Final Technical Report

Forest Management and Biodiversity Conservation Model for the Ratuwamai Plantation Project

Submitted to
The Ministry of Tourism, Forests & Environment
Enhancing Capacity for Sustainable Management of Forests, Land and Biodiversity in Eastern Hills (FLB) Project
Koshi Province

Submitted by
Innovative Vision Pvt. Ltd
Kathmandu

July 2025

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On

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Project Management Unit
Koshi Province, Biratnagar, Morang

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July 2025

ACRONYMS

ABC	Access to benefit sharing
BMP	Best Management Practices
BCR	Benefit Cost Ratio
CFUGs	Community Forest User Group
CITES	Convention on International Trade of Endangered Species of fauna and flora
COP	Conference of Parties
DBH	Diameter at Breast Height
DCCs	District Coordination Committee
DFRS	Department of Forest Research and Survey
DoD	Drivers of deforestation and forest degradations
ES	Ecosystem Services
EM	Enterprise Manager
EMC	Enterprise Management Committee
EOs	Enterprise Operators
EMCC	Enterprise Management Coordination Committee
FAO	Food and Agriculture Organization
FCP	Forest Cover Percentage
FECOFUN	Federation of Community Forestry Users Nepal
FGD	Focus Group Discussion
FLB	Enhancing Capacity for Sustainable Management of Forests, Land and Biodiversity in Eastern Hills
FRA	Forest Resource Assessment
GEF	Global Environment Facility
GIS	Geographical Information System
GPS	Global Positioning System
GRS	Geographic Resource Solution
IAS	Invasive Alien Species
ICIMOD	International Centre for Integrated Mountain Development
IUCN	International Union for Conservation of Nature
INGO	International Non-governmental Organization
KII	Key Informant Interview
LRP	Local Resource Person
MAPs	Medicinal and Aromatic Plants
MoTFE	Ministry of Tourism, Forests and Environment
MoFE	Ministry of Forests and Environment
NGO	Non-governmental Organization
NPV	Net Present Value
NTFPs	Non-Timber Forest Products
OP	Operational Partner
PPP	Public Private Partnership
PMU	Project Management Unit
QA	Quality Assurance
QC	Quality Control
RPP	Readiness Plan Proposal
SFM	Sustainable Forest Managent
SHL	Sacred Himalayan Landscape
TAL	Terai Arc Landscape

UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change

ACKNOWLEDGEMENT

This study report, conducted by the Innovative Vision Pvt. Ltd. technical team presents a comprehensive assessment of the Ratuwamai plantation project with its current status and future trends along with the sustainable forest management and biodiversity conservation model.

This study has been accomplished through the generosity and support of many peoples, experts, practitioners and local communities. We acknowledge the official of the FLB project for supporting to conduct this study and providing the critical feedback and suggestions. We also would like to thank the officials of for the Ratuwamai Plantation Project for their valuable supports during the field study. Similarly, we thank the mayors and ward chairpersons of Shivasatakshi municipality and Kamal rural municipality of Jhapa District. Without their support and encouragement, this study would not have been possible.

We are grateful to the technical staffs of the Ratuwamai Plantation Project and field technicians and local peoples and members of the community forest user groups for providing data and information. We would like to thank our team members and forest technicians Mr. Ashish Ghimire, Mr. Pushpa Raj Malla, Mr. Surya Bahadur Bohara, Mr. Ramesh Gautam, Mr. Rajesh Gupta and Mr. Ashok Pandey, for helping and to undertake the forest assessment and field data collection. Thanks are due to Mr. Bishal Ghimire, Mr. Akhilesh Kumar Gupta and Mr. Prashant Nepal for their feedback, support and managing the logistic and communication support during the field work.

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EXECUTIVE SUMMARY

This study, based on project analysis, stakeholder consultations, field observations, and relevant literature, presents a comprehensive recommendation for the sustainable and integrated management of forest resources within the Ratuwamai Plantation Project area. The findings underscore the need for a multi-faceted approach tailored to the area's ecological, economic, and social contexts.

Key Recommendations:

1. **Sustainable Forest Management (SFM) of Sal Forests**
   A silviculture-based, scientific forest management system is recommended for natural Sal forests. This includes developing detailed SFM plans and revising the current 80-year rotation period to approximately 60 years, aligning with timber market demand. An irregular Shelterwood system is proposed as the most suitable harvesting method.

2. **Clear Felling and Replantation of Eucalyptus and Teak Plantations**
   Mature plantations should be clear-felled and replanted with appropriate rotation periods (15 years for Eucalyptus, 20–30 years for Teak). Given the project's initial objective of supplying fast-growing timber, this approach remains valid and ecologically feasible for the area.

3. **Promotion of Agroforestry and Private Sector Engagement**
   Reintroduction of intercropping Non-Timber Forest Products (NTFPs) and Medicinal and Aromatic Plants (MAPs) during the early plantation stages is recommended. Collaborations with private enterprises can support essential oil production, enhance local employment, and stabilize timber markets through Public-Private Partnerships (PPPs)

4. **Integration of Ecotourism and Community Use Areas**
   Select Forest areas should be developed for ecotourism and recreational use (e.g., children's parks, sports grounds), in partnership with local governments (Palikas). Revenues will be shared and reinvested in forest management. Special attention should be given to religious and environmental considerations, including the creation of artificial lakes for groundwater recharge.

5. **Zoning and Land Use Allocation**
   Out of the total forest area, it is proposed that:
   - 250–300 ha be managed for timber production from Sal (Active SFM),
   - 2,400 ha for Eucalyptus and Teak plantation management (clear feeling and NTFP/MAP intercropping)
   - 200–300 ha be conserved,
   - 100–200 ha be allocated for ecotourism and recreational purposes- managed by the two Rural Municipalities of the area.

   This zoning will result in the sustainable management of approximately 2,700 ha of forest.
6. **Institutional Framework and Governance**

The success of the Integrated SFM Model depends on a robust institutional framework. It is recommended that the Ministry of Forests and Environment of Koshi Province lead the

implementation, with oversight from a multi-stakeholder Management Committee chaired by the Provincial Secretary. Active involvement of federal, provincial, and local governments, as well as private sector stakeholders, is essential.

EXECUTIVE SUMMARY IN NEPALI

नेपाल सरकारको विकास समिति ऐन २०१३ अर्न्तरगत वन पैदावार विकास समिति (विधान) अर्डर २०३३ अनुसार वन पैदावार विकास समिति स्थापना भएको हो । वन पैदावार विकास समितिले वन तथा भू -संरक्षण मन्त्रालयको मातहतमा रहि कार्य सञ्चालन गर्दछ । यस विकास समितिको उद्देश्य छिटो बढ्ने रुख प्रजातिको उचित व्यवस्थापन मार्फत काठ, दाउरा तथा अन्य वन पैदावारको उत्पादन गर्ने, आयोजनाहरुले उत्पादन गरेका वन पैदावारको सदुपयोग, बिक्री तथा आपूर्ति व्यवस्थापन गर्ने र आयोजना वरिपरि बस्ने स्थानीय जनतालाई रोजगारीको अवसर प्रदान गर्ने रहेको छ । हाल वन पैदावार विकास समितिको व्यवस्थापनमा सागरनाथ वन विकास परियोजना र रतुवामाई वृक्षारोपण आयोजना सञ्चालित छन् । वन पैदावार विकास समितिको आफ्नै वित्तीय स्रोतबाट झापा जिल्लामा आर्थिक वर्ष २०३५/३६ देखि रतुवामाई वृक्षारोपण आयोजना शुरु गरिएको हो । यस आयोजनाको कार्यालय कमल गाउँपालिका वडा नं. ३, केरखामा रहेको छ ।

रतुवामाई वृक्षारोपण आयोजना पूर्वमा कन्काइमाई नदी, पश्चिममा रतुवा खोला, उत्तरमा इलाम जिल्लाको चुलाचुली गउँपालिका र माई नगरपालिका, दक्षिणमा झापा जिल्लाको शिवशताक्षी नगरपालिका, कमल गाउँपालिका र दमक नगरपालिकाको पूर्व पश्चिम लोकमार्ग यति चारकिल्ला भित्रको ३१२५.३१ हेक्टरमा फैलिएको छ ।

आयोजना क्षेत्रमा प्राकृतिक र वृक्षारोपण गरी दुई किसिमको वन पाईन्छ । आयोजनाको उत्तर तर्फको सताक्षीधाम क्षेत्रमा साल प्रजातिको वाहुल्यता रहेको प्राकृतिक वन रहेको छ । यस प्राकृतिक वनको कूल क्षेत्रफल २६८.४४ हे. रहेको छ । वृक्षारोपण वनमा छिटो बढ्ने टिक, मसला र कदम प्रजातिहरु वृक्षारोपण गरिएको छ । आ. व. २०७३/०७४ मा केरखा क्षेत्र (कम्पार्टमेन्ट नं. ७) मा परीक्षणको रुपमा पाँच-पाँच हेक्टरमा रबर र अगारउडको वृक्षारोपण गरिएको छ । यसको अतिरिक्त आयोजनाको खोला किनारा तथा छेउछाउमा प्राकृतिक रुपमा बृद्धि भएका सिमल प्रजातिका रुखहरु र झाडी क्षेत्रसमेत रहेको पाईन्छन् ।

रतुवामाई वृक्षारोपण क्षेत्रलाई २६ वटा कम्पार्टमेन्टमा विभाजन गरि वन सम्बर्धन तथा वन विकासका कार्यक्रमहरु सञ्चालन हुँदै आएका छन् । यी कम्पार्टमेन्टहरु पूर्व-पश्चिम तथा उत्तर-दक्षिण दिशाबाट निर्माण गरिएको अग्नी रेखा तथा सडकले छुट्टाईएको छ । कम्पार्टमेन्ट नम्बर ४ मा सालको प्राकृतिक वन रहेको छ भने कम्पार्टमेन्ट नं. १, २, ३ र २२ गरी जम्मा ४ वटा कम्पार्टमेन्टहरुमा टिकको वृक्षारोपण गरिएको छ । बाँकी २१ वटा कम्पार्टमेन्टहरुमा मसलाको वृक्षारोपण गरिएको छ ।

वनको व्यवस्थापकीय दृष्टिकोणले हेर्दा हालसम्म सालको प्राकृतिक वन क्षेत्रलाई संरक्षण मात्र गरेको देखिन्छ । सो वन क्षेत्रको दिगो रुपमा व्यवस्थापन भएको छैन । वन क्षेत्रमा काठ दाउरा, ढुंगा, गिट्टी लगायतका वन पैदवारको चोरी निकासी मुख्य समस्याको रुपमा रहेको छ ।

आयोजना अन्तरगत झिलझिले र केरखा गरि २ वटा यूनीटहरु रहेका छन् । आयोजना सञ्चालनको मख्य दायित्व आयोजना प्रमुखमा रहेकोछ ।आयोजना प्रमुखको रुपमा नेपाल सरकार वनसेवाका निजामति कर्मचारी तथा आयोजनाका कर्मचारीहरु समेत खटिई कामकाज गर्ने गरेका छन् ।

