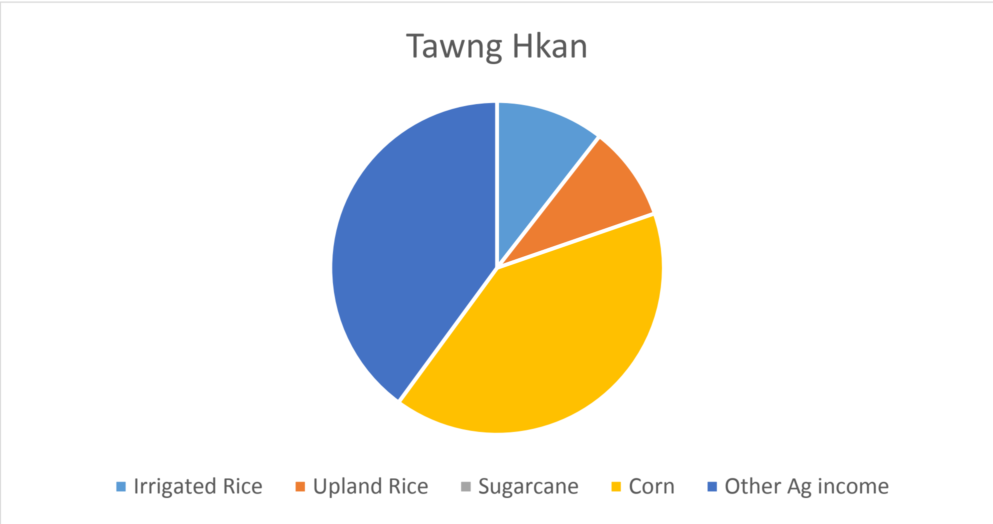


Figure 2: Estimated annual income from major crops

Forest income makes up a vanishingly small proportion of the average household income for households in Tawng Hkan, less than 1%.

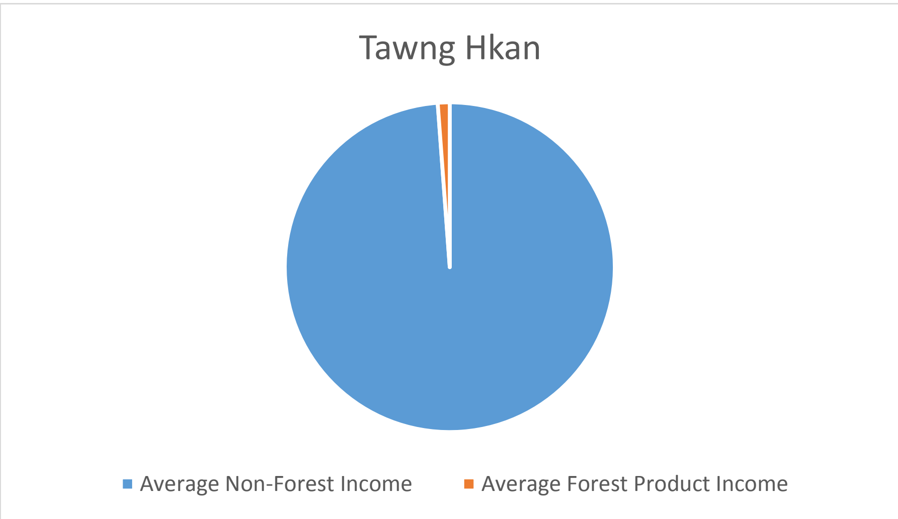


Figure 3: Forest income against non-forest income

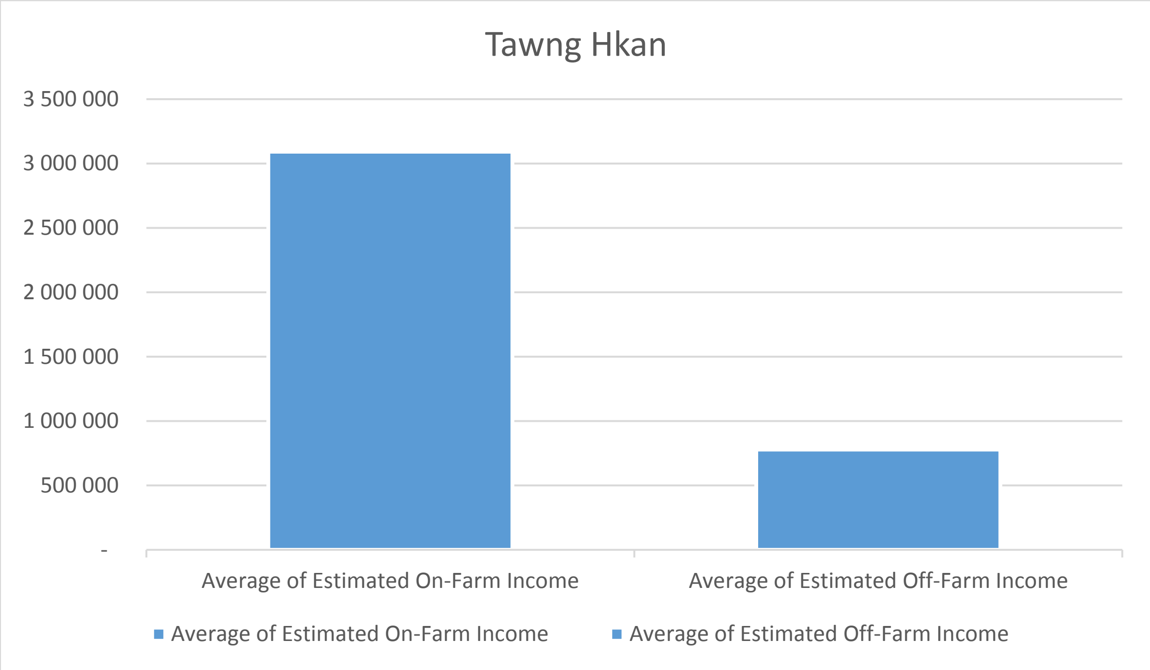


Figure 4: Agriculture income against non-agricultural income

Village profile of Pin Ping:

Village Overview

Pin Ping is a village of more than 300 households located on the left bank of the Mytinge River in the 'Upper Left' quadrant for Middle Yeywa EIA analysis. The SIA survey for Pin Ping was conducted in 2017. The village has extremely poor road access via an unimproved, bad quality dirt road that is extremely steep. In dry season the village is accessible by 4x4; in monsoon it is only accessible by motorbike and local 'trologyi' transport. This road connects to route 41 just south of the dam site as the road climbs out of the valley up to the plateau. Travel time to Kyauk Ku village and market center is 2.5 hours in good weather by 4x4; travel time to Nawnghkio town is 4-5 hours. In poor weather or by motorbike, these travel times can increase significantly.

Ping Ping has existed as a village for over 200 years, though it has grown significantly in the last fifty years. A village elder present for an interview reported that when he was young, there were just 40 households in the village. Far from the main routes connecting larger towns, there has been little out migration: village leaders reported that just 15 people had moved out of the village.

Corn is the main agricultural crop, grown in upland fields and then transported to Nawnghkio for sale and eventual use in China. Other crops that are grown either for local sale or household use include upland rice, ground nut, and sesame. All the land is upland/Taungya and there is one harvest per year. None of the village's farmland is registered with the government so land tenure is based on tradition rather than fiat. Of the approximately 300 households in the village, some 200 have land while the remaining households work as laborers. Villagers measure land in 'blocks', 12 of which is equivalent to an acre. As of the last few years, farmers increasingly use chemical fertilizer and approximately 50 households have hand tractors. There are several large tractors in the village also and crop rotation remains common.

Livestock is raised by only a small number of households (approx. 40) for consumption. There are two households that have converted some of their farmland into tea plantations. Forest use is limited to hunting for household consumption and collecting honey or mushrooms.

Pin Ping has both a primary and a middle school, the latter of which was recently introduced. The nearest high school is in Kyauk Ku village, though wealthier households, the only ones who can afford further education, send their children to Mandalay or Pyin Oo Lwin for high school. There is a government-run rural health center in the village with two midwives stationed there responsible for pre-natal care and immunizations in the surrounding villages.

Water access is via a series of wells and one large pond that is used for washing and livestock drinking water. Each household has its own large water tanks that store monsoon rains. Some households have to fetch drinking water from other villages during the hot season.

Demographics

Pin Ping is a Danu village; all members of interviewed households were ethnically Danu

Table 1: Sample population of Pin Ping by Ethnicity

Group	Female	Male
Danu	199	190

Age figures for Pin Ping indicate that half of the population is under 27 (52%) with just 12% over 52. There is little difference in the population's age distribution by gender.

Table 2:Sample population of Pin Ping by Age Group

Age Group	Female	% female	Male	% male	Total	% of total
0-9	40	20%	33	17%	74	19%
10-18	31	16%	30	16%	61	16%
19-27	34	17%	32	17%	66	17%
28-36	27	14%	32	17%	59	15%
37-45	25	13%	19	10%	44	11%
46-54	19	10%	10	5%	29	7%
55-63	9	5%	16	8%	25	6%
64 >	11	6%	14	7%	25	6%
Not known	3	2%	4	2%	7	2%
Grand Total	**199**		**190**		**390**	