आयोजना सञ्चालन तथा वन क्षेत्रको दिगो व्यवस्थापनको लागि हालसम्म दिर्घकालीन व्यवस्थापन योजना नहुँदा आयोजनका क्रियाकलापहरु योजनाबद्ध रुपमा सञ्चालन हुन नसकेको देखिन्छ । विभिन्न व्यक्ति संस्था तथा सरकारी एवं गैर सरकारी निकायहरुबाट आयोजनाको वन क्षेत्र अतिक्रमण भएको छ । वनको दिगो एवं बैज्ञानिक व्यवस्थापन हुन नसेको तथ्य समेतलाई मध्यनजर गर्दे बन सम्बर्धन प्रणालीमा आधारित व्यवसायिक, दिगो एवं बैज्ञानिक वन व्यवस्थापन मार्फत बन क्षेत्रको उत्पादकत्व र वन पैदवारको उत्पादनमा बृद्धि, मुल्य जडान र वन पैदवारको बजारीकरण गर्दै रोजगारी सृजना गरी स्थानीय तथा राष्ट्रिय अर्थतन्त्रमा योगदान पुऱ्याउने अभिप्रयाले यो सम्भावना अध्ययन गरिएको हो। यो अध्ययनले परियोजना विश्लेषण, हितधारक परामर्श, क्षेत्र अवलोकन, र सम्बन्धित दस्तावेजहरुको आधारमा रतुवामाई वन परियोजना क्षेत्रभित्रका वन संसाधनहरूको सिमित र एकीकृत व्यवस्थापनका लागि व्यापक सिफारिसहरू प्रस्तुत गरेको छ । यसका नतिजाले यस क्षेत्रको पारिस्थितिक, आर्थिक र सामाजिक संरचनालाई ध्यानमा राखी बहु-आयामी दृष्टिकोण आवश्यक भएको देखाएको छ ।

मुख्य सिफारिसहरू:

१. साल वनको सिमित व्यवस्थापन (SFM)

प्राकृतिक साल वनका लागि वैज्ञानिक सिल्भिकल्चर आधारित व्यवस्थापन प्रणाली लागू गर्न सिफारिस गरिएको छ । यसका लागि विस्तृत SFM योजना तयार गरी हालको ८० वर्षे रोटेशन अवधिलाई लगभग ६० वर्षमा समायोजन गर्नुपर्छ, जुन काठ बजारको मागसँग मेल खानेछ । अनियमित शेल्टरवुड प्रणाली यहाँ उपयुक्त कटान विधि हो।

२. युकलिप्टस र सागौन बिरुवाको पुनर्रोपण

पाकेका युकलिप्टस (१५ वर्ष) र सागौन (२०-३० वर्ष) बिरुवाको रोटेशन अवधिमा सफा कटान गरी पुनर्रोपण गर्नुपर्छ। यसले परियोजनाको द्रुत बढ्ने काठ आपूर्ति गर्ने मूल उद्देश्यलाई पूरा गर्नेछ।

३. कृषि वानिकी र निजी क्षेत्रको संलग्नता

बिरुवाको प्रारम्भिक अवस्थामा गैर-काष्ठ वन पैदावार (NTFPs) र औषधीय तथा सुगन्धित बिरुवा (MAPs) लगाइने अन्तरबाली प्रणाली फिर्ता ल्याउनुपर्छ । निजी क्षेत्रसंग साझेदारी गरी आवश्यक तेल उत्पादन, स्थानिय रोजगारी र काठ बजार स्थिरीकरण गर्न Public provate partnership (PPP) मोडेल लागू गर्नुपर्छ।

४. पर्यटन र सामुदायिक उपयोग क्षेत्र एकीकरण

वनको केही भाग पर्यटन (बालपार्क, खेल मैदान) विकास गर्नुपर्छ, जसको आयले वन व्यवस्थापनमा योगदान गर्छ। धार्मिक र पारिस्थितिक महत्वका लागि कृत्रिम ताल निर्माण गर्नुपर्छ।

५. क्षेत्रीकरण र भूमि उपयोग

कुल वनको क्षेत्रलाई यसरी बाँड्नुपर्छ:

- साल काठ उत्पादन: २५०-३०० हेक्टर
- युकलिप्टस/सागौन: २,४०० हेक्टर
- संरक्षण: २००-३०० हेक्टर
- पर्यटन: १००-२०० हेक्टर (स्थानिय नगरपालिकाद्वारा व्यवस्थापन)

६. संस्थागत ढाँचा

एकीकृत दीगो वन व्यवस्थापन (SFM) मोडलको सफलता एक बलियो, समावेशी र राम्रो समन्वय गरिएको संस्थागत संरचनामा निर्भर गर्दछ । झापा जिल्लाको रातुवामाई वृक्षारोपण वनको सन्दर्भमा यो मोडल स्पष्टता, सहकार्य र प्रतिवद्धताका साथ विभिन्न सरकारका तहहरूसँग कार्यान्वयन गर्नुपर्छ। यस कार्यान्वयनको नेतृत्वको लागि कोशी प्रदेशको वन तथा वातावरण मन्त्रालयलाई मुख्य भूमिका दिइनु आवश्यक छ। यस कार्यको निगरानीका लागि बहुपक्षीय व्यवस्थापन समितिको गठन गरिनु पर्छ, जसको अध्यक्षता प्रदेश सचिवले गर्नेछन्। यस समितिमा संघीय, प्रदेश र स्थानीय सरकारका प्रतिनिधिहरू, स्थानीय समुदाय, वन उपभोक्ता समूहहरू र निजी क्षेत्रका सरोकारवालाहरूको सहभागिता अनिवार्य छ, ताकि निर्णय प्रक्रियामा सबैको आवाज सुन्न र उत्तरदायित्व सुनिश्चित गर्न सकियोस्।

रातुवामाई वृक्षारोपण वन विगतका दशकहरूमा ठूलो महत्व राख्ने पर्यावरणीय सम्पत्ति भएको छ। विगतमा, यहाँ अपार वनविनाश, जमिनको क्षयीरण र जैविक विविधताको विनाश जस्ता समस्याहरू देखा परेका थिए। अनियन्त्रित भूमि प्रयोग र जनसंख्या दबाबका कारण वनक्षेत्रमा ठूलो हानि भएको थियो। तर, यस समस्यासँग लड्नको लागि वृक्षारोपण र हरियाली पुनर्स्थापना अभियानहरू चलाइएका थिए, जसमा सरकार र समुदायको सहकार्यले महत्वपूर्ण भूमिका निभाएको थियो। यद्यपि दीगो व्यवस्थापनको कमी र संस्थागत समन्वयको अभावले दीर्घकालीन परिणाम दिन सकेन। हाल, रातुवामाई वनले माटोको क्षरण नियन्त्रण, स्थानीय जलवायुको नियमन, जैविक विविधताको संरक्षण, र आसपासका समुदायहरूलाई काठ, दाउरा र घाँसको आपूर्ति गर्ने कार्य गर्दैछ । यसले पारिस्थितिकीय सेवाहरूको माध्यमबाट अप्रत्यक्ष आर्थिक लाभहरू पनि पुर्याएको छ र यहाँको पर्यटकीय सम्भावनालाई पनि बढाएको छ। तथापि, वन डढेलो, अनियन्त्रित अतिक्रमण, सरकारी निकायहरूको बीचमा समन्वयको कमी र निजी क्षेत्रको सीमित संलग्नताले अझै पनि दीगो प्रयोगमा बाधा पुर्याइरहेका छन्।

भविष्यमा, एकीकृत SFM मोडलले रातुवामाई वृक्षारोपणलाई पारिस्थितिकीय लचिलोपन, सामाजिक समावेशिता र आर्थिक उत्पादकत्वको आदर्श मोडलमा परिणत गर्न सक्छ। यसको लागि वातावरणीय संरक्षण र सामाजिक आवश्यकतासँगै आर्थिक अवसरहरूको सन्तुलन गर्नु महत्त्वपूर्ण छ। वातावरणीय रूपमा, यस मोडलले जैविक विविधताको संरक्षण, कार्बन संचिती, र जलवायु परिवर्तनको न्युनिकरणमा सहयोग पुर्याउँछ। सामाजिक रूपमा, यसले स्थानीय समुदायलाई सशक्त बनाउँछ, विशेष गरी सीमान्तकृत र महिला समूहहरूलाई निर्णय प्रक्रियामा समावेश गर्ने र समान लाभ वितरण गर्ने प्रयास गर्छ । आर्थिक रूपमा, यसले रोजगारी सृजना, वनजन्य उद्योगको प्रोत्साहन र वन तथा गैर-काष्ठ वन पैदावार (NTFPs) र औषधीय तथा सुगन्धित तेल जन्य वनस्पतीहरु (MAPs) कोउद्यम विकास र प्रवर्द्धन गर्ने अवसरहरू प्रदान गर्दछ।

यो दृष्टिकोणलाई सफल बनाउनका लागि एक बलियो संस्थागत संरचना आवश्यक छ। वन तथा वातावरण मन्त्रालयको नेतृत्व र विविध व्यवस्थापन समितिको मार्गदर्शनले नीतिहरूको सन्तुलन, प्राविधिक र वित्तीय स्रोतहरूको समन्वय, र पारदर्शिता सुनिश्चित गर्न मद्दत पुर्याउनेछ। संघीय, प्रदेश र स्थानीय सरकारको सक्रिय सहभागिता वनसम्बन्धी कानूनी कार्यान्वयन, समुदायका आवश्यकताहरूको समावेश र क्षेत्रीय विवादहरूको समाधानमा महत्त्वपूर्ण भूमिका निभाउँछ। साथै, निजी क्षेत्रका सरोकारवालाहरूको समावेश नवीनता, प्रविधि हस्तान्तरण र लगानीको लागि महत्त्वपूर्ण हुनेछ।

अन्ततः, रातुवामाई वृक्षारोपण वनको भविष्य संस्थागत समन्वय, सबै सरोकारवालाहरू बीचको सहभागिता र दीगो सोचमा आधारित लामो समयको प्रतिबद्धतामा निर्भर गर्दछ। एकीकृत SFM मोडल यसको सफल कार्यान्वयनका लागि एक मार्गनिर्देश प्रदान गर्दछ, तर यसको सफलता सम्पूर्ण सरोकारवालाहरूको समावेशी शासन, साझा उत्तरदायित्व र दीगो सोचमा निर्भर हुनेछ।

Table of Contents

1. INTRODUCTION

1.1. Background

A GEF-supported project entitled ***"Enhancing capacity for sustainable management of forests, land and biodiversity in the Eastern Hills (FLB Eastern Hills)"*** is being implemented in five districts (Taplejung, Panchthar, Terhathum, Ilam, and Sankhuwasabha) of Koshi province, Nepal since 2022.