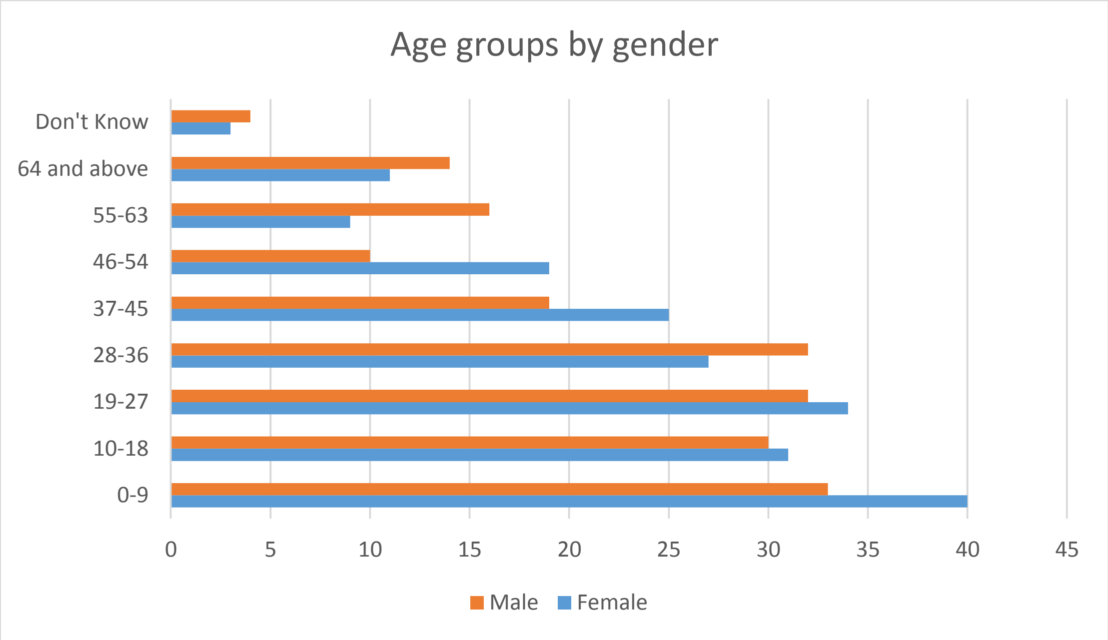


Figure 1: Age group by gender

Household size is similar to other villages, with 3-4 and 5-6 being the most common household sizes. 28% of interviewed households have 4 people in their households.

Table 2 Sample households of Pin Ping by Household Size

Number of Households Members	# of Households
1-2	6
3-4	37
5-6	24
7-9	15
10+	1
Total	**83**

Education

Education levels are low in Pin Ping: as with other villages a large proportion, over 50%) of the members of respondent households have primary education, but Pin Ping also has a high proportion (over 30%) who reported having no education. Most of these are women—men reported much higher levels of monastic education which is less accessible to women—suggesting a larger gender education gap than is found in other areas of the impact zone. While a small number of these individuals would be children, this is still much higher than villages in other parts of the impact zone and reflects the lack of access to education in the village until recent years, and the continued challenges of accessing education facilities beyond the village given poor transportation links.

Table 3: Education levels of sample population of Pin Ping by Gender

Education level	Female	Male	Total
Primary School	81	75	156
No Education/Child	89	32	122
Monastic Education	7	48	55
Middle School	19	25	44
High School	1	7	8
Unknown	2	6	8
Adult Literacy Campaign (AAA)	3		3
Graduate	1		1