The project is funded by the Global Environment Facility (GEF) and executed by the Ministry of Tourism, Forests and Environment (MoTFE), Koshi province, as an Operational Partner (OP) with overall execution and technical responsibility. The Food and Agriculture Organization of the United Nations (FAO) provides oversight and technical support to the project as the GEF Accredited Implementing Agency. The Project Management Unit (PMU) is situated within MoTFE and includes experts recruited by OP and FAO, while the project support unit is established at Division Forest Offices (DFOs) in five districts.

The project's objective is to protect significant biodiversity beyond protected areas and enhance ecosystem services to support sustainable livelihoods in the Eastern Hills of Nepal. Located within the districts of Koshi Province, the project covers 34 Palikas (186 wards) out of 43 local levels across the five districts. With an outreach goal of reaching 150,000 beneficiaries, the project focuses on key biodiversity hotspots such as Tinjure Milke-Jaljale, Mai Valley Forest, and the Tamur Valley.

The Project Management Unit of the Ministry of Tourism, Forests, and Environment in the Government of Koshi Province has launched a comprehensive study focused on the Forest Management and Biodiversity Conservation Model for the Ratuwamai Plantation project area.. This document serves as the comprehensive technical report of the study, detailing the methodologies and approaches that were employed, aiming to develop a robust model for sustainable forest management and biodiversity conservation within the Ratuwamai Plantation Project area.

1.3 Rationale of the study

The ecological health of the forests and the biodiversity within the project area face significant threats from invasive species, overharvesting, grazing, illegal encroachment, and insufficient monitoring. Despite its long-standing history, the project has struggled with severe challenges, including ongoing forest degradation, a lack of emphasis on biodiversity conservation, and inadequate integration of forest management with local poverty alleviation efforts. These issues have hindered the project's ability to achieve its goals of sustainable resource management. Additionally, the limited participation of women and marginalized communities in forest management has exacerbated social inequalities. Considering these challenges, the Ministry of Tourism, Forests, and Environment (MoTFE) in Koshi Province has initiated a comprehensive study on the Forest Management and Biodiversity Conservation Model for the Ratuwamai Plantation Project, with the aim of developing and implementing strategies to rejuvenate the project and fulfill its objectives.

The importance of this study is highlighted by the Ratuwamai forest's crucial role in the region's ecological and socio-economic framework; located between the Ratuwamai and Kankaimai rivers, it acts as a vital biological corridor linking Ilam and Jhapa districts, thereby supporting essential

biodiversity and ecosystem services for local communities. However, the forest's vitality has been undermined by poor management practices, forest fires, soil erosion, and encroachment.

1.4 Objectives

The general objective of the present study was to evaluate the current practices in forest management and biodiversity conservation, while identifying significant gaps, challenges, and opportunities for integrating these practices within a sustainable institutional framework that preserves natural resources. and addresses the needs of local communities and ecosystems.

While the specific objectives are to:

1. Assessing the forest's current condition, including its growing stock and biodiversity (species diversity and abundance);
2. Mapping areas of encroachment digitally;
3. Analyzing key issues in forest management and biodiversity conservation;
4. Proposing recommendations for improved practices for forest management and biodiversity conservation, and
5. Suggesting alternative management models to the provincial government for the sustainable stewardship of Ratuwamai Forest.

1.4 Limitations of the study

The present study was conducted within a small geographical area rather than covering the wide range of the diverse geography. Ecological sampling was limited only to the Fifty-nine plots from the single plantation area. The present study was a rapid assessment of the forest's current condition, including its growing stock and biodiversity, identifying the key issues in forest management and biodiversity conservation. The sustainable management models proposed in the reports are based on the previous experiences and practices adopted in the plantation area and based on the perceptions of the local stakeholders.

1.5 Organization of the report

Chapter 1 covers the **Background, rationale, and the objectives and limitations of the study**. **Chapter 2** gives an **overview of the study sites** in terms of physiography, geology and climatic condition of the study site. **Chapter 3**, provides details on the **approach and methodology, including study design, sampling design, field arrangement and field inventory and analysis**. **Chapter 4**, contains **results and discussion** of the study and **Chapter 5,** provides some **recommendation** based on the findings, followed by **References and Annexes.**

2. AN OVERVIEW OF THE PROJECT SITE

2.1 Site description

The Ratuwamai Plantation project was launched by the then Ministry of Forests and Soil Conservation of Nepal in the fiscal year 2035/36 (1978/79) to enhance forest management in the region. Its primary aim was to replicate the concepts of Sagarnath Forestry Development Project by establishing fast-growing, short-rotation tree plantations to rehabilitate approximately 2,800 hectares of degraded natural forest in Jhapa and Ilam districts, thereby increasing the local supply of fuelwood and timber. The project also sought to create job opportunities for local landless and unskilled workers, provide systematic training in forestry operations, and develop a model plantation that could serve as a prototype for restoring other depleted forests in the Terai region. The plantation project also bordering the up to Chulachuli Rural Municipality in Ilam district and Kamal Rural Municipality and Shivasatxi Municipality in Jhapa district (Figure 1).

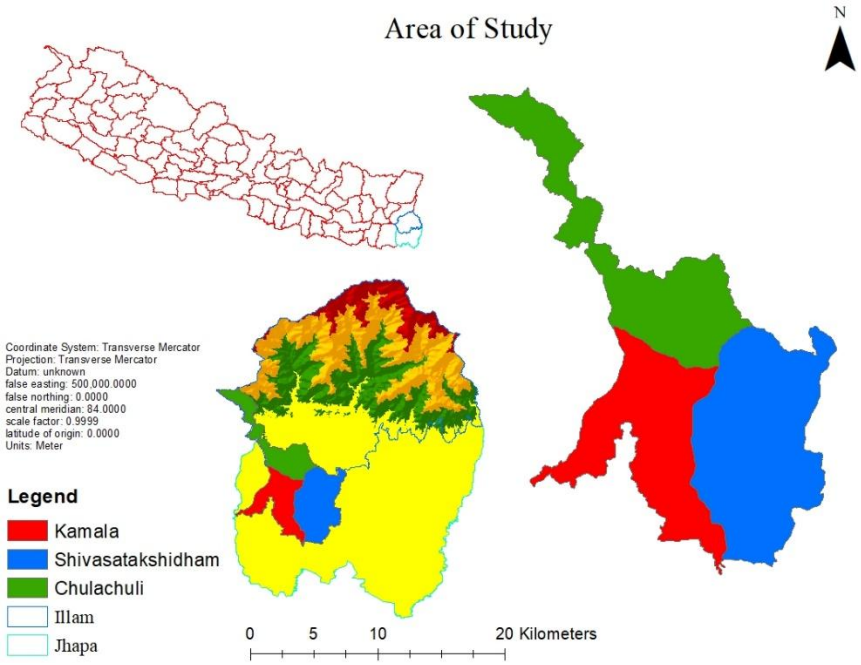


Figure 1. Map showing the Ratuwamai Plantation Project Area.

The area is characterized by natural forests primarily composed of Sal species, alongside plantations of fast-growing varieties such as Teak, Eucalyptus and Kadam, and is organized into 26 management compartments (Figure 2). Northern area of Satakshidham palika is dominated by natural Sal forests covering a total area of 268.44 hectares.

Figure 2. Ratuwamai Plantation area with different compartments

2.3 Climate

Koshi Province experiences diverse climatic conditions due to its varied topography and altitude, ranging from subtropical climates in the Terai and foothills, to temperate conditions in the mid-mountains, and alpine or arid climates in the Himalayas. Temperature and rainfall vary widely across these zones, with annual rainfall from 15 cm in the high Himalayas to 300 cm in the Terai.

2.4 Geography

Koshi Province spans 25,905 sq. km, with 17.16% forest cover. It is bordered by India and other provinces, and features both the country's lowest point, Kechana Kawal (67 m), and its highest, Mt. Sagarmatha (8,848 m). The province is divided into four main regions based on its topography: the Himalayas, Sub-Himalayas, valley basins, and the Terai plains.

3. APPROACH AND METHODOLOGY

This chapter discusses the detailed approach and methodology used to conduct the study. It contains methodologies for quantifying the forest biomass and status of the natural regeneration. This chapter also includes descriptions of the different approaches, tools and techniques applied during the data collection and analysis of the data and information.

3.1 Approach

The overall approach of the study was participatory, consultative and facilitative. The approach was concentrated on exploration and investigation of the actual situation in the Ratuwamai Plantation Project area. The study included gathering both primary and secondary data sources, including participatory resource mapping in the respective site, direct observation, field survey, spatial analysis, key informant interviews (KIIs), and focus group discussions (FGDs). Primary data were collected from the specified project sites while secondary data were collected from published and unpublished documents and reports. The following key approaches were followed during the entire study period.

Participatory, Consultative and Multi-Perspective Approach
A Multi-Perspective (Poly-vocal) approach that aims to reflect the views and concerns of local communities, right holders, stakeholders and private sectors who are directly or indirectly related to the Ratuwamai plantation project were employed and interviewed. During the task, a range of groups from the Ratuwamai plantation project, local forest dwellers, forest dependent rural communities including local governments were consulted.

Facilitative Approach
Since the final report was expected to be respected, owned, implemented and replicated, a facilitative approach, which aims to optimize the involvement of all right/stakeholders in the overall process of identifying opportunities and challenges in the current management practices and models and sustainability of the resources and ecosystems in the study sites was adopted. The consultants facilitated the process of data collection and sharing with community and district level stakeholders. This, in turn, developed a sense of ownership over the process and outputs. During the process, the consultant developed a wider understanding and ideas to facilitate the process and sincerely documented the perceptions.

Disclosure and Verification Approach
The team followed the disclosure and verification approach to ensure the transparency of the findings as well as to develop ownership and ensure accountability. This approach facilitated dialogues with concerned stakeholders on issues raised apart from providing the explanations for given situation. For this, briefing and field level consultations were organized to discuss and share the study objectives especially on the sustainable forest and biodiversity conservation model development.

3.2 Study Framework

The following study framework was designed in to meet over overall objectives of the present study. The overall approaches of the study were participatory, consultative and facilitative, disclosure and do no harm basis.