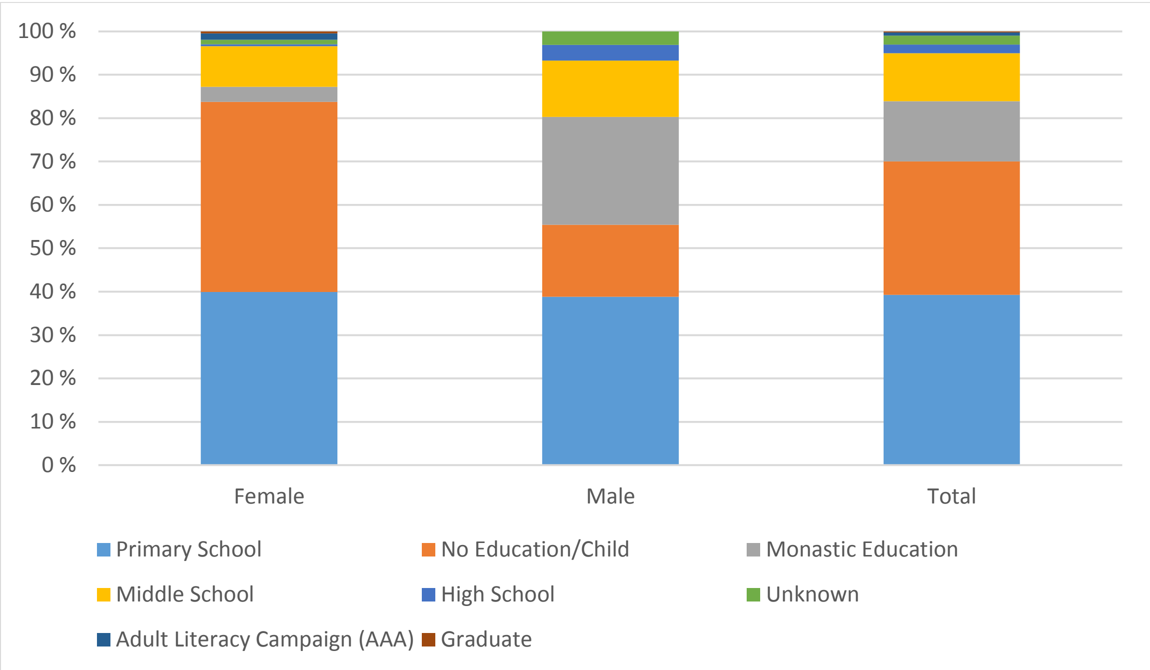


Figure 2: Education by gender of respondents

Table 4: Occupation of Respondents by gender of Pin Ping sample population

Occupation	Female	Male	Total
Farmer	149	141	290
Dependent/Child	26	22	48
Student	20	21	41
Novice		1	1
Trader		1	1

Vulnerability

Of the 83 households interviewed, 8 were reported as having a female household head.

Table 5: Households with disabled people in Pin Ping Sample

Type of Disability	Number of Afflicted Individuals
Blindness	1
Deafness	2
Other	

Livelihoods

As with most of the impact zone's villages, the majority of income comes from the sale of agricultural crops. Pin Ping's position in cone4 the upper left quadrant means its farmers rely primarily on corn as the major cash crop, but upland rice and secondary crops, such as groundnut, are also common.

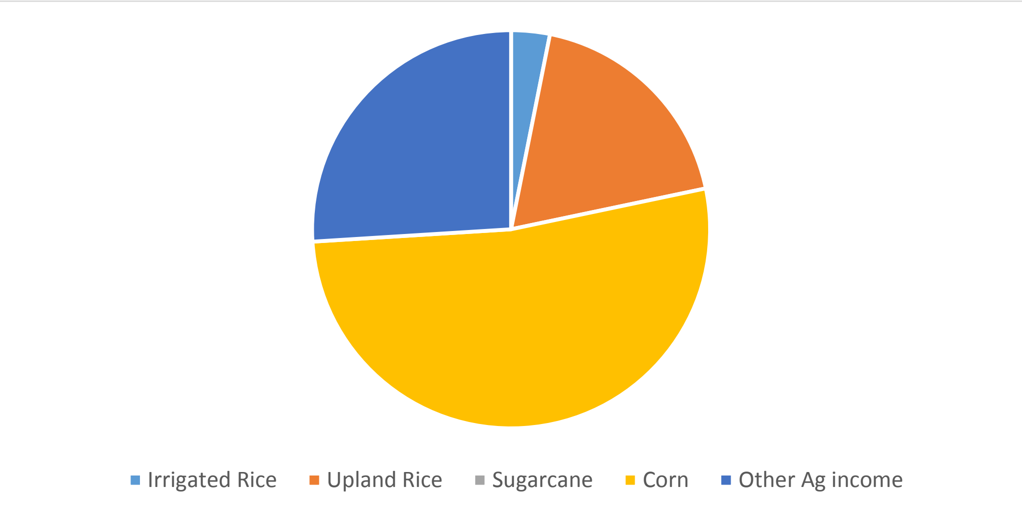


Figure 3: Estimated annual income from major crops

Income from forest sources makes up a very small proportion of the average income in Pin Ping.

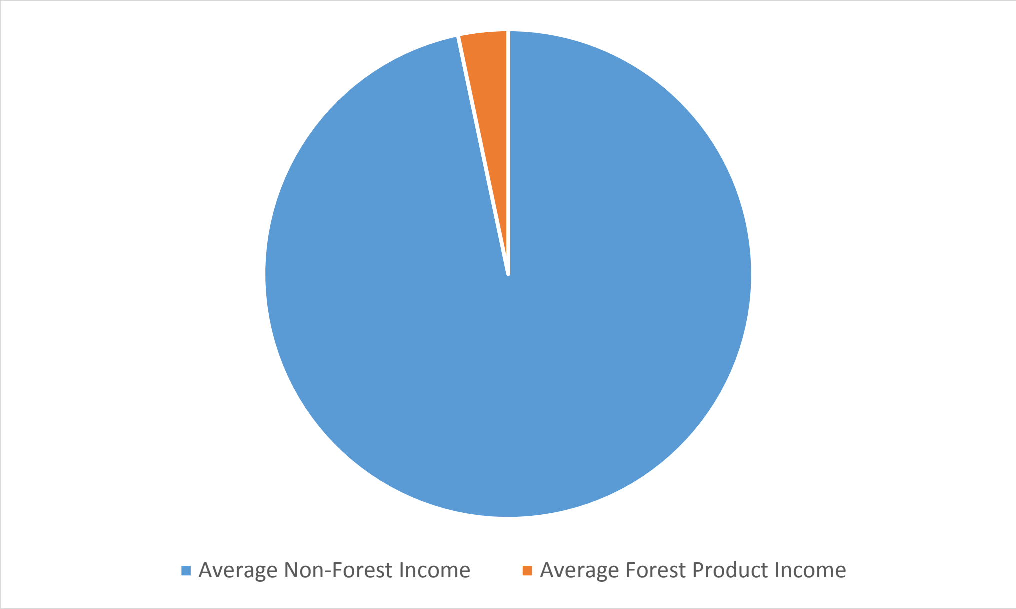


Figure 4: Forest income vs. Non-forest income

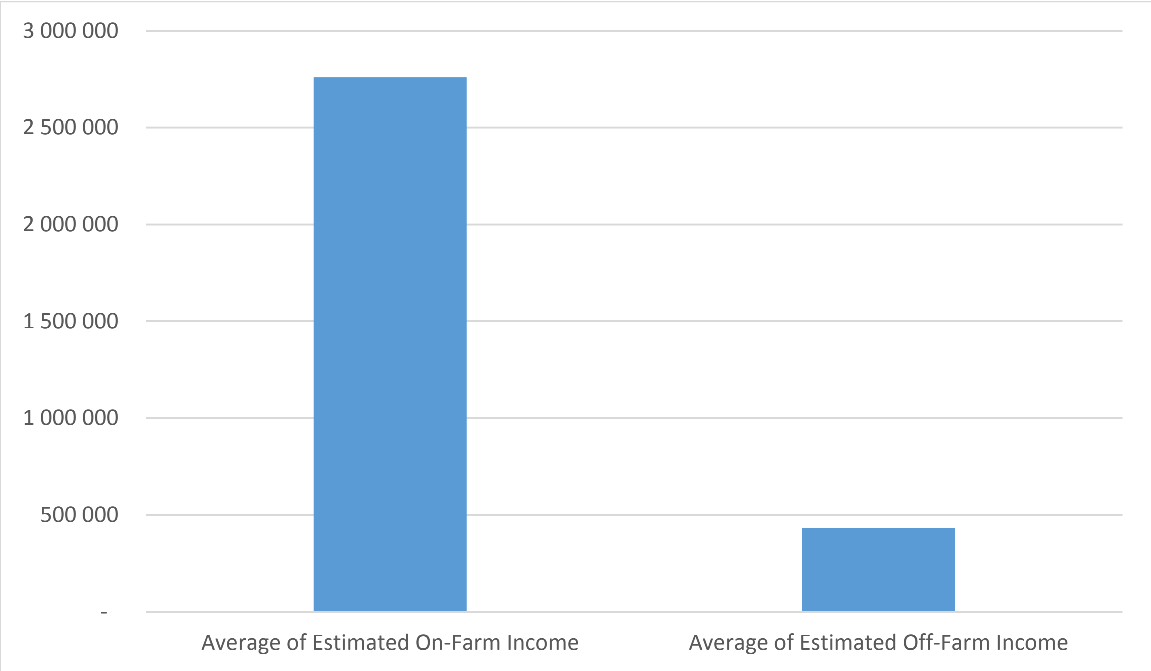


Figure 5: Farm income vs. Non-Farm income

Village profile of Thar Si

Village Overview

Thar Si is a village of approximately 275 households located on the left bank of the Myitnge River in zone 4C of the indirect impact zone. The socio-economic survey was conducted in 2017. The village has extremely poor road access via an unimproved, bad quality dirt road that is extremely steep. In dry season the village is accessible by 4x4; in monsoon it is only accessible by motorbike and local ‘trologyi’ transport. This road connects to route 41 just south of the dam site as the road climbs out of the valley up to the plateau. Travel time to Kyauk Ku village and market center is 1.5 hours in good weather by 4x4; travel time to Nawnghkio town is 3.5-4.5 hours. In poor weather or by motorbike, these travel times can increase significantly.

The village was established in 1936 by inhabitants of two other villages that were located in so-called ‘brown zones’ where there was active conflict between ethnic armed groups and the Myanmar government. These villagers’ farmland was located near where Thar Si is today; during the conflict the villagers would often stay near their farmland and, over time, built homes and moved permanently. The village has grown significantly since that time: interviewed village elders reported that when they were young, there were just 40 households in Thar Si.