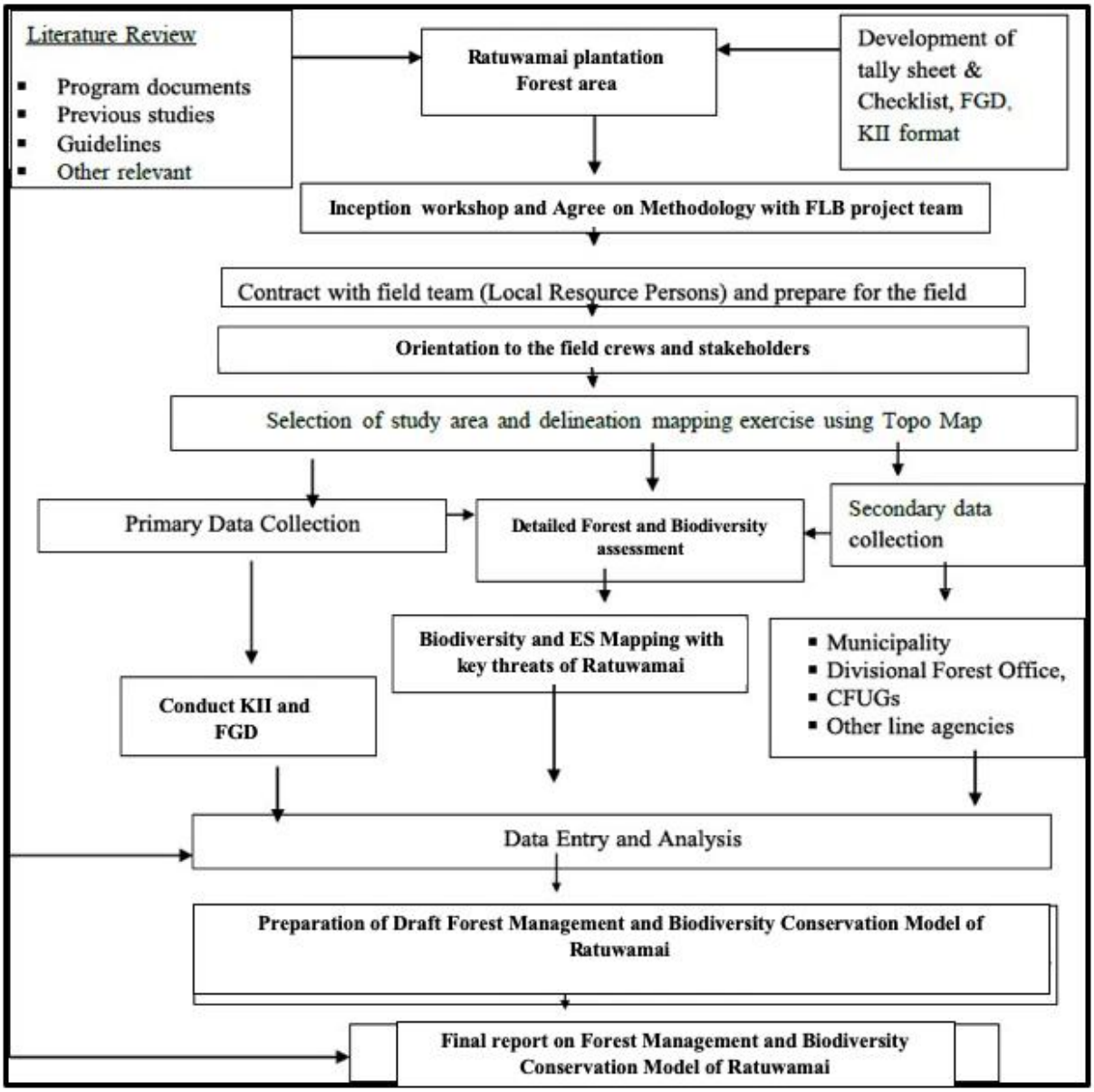


Figure 3: Overall study framework

3.3 Study Methods

The study combined both quantitative and qualitative techniques and approaches for conducting assessment of functionality of forests, biodiversity and other ecosystem services of the Ratuwamai Plantation Project for comprehensive understanding of the present problems, issues and challenges. The study adopted following four methodological steps to accomplish the study:

Phase 1. Desktop Review Phase;
Phase 2. Inception Phase;
Phase 3. Sampling Design Phase;
Phase 4. Planning, Field Surveys, Data Collection and Stakeholder Consultation Phase;
Phase 5. Data Analysis and Report Drafting and finalization Phase;

3.3.1 Desk Review

Inception phase of the study has formally started after signing of the contract for the assignment. Review of literature related to the assignment (Study on the Forest Management and Biodiversity Conservation Model of the Ratuwamai Plantation Project), their accuracy and validation is an ongoing process and was continued till the final report submitted to the MoTFE, Koishi Provice Government.

Initially, a comprehensive desk review was conducted to examine existing documents related to the Ratuwamai Plantation Project, focusing on historical records and project reports to evaluate the evolution of forest management plans. Additionally, government policies at various levels concerning biodiversity conservation and forest management was analysed to clarify the regulatory landscape. Secondary data sources, including the Forest Management Plan of Ratuwamai and reports from the National Forest Inventory conducted by the FRTC and the National Statistics Office, was also scrutinized.

Various government policies at the federal, provincial, and local levels, along with relevant Acts, Regulations, and other pertinent documents and reports, were reviewed as part of this process. These include but not limited to:

- Forest Act, 2076
- Forest Regulation, 2079
- Forest Sector Strategy (2016-2025)
- Community Foretry Inventory Guideline 2065;
- National Forest Policy, 2075
- Soil and Watershed Conservation Act, 2039
- Soil and Watershed Conservation Regulation, 2042
- Water Resources Act, 1992
- Water Resource Strategy, 2002
- National Land Use Policy, 2015
- Environment Protection Act, 2076
- National Climate Change Policy, 2076
- National Ramsar Strategy and Action Plan, Nepal 2018-2024
- National Parks and Wildlife Conservation Act, 2029
- Nepal Biodiversity Strategy (NBS)
- Other relevant policies and guidelines.

3.3.2 Inception Phase

Following the signing of the contract with the client, an inception workshop was held on 23 May 2025 at the meeting hall of the Ministry of Forests and Environment (MoFE), Koshi Province (minute attached in Photograph 17). The workshop brought together a diverse group of stakeholders, with a total of 10 participants who actively engaged in the discussions. Valuable insights and feedback were provided regarding the Ratuwamai Plantation Project, along with constructive comments on the proposed approach and methodology.

The inception phase primarily focused on preparatory activities, including the planning of data processing, analysis, and reporting. Key preparatory tasks undertaken prior to the commencement of fieldwork involved a comprehensive review of relevant documents and the systematic compilation and collation of secondary literature.

Based on the preliminary analysis of information gathered, a draft inception report was prepared and submitted within seven days of contract signing. The final inception report was completed and submitted within ten days, following consultations and discussions with relevant officials.

3.3.3 Sampling designing

a) Multi stage sampling:

A multi-stage sampling technique was used to select the study sites i.e., municipalities or rural municipalities (including patches of the Ratuwamai Plantation forests) to estimate regeneration, forest biomass, tree volume, density, frequency, abundance, and the availability of key species across the proposed forests within various natural ecosystems. This approach is commonly applied in ecological and environmental studies when surveying an entire area or population is impractical or too costly.

The multi-stage sampling process involved dividing the sampling procedure into multiple steps or stages, resulting in sampling units that were progressively smaller, more specific, and more homogeneous. The following steps were carried out as part of the sampling process:

District level participatory resources mapping:

The study team first consulted the officials of Ratuwamai plantation project, Division Forest Office (DFO) and the Federation of Community Forest Users Nepal (FECOFUN), local governments (ward chairpersons), local traders and local communities, in the respective districts and established rapport regarding the identification of key study sites. Following the rapport-building process with the DFOs, FECOFUN, and other relevant stakeholders at the district level, the project team conducted participatory resource mapping with key stakeholders, including the Divisional Forest Office, FECOFUN, District Coordination Committee (DCCs), and Community Forest User Group (CFUG) members, at the district headquarters.

Based on the outcomes of the district-level participatory resource mapping, the team identified potential sites within the proposed forest and biodiversity rich areas. Potential biodiversity hotspots, areas with high concentrations of Non-Timber Forest Products (NTFPs)/Medicinal and Aromatic Plants (MAPs), ecosystem services (ES), encroachment zones, and key drivers of degradation (DoD) were selected based on scores obtained during the participatory mapping process. The selection was guided by the following key criteria:

i) Availability of prioritized species;
ii) Abundance of the targeted species;
iii) Major threats to the species, including drivers of forest degradation such as forest fires, overgrazing, and invasive species;
iv) Current status of forest and biodiversity; and
v) Level of dependency of local communities on forest resources.

Selection and identification of the potential forests patches in the plantation sites:

After identifying the potential sites within the Ratuwamai Plantation area, the study team proceeded to these locations to conduct participatory resource mapping with the project staffs at the local level (Figure 4).

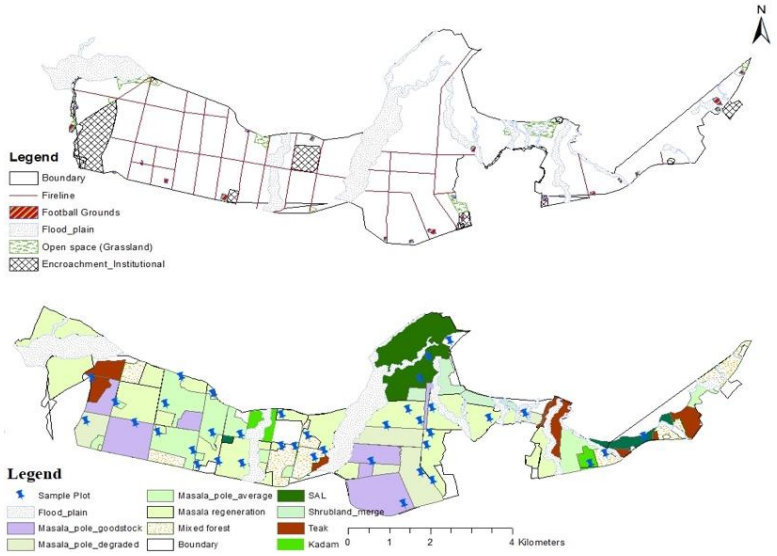


Figure 4: Potential study sites in Ratuwamai pnantation project

The mapping process involved local stakeholders, including NTFP/MAP traders, community leaders, and forest guards, to validate and finalize study sites in the Ratuwamai plantation project, supported by a review of existing forest management plans.

The participatory resource maps were digitized using GIS software, and a detailed map outlining the potential regeneration survey areas was developed. During the forest stratification process for biophysical data collection, the team identified two strata dense and sparse forests to ensure the formation of homogeneous sampling units.

Sampling intensity:

After identifying the potential forest areas within the plantation sites, the study team digitized and produced effective area maps using ArcMap 10.2.2. For the detailed biophysical survey, a sampling intensity ranging from 0.1% to 0.05% of the potential habitat area was maintained, depending on the size of the species distribution area. Based on this, the total number of sample plots to be measured on the ground was determined.

The sampling process followed the Community Forest Inventory Guideline 2061 of the Government of Nepal, the Carbon Stock Measurement Guideline, and the Participatory Inventory Guidelines for NTFPs developed by ANSAB in 2010 and 2011 respectively (see Table 1).

Table 1: Standard Sampling Intensity

Forest Size	**Sampling Intensity (%)**
<100 ha	0.05-0.1
100-500 ha	0.05
>500 ha	0.01

Size and shape of sample plots:

The targeted species in this study ranged from seedlings to mature trees. Therefore, a co-centric circular plot design was used for detailed assessment. A standard sample plot size of 500 m² (with a radius of 12.82 meters) was employed for tree-level data collection. Nested within this plot, a 100 m² sub-plot (5.64 meters radius) was used for assessing saplings, a 1-meter radius sub-plot for regeneration or seedling surveys, and a 0.56-meter radius subplot for herbs and litter sampling (Figure 5).