Thar Si’s main cash crop is corn which grown and sold to Nawnghkio for export to China. Households also grow paddy for consumption; the bulk of this is upland paddy as there is little irrigation and most farmland is taungya. Other crops, grown for smaller scale sale and village-level consumption include black sesame and groundnut. There is no formal land tenure but almost all households have access to customarily-owned land (village leaders estimated that 8-10 households did not have land). The village’s farmers are roughly split in three when it comes to land holding: one third have less than five acres, one third has between 20 and 50 acres, one third are larger farmers with between 50 and 300 acres. Land holdings in Thar Si are larger than other villages included in the impact zone. A few of the largest farmers have more than 300 acres. These larger farmers higher landless workers and larger farmers as labour across the growing season—an exception from other villages in the impact zone where non-family labour was generally reported as necessary only during peak planting and harvesting seasons.

All of Thar Si’s farmers use chemical fertilizer but this is only in the last few years. Approximately one third of households have small hand tractors while four of the largest farmers have large tractors. Other households rely on buffalos and cows, or rent hand tractors from other villagers. Almost all households raise animals for household consumption; there is little sale of livestock.

Market access is primarily to Kyauk Ku’s rotating market for purchasing goods while crops are sold in Nawnghkio. Due to the poor road quality, transportation costs are significant: it costs MMK 10,000 per visit to transport their harvest to the brokers in Nawnghkio.

Forest use is limited; there is no community forest and some villagers use forest products for consumption including a limited amount of charcoal production for household use and in the village. Thar Si households, as shown below, do indicate a higher reliance on forest products as contributors to income than in other impact zone villages.

Thar Si has a primary school and the nearest middle school is at the fellow impact zone village of Pin Ping, approximately 40 minutes by motorbike away. There is a high school at Taung Kham, some 20 miles away, and at Kyauk Ku. As a result, high school students have to board; for most education ends at the primary level. There is no rural health centre in Thar Si, villages generally visit the one in Taung Kham village.

Most of Thar Si accesses water from natural springs some ten minute's walk from the village centre. Five wealthy households hired a company to build each of them a tube well some years ago, each of which cost approximately MMK 2 million. Most households also have large tanks to store monsoon rains. Approximately 30% of Thar Si's households have solar panels to provide electricity, the remainder rely on candles.

Demographics

As with other villages in the impact zone, Thar Si is a Danu-majority village with small numbers of other ethnic groups who generally have married in to the community.

Table 1: Thar Si Demographics by ethnic group

Ethnic Groups	Female	Male	Total
Bamar	1	2	3
Danu	111	112	223
Other	3	4	7
Shan		1	1
Total	**115**	**119**	**234**

Age figures for Thar Si indicate that almost 60% of the population is under 27, with just 12% over 55. As with other impact zone villages, there is a large youth population.

Table 2: Sample households' population of Thar Si by age group

Age Group	Female	% Female	Male	% Male	Total	% of Total
0-9	22	19%	26	21%	48	20%
10-18	24	20%	30	24%	54	22%
19-27	20	17%	21	17%	41	17%
28-36	10	8%	12	10%	22	9%
37-45	14	12%	15	12%	29	12%
46-54	11	9%	10	8%	21	9%
55-63	11	9%	6	5%	17	7%
64 >	6	5%	5	4%	11	5%
Total	**118**		**125**		**243**	

Household size in Thar Si is similar to other villages with the 3-4 and 5-6-member households being the most common.

Table 3: Sample households of Thar Si by Household Size

Household Members	Number of Households
1-2	3
3-4	18
5-6	22
7-9	6
10+	0

Education

Education levels are similar to other impact zone villages with just under half having a primary school education. Given the isolated nature of Thar Si, monastic schools have also been an important education provider and very few have had the opportunity to attend middle school, let alone high school.

Table 4: Education levels by gender of Thar Si

Education	Female	Male	Total
Not known	1		1
High School	4	5	9
Middle School	6	6	12
Monastic Education	13	22	35
No Education	31	9	40
Primary School	48	65	113
University		1	1
Kindergarten	2	1	3
Child/Other	11	13	24
Grand Total	**116**	**122**	**238**

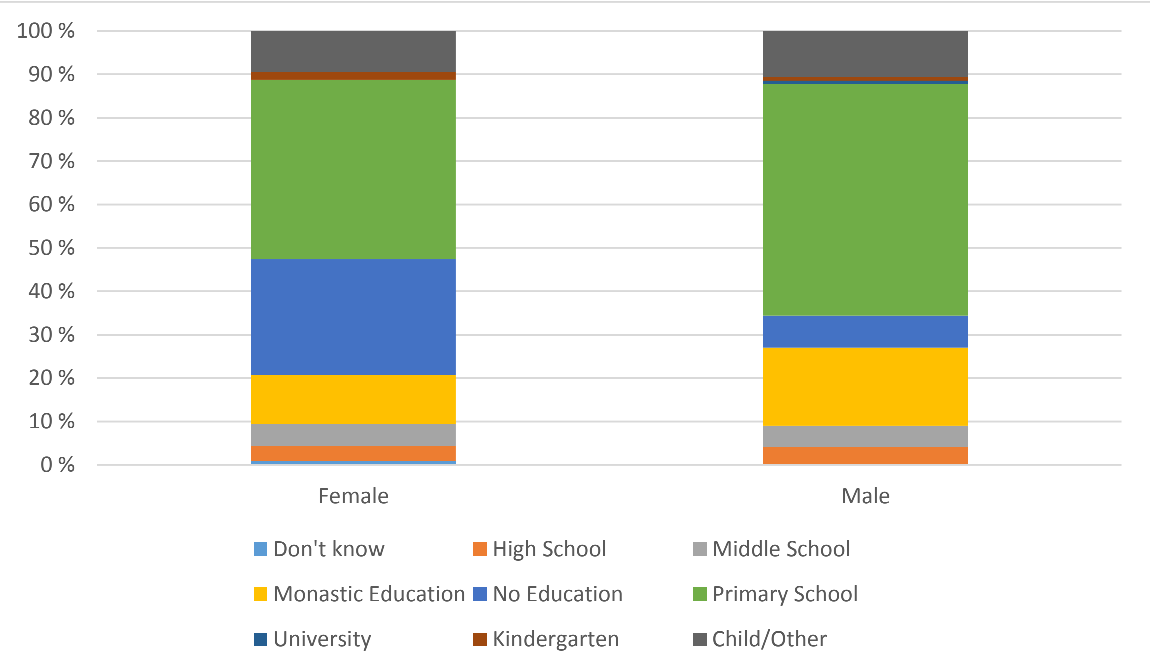


Figure 1: Education levels by gender of Thar Si

Table 5: Occupation of respondents by gender of Thar Si sample population

Occupation	Female	Male	Total
Farmer	75	80	155
Monk		1	1
Novice		2	2
Student	20	21	41
Other	2	2	4
Child/Dependent	20	18	38
Total	**117**	**124**	**241**

Vulnerability

Of the 49 households interviewed, 4 were reported as having a female household head.

Table 6: Households with disabled people in Thar Si

Type of Disability	Number of Afflicted Individuals
Deafness	1
Lame	1
Other	4

Livelihoods

As with other impact zone villages, the majority of Thar Si's income derives from the sale of agricultural crops. Interestingly, Thar Si's appears to have a more even split between different lrop types compared to the other left bank villages that tend to be more completely reliant on corn production.

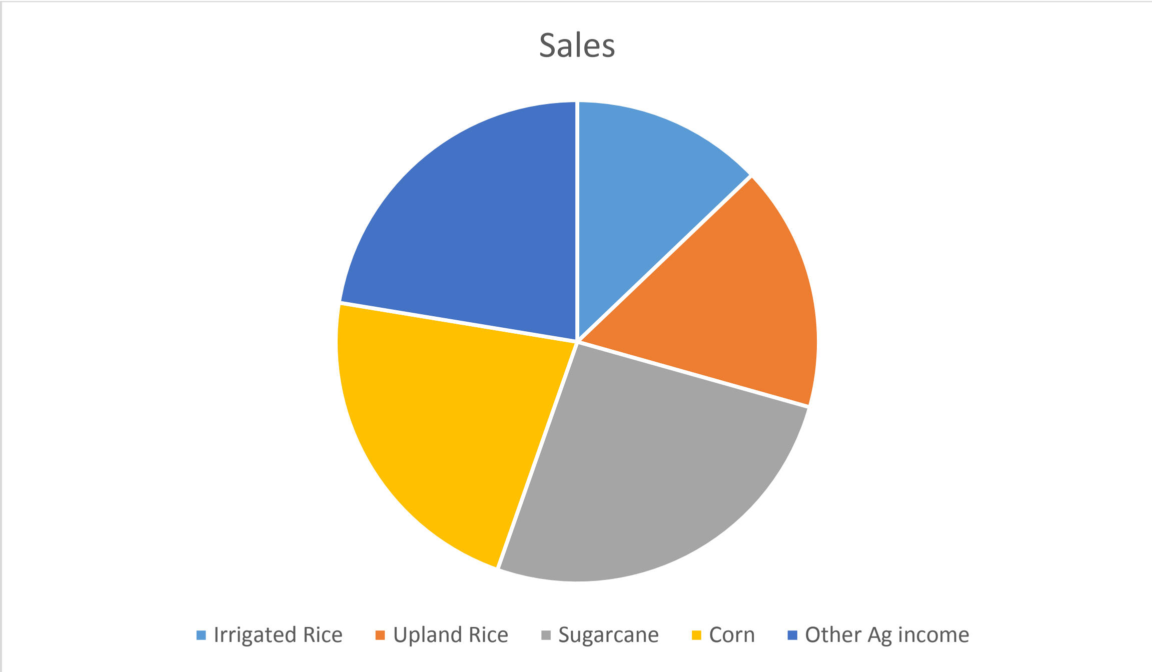


Figure 2: Estimated annual income from major crops

Of all the villages in the impact zones, Thar Si has the greatest access to forests. Other villages have cleared most available land for agriculture but the steep hills around Thar Si limit their ability to be cleared and planted. As a result, it is unsurprising that Thar Si reports a higher proportion of income derived from forest sources compared to other communities, which also affects the proportion of income derived from farm vs non-farm sources.