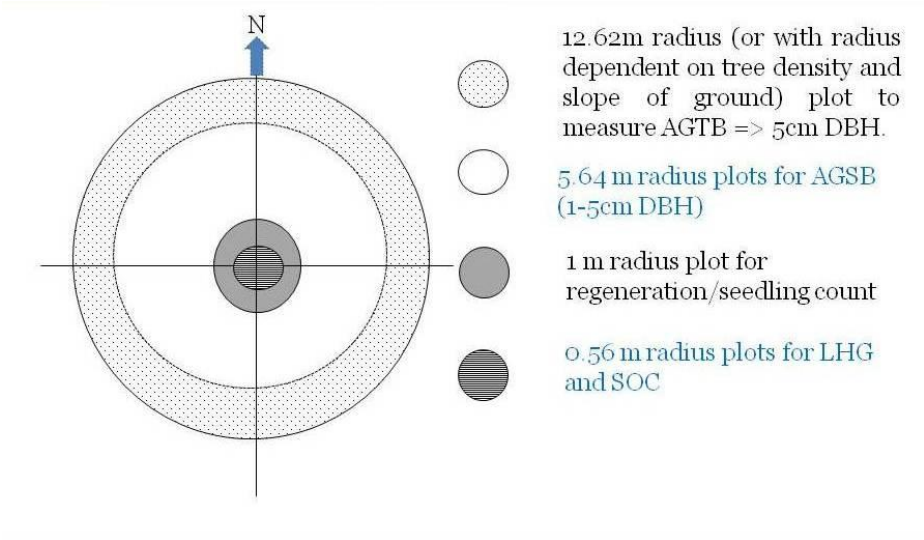
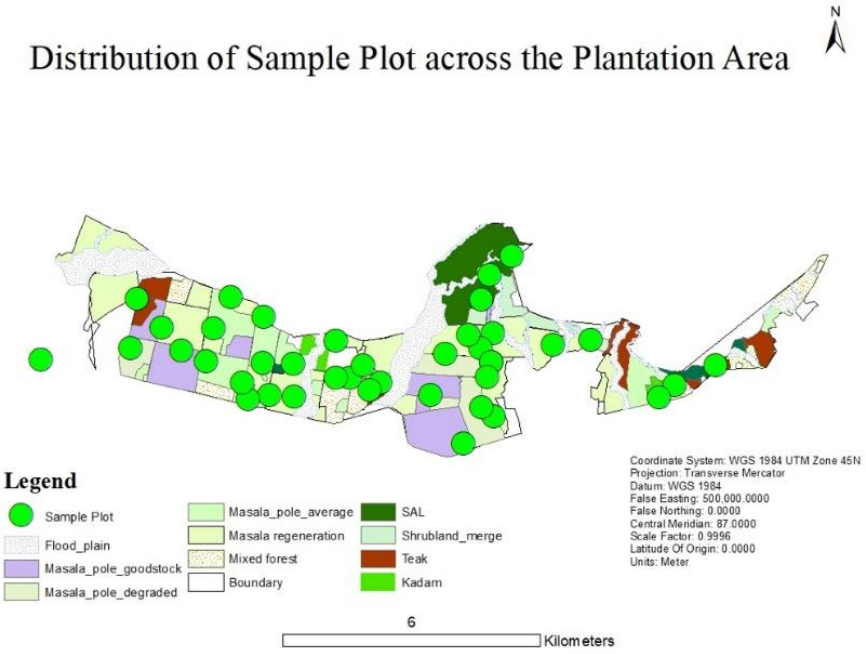


Figure 5: Shape and Size of Nested Co-Centric Circular Plot

Lay out and distribution of sample plots on the map:



The individual sample plots were laid out within the species-effective areas using the stratified random sampling method. ArcMap 10.2 was used to distribute the required number of sample plots across the GIS map of the species-effective area. The GPS coordinates of the individual plots were then uploaded into GPS devices using Garmin software to accurately locate the plots within the designated potential areas in the forests.

Figure 6: Sample plot distribution map

3.3.4 Planning for the field surveys, data collection and stakeholder consultation

Detailed planning for the field surveys, data collection and stakeholder consultation was done just after the completion of the inception workshop and just before actual field survey and observation starts. This includes orientation for the field crew members, arrangement of equipment needed for the field surveys vehicle hiring and developing different forms for data collection. This involves the following steps:

Preparation of equipment and materials

All necessary equipment and materials were gathered prior to field deployment. Each instrument and piece of equipment was properly prepared, thoroughly checked, and calibrated in advance. The operational team ensured that all devices were functioning correctly to prevent any disruptions during fieldwork. A comprehensive checklist was developed to ensure that no items were overlooked; this checklist also proved valuable during field operations, particularly as the team transitioned from one plot to another.

Field planning and orientation

To ensure the efficient and timely completion of the assigned tasks and to maintain consistency in data collection and field measurements, a field planning and hands-on training session was conducted in the field. This session targeted forest technicians and interested field staff involved in the Ratuwamai Plantation Project. Participants received comprehensive practical training on forest and biodiversity assessment methodologies, including natural regeneration assessment and forest inventory techniques. These forest technicians, trained in advance of the detailed fieldwork, served as the core field crew and acted as the principal technical personnel supporting field implementation and data collection activities.

Human resource management

A complete team of 6 members was formed well in advance of the initial field operations to ensure accurate and comprehensive data collection. Two forest technicians served as the core crew and led the entire field study. They were assigned based on their detailed knowledge of the methodology, ability to operate all equipment properly, and understanding of the importance of even the smallest details of the work. Additionally, four local field assistants were involved to support the data collection, measurement and filling the data entry sheets and the local resources persons have supported on the navigating the field sites and communication.

Preparation of tools and other field equipment

The followings tools and materials were gathered for the measurement of seedlings, saplings and tree vegetation in the sample plots of Ratuwamai Plantation forest area.

- GPS

- Silva Compass
- Vertex an transponder IV
- Measuring tape (50 or 100 m)
- DBH measurement tape
- Tree and Shrub cutter (Scattier)
- Digital measuring scale upto 0.01 - 10 kg with 0.1 kg precision
- Materials: 1.3 m pole, markers, poly bags, ropes and field data forms for record keeping.

Based on the field work plan, the tools and materials were prepared, callibarited adequately before the field work takes place.

Measurement of tree diameter and height of the sampled trees

Standard tree diameter and height measurement principles were applied during the field data collection for above-ground tree biomass estimation. Irregular tree stems were measured according to the guidelines illustrated in Figure 7. For stems that forked from the ground, each individual stem was measured separately but assigned a letter suffix to indicate they belonged to the same tree (e.g., 1a and 1b were both parts of tree number 1). Care was taken to ensure the diameter tape was placed accurately around the stem at the designated measurement point. Tree diameter at breast height (DBH) was measured at **1.3 meters** using a diameter tape. In cases where trunks were deformed at breast height, the diameter was measured at the nearest well-formed point above or below the standard height.

DBH was used as the fundamental measurement for both trees and saplings. Each tree was marked inwardly to prevent accidental double counting. Tree height was measured using clinometers and laser-sensitive instruments **Vertex IV** and **Transponder T3**. Special attention was given to measuring the height of leaning trees with the Vertex IV, as attaching a transponder directly to the bole of a leaning tree could have biased height estimates unless the lean was exactly perpendicular (90°) to the observer. Each tree was recorded individually with its species name. Trees located on plot boundaries were included if more than 50% of their basal area fell within the plot and excluded if more than 50% fell outside. Trees overhanging the plot were excluded, while trees with trunks inside the plot but branches extending outside were included. For trees with unusual shapes, standard forestry practices were followed (Karky and Banskota, 2007; MacDicken, 1997) consistently across all plots prior to sampling.

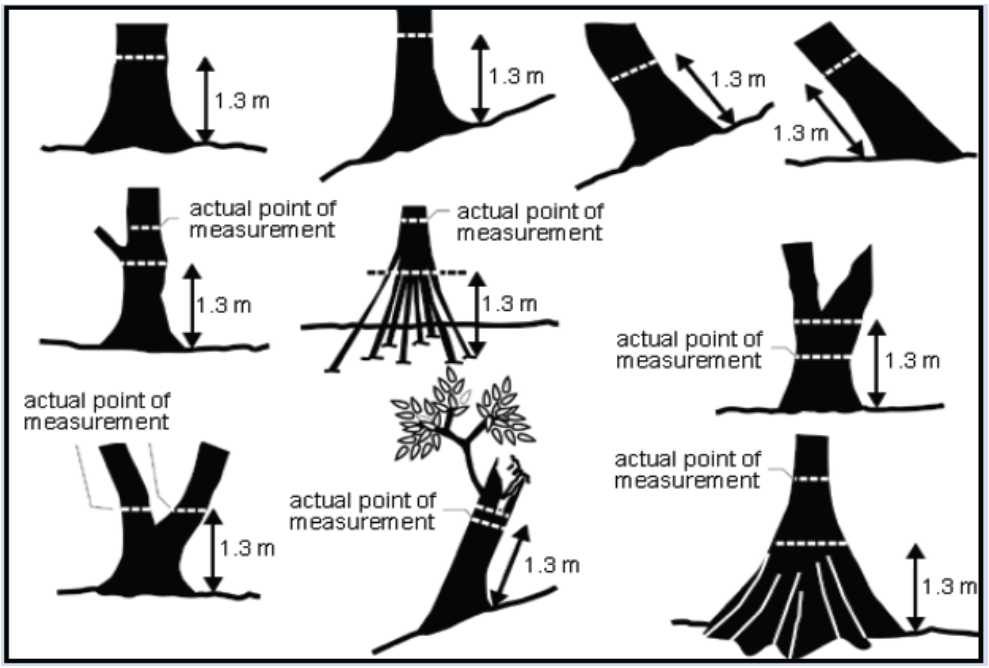


Figure 7: Standard Forestry Practices while Measuring Tree Diameter at Breast Height

Quantitative forest vegetation data collection

For the quantitative data for tree density, basal area and stem volume of tree species was calculated by using the method described by Zobel et al. (1987) and Sharma and Pukkala (1990) with some modifications (MoFSC/CPFD, 2000).

Tree density

The tree density per hectare was calculated using the following equation (i) provided by (Zobel et al. (1987)

$$\text{Density}\left(\frac{\text{no}}{\text{ha}}\right) = \frac{\text{No.of individuals of species}}{\text{Total no.of plots studied x area of each plot}} \text{ x10000 equation.....(i)}$$

Tree basal area

Basal area refers to the ground actually penetrated by the stems (Hanson and Churchill, 1961). It is one of the characters that determine the dominance. It was calculated using following equation (ii).

$$\text{Basal area (sq. m)} = \frac{(3.1416)\text{x (dbh)}^2}{4} \quad \text{equation.....(ii)}$$

Standing Tree Volume

The standing tree volume was calculated following the community forestry inventory guideline 2065 of Nepal (CPFD, 2000) as shown in below equation (iii)

$V = FF*\pi d^2/4*h$……..…(iii)

Sapling biomass

National allometric biomass equations (developed by the Department of Forest and Department of Forest Research and Survey, Nepal 2000) was used to determine the sapling biomass (≤5cm DBH).