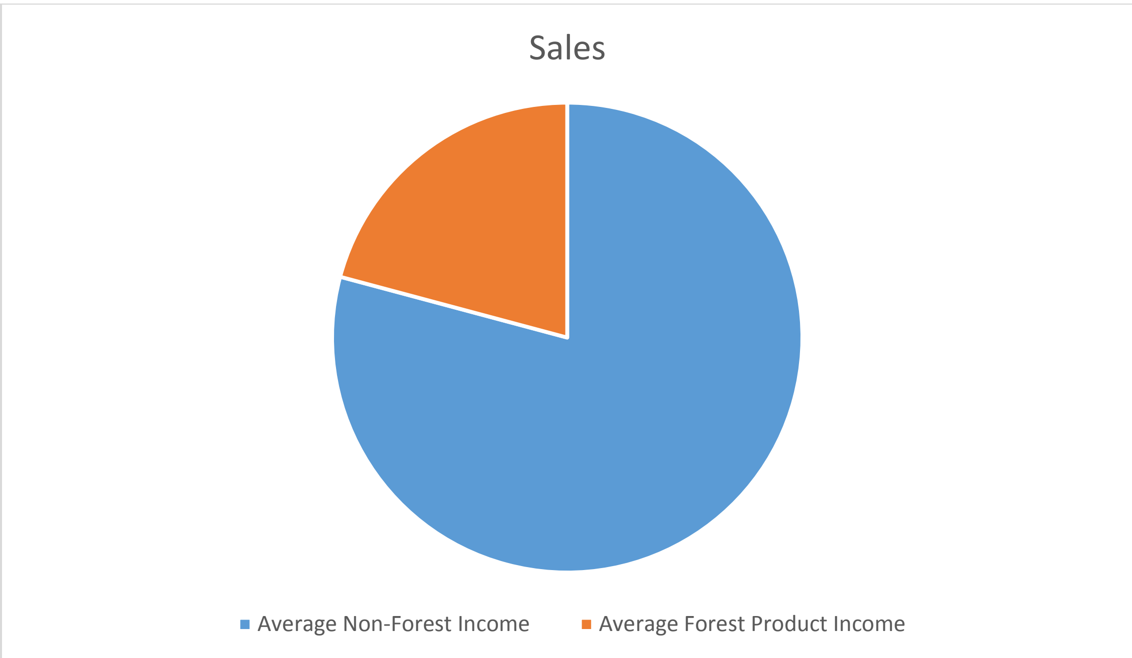


Figure 3: Forest income against non-forest income.

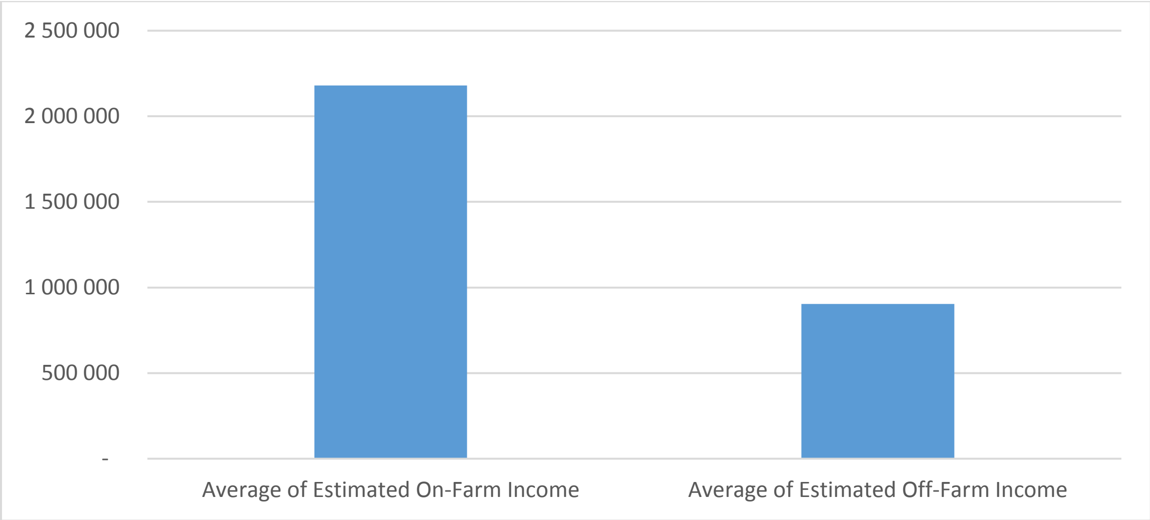


Figure 4: Agriculture income against non-agricultural income