In case of tree species (other than the equations provided in the biomass table) equations was applied according to given associations of species (forest type).

The regression model below [Eq. iv)] was applied to calculate sapling biomass.

$$\log(AGSB) = a + b\ log(D)$$ ……. Equation (iv)

Where,

Log = natural log (dimensionless)

AGSB = aboveground sapling biomass (kg)

a = intercept of allometric relationship for saplings (dimensionless)

The

b = slope allometric relationship for saplings (dimensionless) and

D = diameter at breast height of the sapling (at 1.3m above ground) (cm)

variables of the previously developed regressions i.e. slope (a) and intercept (b) for all saplings developed by the Department of Forest Research and Survey (DFRS) and the TISC, Nepal (Tamrakar, 2000).

Tree biomass

According to the ecological condition of the forest, the above ground biomass calculations was performed based on the appropriate equation Eq (v) guided by the forest carbon measurement guideline and suggested by Chave (2005, p. 93) (for moist forest stand).

$$AGTB = 0.0509 * \rho D^2 H$$ …….…… Equation (v)

Where,

AGTB = aboveground tree biomass (kg)

ρ = wood specific gravity (kg m^{-3});

D = tree diameter at breast height (DBH) [cm]; and

H = tree height (m)

Specific wood gravity (ρ), as mentioned in the Master Plan for Forestry Sector (MFSC), was used in the calculation. For the tree species not having wood specific gravity, a general value was used according to associated forest types (MSFC,1989).

Below ground (BGB)biomass

Below ground biomass, commonly known as root biomass, was estimated using the default root-to-shoot ratio value. According to Geider et al., 2001, measurements of root biomass are indeed highly uncertain, and the lack of empirical values for this type of biomass has for decades been a major weakness in ecosystem models. In this study, below ground biomass was calculated with the root-to-shoot ratio value as suggested by MacDicken (1997). Meaning, belowground biomass represents nearly (20%) of aboveground tree biomass.

Total forest carbon stock calculation

The total forest biomass of each pool was converted into carbon multiplying by default carbon fraction of 0.47 as recommended by the IPCC (2006). Then, the equation (vi), was used to estimate total forest carbon stock by summing up all carbon pools calculated to have total forest carbon stock (in ton) per unit area.

$$C(LU) = C(AGTB) + C(SB)$$ ……Equation (vi)

Where,

TC (LU) = carbon stock for a land use category [tC ha^{-1}];

C (AGTB) = carbon stock in aboveground tree biomass [tC ha^{-1}];
C (SB) = carbon in sapling biomass [tC ha^{-1}];

The carbon stock was converted to tons of CO_2 equivalent by multiplying it by 44/12, or 3.67 (Pearson et al. 2007).

Mapping of water bodies and springs

Mapping water bodies is essential for visualizing their distribution and developing management plans. Local community members and ward representatives provided locations, which were verified through transect walks and GPS points.

Flood Hazard Mapping

Flood hazard assessment and mapping identify areas at risk of flooding to improve flood risk management and disaster preparedness. They are crucial for land use planning in flood-prone areas, helping to create accessible charts and maps. This process considers climate change impacts and produces flood risk maps by analyzing the elements exposed to flooding.

Identification of Issues, Threats and Opportunities, and their Analysis

The study team identified and analyzed threats, problems, and issues related to sustainable forest management (SFM) and biodiversity conservation, which impact water quantity and quality, affecting local communities' livelihoods. Tools such as, meeting with key informants and focus group discussions (FGDs)-10, workshops with stakeholders and local communities at ward levels -10, workshops with stakeholders at local communities at local levels-3 and meeting with MoTFE inception and final sharing workshops -2 and transect walks were conducted to gather information. Respondents discussed existing sustainable measures and their effectiveness in addressing these issues.

Meeting with Key Informants and Focus group discussion:

A total of 10 meeting with key informants and focus group discussions were conducted with a diverse group of stakeholders, including forestry officials, subject matter experts, project managers, community leaders, and policy specialists. These interviews aimed to gather in-depth insights on strategies for developing sustainable forest management and biodiversity conservation models, as well as to explore associated challenges, policy implications, and potential future directions (Annex 3).

These interviews were designed to collect in-depth qualitative insights on sustainable forest management, biodiversity conservation, and human-wildlife conflict mitigation strategies. Key informants highlighted the ecological significance of the Ratuwamai Plantation Forest, particularly its role as an elephant corridor, while also emphasizing the growing challenges posed by habitat fragmentation, illegal logging, and human-elephant conflicts (HEC). Discussions revealed that while existing policies aim to balance conservation and livelihood needs, implementation gaps, lack of community participation, and insufficient funding hinder effective forest governance. Experts stressed the need for integrated landscape management, combining scientific research,

community-based monitoring, and policy reforms to ensure long-term sustainability. Additionally, informants proposed innovative solutions such as eco-tourism initiatives, agroforestry models, and wildlife-compatible farming practices to reduce dependency on forest resources while enhancing local livelihoods. The interviews also explored policy implications, with recommendations for strengthening legal frameworks, improving inter-agency coordination, and incentivizing community-led conservation efforts. Overall, the KIIs provided valuable perspectives on current challenges, best practices, and future directions, underscoring the necessity of multi-stakeholder collaboration to achieve a balanced approach that safeguards biodiversity while supporting sustainable development in the Ratuwamai region.

Workshops with stakeholders and local communities at ward levels

A total of 10 workshops with stakeholders and local communities at ward levels were organized with representatives of local communities and user groups to explore various aspects of forest management. These discussions covered topics such as the use of forest resources, perceptions of current management practices, and suggestions for improvement (Annex 4).

Focus Group Discussions (FGDs) were conducted in the Ratuwamai Plantation Project area to gather insights from a diverse range of stakeholders, including local farmers, forest-dependent communities, plantation workers, and representatives from conservation organizations. A total of three FGDs were organized, each comprising 8-12 participants, ensuring a balanced representation of gender, age, and socio-economic backgrounds. The discussions aimed to explore key issues related to forest resource use, human-elephant conflict (HEC), and sustainable management practices. Participants were encouraged to share their experiences, challenges, and recommendations, fostering an inclusive dialogue on how to balance ecological conservation with livelihood needs.

The FGDs revealed that forest resources, such as timber, fuelwood, and non-timber forest products (NTFPs), play a critical role in local livelihoods. However, overharvesting and illegal logging were identified as major concerns, leading to habitat degradation and increased human-wildlife conflicts. Participants expressed frustration over frequent elephant raids on crops, which destroy livelihoods and escalate tensions between communities and wildlife. Many attributed the rising conflict to shrinking elephant corridors due to plantation expansion and infrastructure development. Despite these challenges, there was a strong consensus on the need for community-based forest management and alternative income sources, such as eco-tourism or agroforestry, to reduce dependency on forest resources.

Participants also shared their perceptions of current forest management policies, with some criticizing top-down approaches that exclude local voices. Suggestions for improvement included strengthening community patrols to prevent illegal logging, restoring degraded elephant corridors, and implementing early warning systems to mitigate HEC. Women participants emphasized the need for gender-inclusive conservation programs, as they are often

the most affected by resource scarcity yet remain underrepresented in decision-making. The discussions concluded with a call for greater collaboration between government agencies, NGOs, and local communities to develop practical, culturally appropriate solutions that ensure both forest sustainability and human well-being. The findings from these FGDs were to inform future conservation strategies, ensuring they are participatory, equitable, and effective in addressing the complex challenges facing Ratuwamai's forests and wildlife.

Final sharing workshops:

The final sharing workshop was held on 30 June 2025 at the meeting hall of the Ministry of Tourism, Forests and Environment (MoTFE), Koshi Province. The sharing meeting was chaired by the secretory of the Ministry of Tourism Forests and Environment (MoTFE), Koshi Province. The key results of study were shared by tea leader. An intensive discussion was heled during the workshop. A total of 18 participants have actively participated (Photograph 18).
The valuable feedbacks and comments on the report were received and were incorporated in the final report.

3.3.5 Data Analysis and Report Drafting Phase

Data analysis

All collected data and information were analysed using both quantitative and qualitative methods to get comprehensive understanding of present status of forest resources and biodiversity and their functionality, as well as management issues and challenges of Ratuwamai Plantation Project. R-core development statistical tools was also applied for quantitative analysis (to analyse biodiversity indices, tree growth trends, resource use patterns and economic benefits). Information collected through KII and community surveys were analysed using qualitative methods; using coding software (R-core development and SPSS as far as possible to identify key themes, stakeholders' perspectives, and management issues.

3.3.6 Quality assurance and quality control

An adequate quality assessment of an inventory and data collection requires both internal and external control procedures. Internal control activities are intended to ensure accuracy, documentation and transparency of the inventory operations. This control is first implemented by the agency that is responsible for compiling the inventory in each country during the compilation of the data and calculations. Efforts were made by the technical team to check availability of actual data, correctness, consistency, completeness, and to document the origin of data and the specific assumptions adopted. The implementation of an approved standardized procedure for emission calculations may facilitate the accuracy of an inventory and internal control. The QA/QC provisions was applied at the following stages: (1) collecting reliable field measurements; (2) verifying data entry and analysis techniques.

QA/QC for field measurement

Rigorous orientation and hands on training were conducted and followed during fieldwork. The orientation training ensures that measurements carried out by field study teams at different times are consistent and comparable. All the forest technicians and local resource persons involved in the resource's assessment (Biomass, carbon, biodiversity, ES and NTFPs/MAPs) were fully trained in all aspects of field data collection and data entry. Field crews were provided with extensive training to be fully cognizant of all procedures and to ensure that accurate data was collected.

QA/QC for data entry and analysis

The orientation and hands on training were conducted to the forest technicians and local resources person's regarding the data entry of the collected data. Data entry was done immediately after collecting the field data in the field. Data entry into spreadsheets is often a significant source of error. Ongoing communication between all personnel involved in measuring and analyzing data is critical for resolving apparent anomalies before final analysis of the monitoring data is completed. Special attention was paid to units used in the field (a standard measurement system was used for all DBH and height measurement of trees. All measurements contained in spreadsheets were clearly indicated. Errors were reduced through spot checks of the entered data by crew forest technicians. In addition, checking each value within an expected range identified any outlier trees.

4. RESULTS AND DISCUSSIONS

4.1 Vegetation Parameters in the study sites

4.1.1 Dominant tree species and Diameter distribution curves

In the present study a total of 13 seedlings, 12 saplings and 10 trees belonging to some 10 families were measured and recorded with various biophysical parameters. There was a dominant canopy of *Eucalyptus, Teak, Sal, Kadam, Simal, Rubber, Simal* followed by *Bel.* The soil type within the studied forest plot is of boulder, sandy with black to brown soil colour. The vegetation type is of the mixed broad leaved with about 72.5% crown cover, 15% shrub cover and about 75% of the grasses in the natural forest.

The overall mean of the tree DBH and height was found to be to be 24.1 cm and 12.5 m in the plantation sites. While that of natural Sal dominant forest site was 31.6 cm and 15.5 m. As evident from plotted diagrams of DBH distribution, the DBH distributions follow a left-skewed trend in forest plots of natural forests on steep slope (Figure 8)

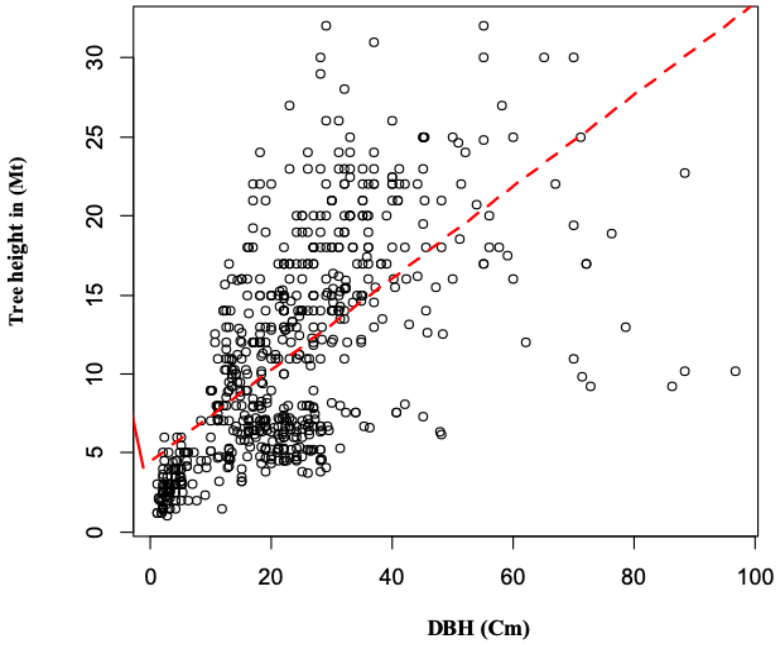


Figure 8: Plotted diagrams of tree DBH and height distribution

Likewise, a reversed j-shaped curve was obtained indicating most of the trees in all the strata are younger and there is high potential to enhance tree volume, biomass and carbon stock. The proportion of very young diameter classes with DBH between <10 cm was 44.5%, DBH classes between 10-20 cm was 33.25%, DBH classes between 20-30cm was 12.28%, DBH classes between 30-40cm was 4.4%, DBH class between 40-50 cm was 4.09% and >50 cm DBH was 1.28% respectively (Figure 9).

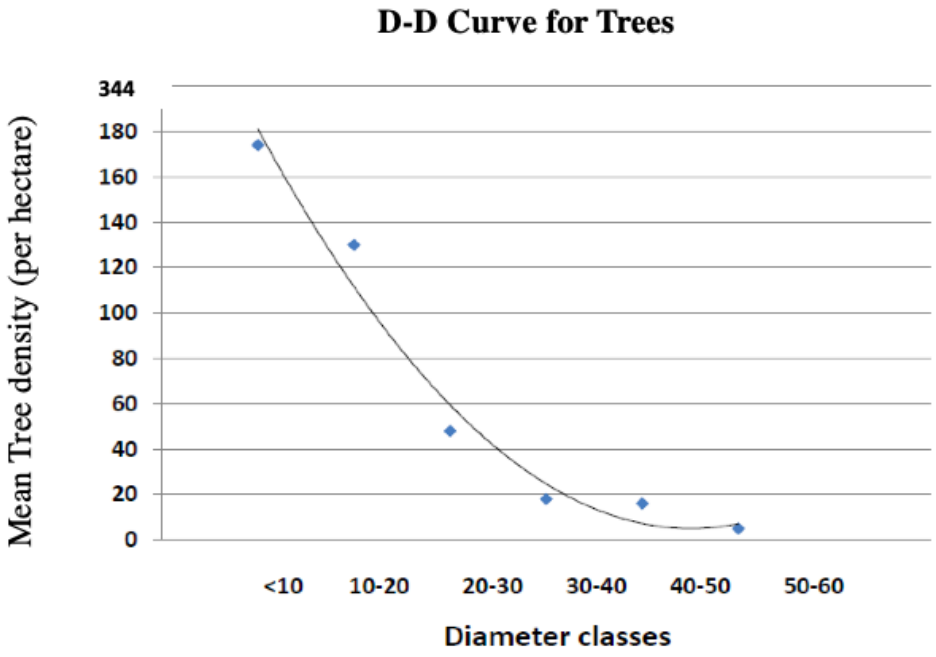


Figure 9: Diameter class distribution

Whereas plotted diagrams of DBH distribution, the DBH distributions also follow a left-skewed trend in forest plots and a reversed j-shaped curve was obtained indicating most of the trees in all the strata are younger and only very few proportion of the tree were of bigger diameter classes and there is high potential to enhance tree biomass stock in future for in the long run through the conservation and sustainable forest management. The proportion of very young diameter classes with DBH between <10 cm was 66.90%, DBH classes between 10-20 cm was 20.42%, DBH classes between 20-30cm was 4.93%, DBH class between 30-40 cm was 2.82%, DBH class 40-50 cm was 1.41% and >50 cm DBH was 5.52% respectively (Figure 10).

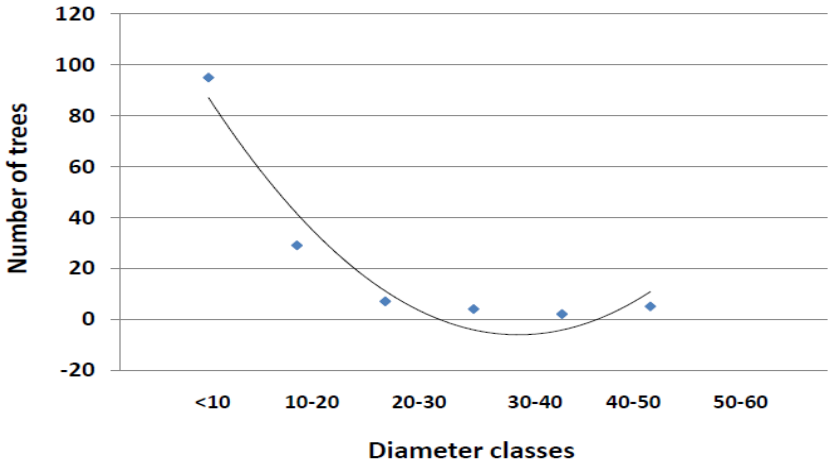


Figure 10: Diameter class distribution in Ratuwamai plantation forests

While plotting a relationship between Seedlings, Saplings and trees in sampled sites an inverted J-shaped curve has been observed- It means the forest is regenerating type in the the plantation area (Figure 11).

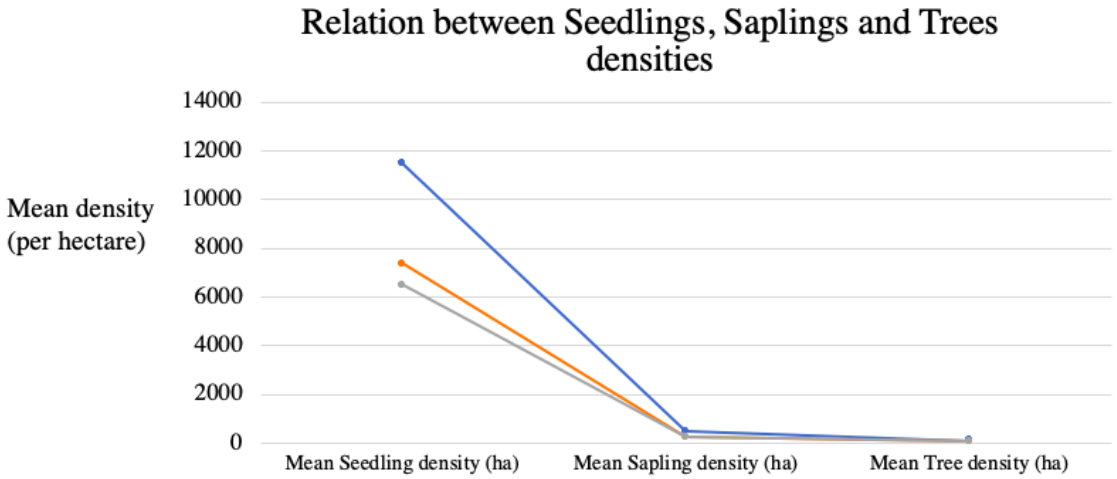


Figure 11: Relationship between seedling, sapling and trees density

4.1.2 Basal Area

The overall the total tree basal area at of the Ratuwamai plantation forest was found to be 5.24m^2 ha^{-1}. While the tree basal area of Sal dominant natural forest was 1.80 m^2 ha^{-1} followed by Eucalyptus plantation 1.01 m^2 ha^{-1} and the lowest (0.39 m^2 ha^{-1}) tree basal area was expressed by Rubber plantation (Table 2).

Table 2: Forest site wise basal area of key species

SN	Forest sites	Mean basal area (m^2ha^{-1})
1	Eucalyptus plantation	1.01
2	Kadam plantation	0.51
3	Pure Sal	1.80
4	Rubber plantation	0.39
5	Simal plantation	0.93
6	Teak plantation	0.60

4.1.3 Site wise seedling density

The mean seedling density in the Ratuwamai plantation area was found to be 6,807 seedlings per hectare. Among the different forest strata sampled, the highest seedling density was recorded in natural Sal Forest with 14,125 seedlings per hectare, followed by pure Teak plantation with 7,115 seedlings per hectare. The pure Simal plantation had 6,368 seedlings per hectare, while the lowest density was observed in the Eucalyptus plantation, with only 3,293 seedlings per hectare. Species-wise, Sal (*Shorea robusta*) showed the highest seedling density at 20,160 seedlings per hectare, whereas Siris (*Albizia* spp.) exhibited the lowest, with 6,066 seedlings per hectare, as presented in Table 3 below.

Table 3: District wise seedling density of key species

SN	Forest sites	Density ($ha^{-1)}$
1.	**Pure Sal**	
a)	Sal	20,160
Mean density		**14,125**
2.	**Pure Eucalyptus plantation**	
a)	Bhati	9,549
b)	Eucalyptus	6,366
c)	Sisoo	15,915
d)	Teak	10,610
Mean density		**3,293**
3.	**Pure Teak plantation**	
a)	Sal	6,306
b)	Siris	6,066
c)	Teak	8,325
Mean density		**7,115**
4.	**Pure Simal plantation**	
a)	Simal	6,368
Mean density		**6,368**
5.	**Rubber plantation**	0
6	**Kadam plantation**	0

4.1.4 Site wise saplings density

The overall mean sapling density in the Ratuwamai plantation area was 577 saplings per hectare. Among the sampled forest strata, the highest sapling density was recorded in the natural teak plantation with 1,200 saplings per hectare, followed by the pure Eucalyptus plantation with 800 saplings per hectare, Rubber plantation with 500 saplings per hectare, and natural Sal forest with 300 saplings per hectare. The lowest sapling density was observed in the Simal plantation, with only 200 saplings per hectare. Species-wise, the highest sapling density was recorded for Teak (1,200 saplings per hectare), whereas the lowest densities were

observed for Simal and Eucalyptus, both with 200 saplings per hectare, as presented in Table 4 below.

Table 4: Site wise saplings density of key species

SN	Forest sites	Density (ha^{-1})
1.	**Pure Sal**	
b)	Sal	300
Mean density		**300**
2.	**Pure Eucalyptus plantation**	
a)	Masala	1000
b)	Simal	100
c)	Teak	1300
Mean density		**800**
3.	**Pure Teak plantation**	
a)	Teak	1200
Mean		**1200**
4.	**Pure Simal plantation**	
a)	Simal	200
Mean density		**200**
5.	**Rubber plantation**	500
Mean density		**500**

4.1.5 Site wise tree density

The overall mean tree density in the Ratuwamai plantation area was 814 trees per hectare. Among the sampled forest strata, the highest tree density was recorded in the Teak plantation, with 840 trees per hectare, followed by the pure Eucalyptus plantation with 1,575 trees per hectare. The natural Sal forest had 440 trees per hectare, the Kadam plantation had 260 trees per hectare, and the Rubber and Simal plantations recorded the lowest density, with 100 trees per hectare each. These values are presented in Table 5 below.

Table 5: Site wise tree density of key species

SN	Forest sites	Density (ha^{-1})
1.	**Pure Sal**	
d)	Sal	440
Mean		**440**
2.	**Pure Eucalyptus plantation**	
a)	Bel	20
b)	Eucalyptus	6,040
c)	Sissoo	40
d)	Teak	200
Mean		**1,575**

3.	**Pure Teak plantation**	
a)	Teak	840
Mean		**840**
4.	**Pure Simal plantation**	
a)	Simal	100
Mean		**100**
5.	**Rubber plantation**	100
Mean		**100**
6. Kadam		260
Mean		**260**

4.2 Status of Natural Regeneration in Ratuwamai plantation sites

The status of the natural regeneration in the Ratuwamai plantation was found to be excellent as the overall mean of the seedlings was found to be 8, 655 seedlings per hectare. The forest is considered good if the average number of the seedlings is above the 5000 per hectare (MoFSC/CPFD, 2000). In the present study the number of the seedlings per hectare are comparable with the numbers of seedlings in the forest floor of the various forest types of Nepal i.e. the average number of seedlings in the study sites in both the natural forest on steep slope and seedlings in shrub land on valley on the were slightly higher than the number of seedlings present in the forests of the Churia (19,805 seedlings per hectare) and Terai forest (29,649 seedlings per hectare). This might be due to the better forest management and timely silvicultural treatments and practices adopted and better forest protection (restriction on open grazing, lopping, fodder collection, illicit felling, encroachment to the forest land etc.).

4.3 Standing tree volume

The volume assessment of different forest sites reveals significant variation in timber stock. Pure Sal forest exhibits the highest volume at 122.6 m^3 ha^{-1}, closely followed by eucalyptus plantations at 119.0 m^3 ha^{-1}, indicating their strong potential for timber production. Teak plantations show moderate volume with 17.8 m^3 ha^{-1}, reflecting their slower growth compared to fast-growing species. In contrast, rubber, kadam, and Simal plantations demonstrate very low volumes of 0.3, 1.4, and 0.7 m^3 ha^{-1} respectively, suggesting limited timber yield or younger stands. Comparing these data with the national level as published by FRA 2015,the estimated total stem volume is (164.76 m3 /ha).while the total stem volume in the Ratuwamai plantarion foret is slightly below as compared to the national average and highest was shown by Sal i.e 122 m3/ha). Also, The FRA 2015 showed that in High Mountains and High Himal physiographic regions together has the highest stem volume per hectare (225.24 m3 /ha) whereas Middle Mountains has the lowest stem volume per hectare (124.26 m3 /ha). Terai and Churia regions have 161.66 m3 /ha and 147.49 m3 /ha, respectively. These values of present study in Ratuwamai are presented in Table 6 below.

Table 6: Site wise standing tree volume in Ratuwamai

Forest sites	**Volume (m^3ha^{-1})**
Eucalyptus plantation	119.0
Kadam plantation	1.4
Pure sal	122.6

Rubber plantation	0.3
Simal plantation	0.7
Teak plantation	17.8

The species wise net timber volume and fire wood stock in the Ratuwamai plantation forest is dominated by Eucalyptus (3,067.19 cubic feet) and Sal (2,562.19 cubic feet), which together account for the majority of the merchantable wood, while Teak contributes a smaller but significant volume (490.63 cubic feet). Minor species such as Kadam (37.87 cubic feet), Simal (21.15 cubic feet), Mixed species (16.65 cubic feet), Bel (33.92 cubic feet), Rubber (8.17 cubic feet), and Sissoo (8.66 cubic feet) make up the remaining timber stock. Additionally, firewood (Chatta) volumes are highest for Eucalyptus (7.42 units) and Sal (5.06 units), with negligible quantities from other species, reflecting their secondary use as fuelwood. This distribution highlights the plantation's reliance on fast-growing Eucalyptus and high-value Sal for timber production, with limited but diverse contributions from other species as provide in table 7.

Table 7: Species wise net tree volume and fire wood stock in Ratuwamai

Species	**Net volume (Cubic feet)**	**Fire wood (Chatta)**
Eucalyptus	3,067.19	7.42
Kadam	37.87	0.10
Mixed species	16.65	1.02
Rubber	8.17	0.02
Sal	2,562.19	5.06
Simal	21.15	0.05
Sissoo	8.66	0.05
Teak	490.63	1.23
Bel	33.92	0.08

4.4 Sapling biomass and carbon stock

Below table 6, presents biomass and carbon stock data (in tonnes per hectare) across five forest strata, highlighting variations in carbon sequestration potential among different plantation types. Eucalyptus plantations exhibit the highest biomass (5.12 t ha^{-1}) and carbon stock (2.41 t ha^{-1}), indicating their superior capacity for carbon storage compared to other species. This may be attributed to their fast growth rate and high wood density.

The overall mean biomass across all strata is 2.30 t ha^{-1}, with an average carbon stock of 1.08 t ha^{-1}. These averages are heavily influenced by the high biomass of eucalyptus, which skews the mean upward. This analysis underscores the importance of species selection in forest planning for optimizing carbon sequestration and contributing effectively to climate change mitigation goals.

Table 6: Site wise sapling biomass and carbon stock in Ratuwamai

SN	**Forest strata**	**Biomass (**t ha^{-1}**)**	**Carbon (**tC ha^{-1}**)**

1	Eucalyptus plantation	5.12	2.41
2	Pure Sal	2.23	1.05
3	Rubber plantation	1.28	0.60
4	Simal plantation	0.51	0.24
5	Teak plantation	2.33	1.10
Mean		**2.30**	**1.08**

4.5 Tree biomass

The provided table 7, compares the mean biomass and carbon stock across six different forest strata: Eucalyptus, Kadam, Pure Sal, Rubber, Simal, and Teak plantations. Among these, Pure Sal (*Shorea robusta*) exhibits the highest biomass at 25.1 t ha^{-1} and carbon stock at 9.8 tC ha-^{1}, highlighting its significant ecological role in carbon sequestration and forest productivity. Sal forests are naturally dense and slow-growing hardwood stands, making them valuable not only for timber but also for climate mitigation through carbon storage. Following Sal, Eucalyptus plantations show the second-highest biomass (8.1 t ha^{-1}) and carbon (3.2 tC ha^{-1}), indicating moderate carbon sequestration potential. Eucalyptus is a fast-growing species used widely in commercial plantations, though its ecological impacts, such as high-water consumption and poor understory biodiversity, should be considered in afforestation programs. Teak plantations demonstrate intermediate values with 3.2 t ha^{-1} biomass and 1.3 tC ha^{-1} carbon stock. While Teak is a high-value timber species, its moderate carbon stock suggests younger plantation age or intensive harvesting practices. The remaining forest strata like Kadam, Rubber, and Simal plantations showed relatively low biomass and carbon values. Kadam and Simal have biomass below 2.5 t ha^{-1} and carbon stock under 1.2 tC ha^{-1}, reflecting limited carbon sequestration capacity, likely due to their lightweight wood and fast growth. Rubber plantations perform the lowest in terms of carbon (0.5 tC ha^{-1}), indicating that while economically important, their ecological contribution to carbon storage is minimal. The FRA 2015, estimated that the total above-ground air-dried biomass in the Forest of Nepal is 1,159.65 million tonnes with average 194.51 t/ha (FRA,2015).

Overall, the data suggests that native forests like Pure Sal offer the highest ecological benefits in terms of biomass and carbon storage. Plantation forestry, especially with exotic or fast-growing species, must be carefully planned, considering both short-term economic gains and long-term environmental sustainability. Integrating native species into reforestation efforts can significantly enhance carbon stocks and ecosystem resilience.

Table 7: Site wise tree biomass and carbon stock in Ratuwamai

Forest strata	**Mean Biomass (t ha^{-1})**	**Mean Carbon (tC ha^{-1})**
Eucalyptus plantation	8.1	3.2
Kadam pantation	2.3	0.9
Pure Sal	25.1	9.8
Rubber plantation	1.3	0.5
Simal plantation	1.8	0.7
Teak plantation	3.2	1.3

Similarly, the below table 8, provides the species wise forest biomass and carbon stock in the Ratuwamai plantation forest.

The table presents species-wise mean biomass and carbon stock values in the Ratuwamai plantation area, highlighting significant variation in carbon sequestration potential among different forest strata. Among all species, Sal (*Shorea robusta*) stands out with the highest mean biomass of 32.3 t ha^{-1} and carbon stock of 12.6 tC ha^{-1}, reaffirming its vital role in forest-based climate mitigation strategies. Sal's performance in Ratuwamai aligns with national-level forest assessments where natural Sal forests, particularly in the Terai region, often exhibit high biomass (up to 200 t ha^{-1}) and carbon values (above 80 t ha^{-1} in mature stands), though plantation stocks are lower due to younger age or density.

Comparatively, Eucalyptus, a fast-growing exotic species, showed moderate values (8.1 t ha^{-1}; 3.2 t ha^{-1}), consistent with national trends where its productivity is high but ecological benefits are debated. Sissoo (*Dalbergia sissoo*), a nitrogen-fixing species with multiple uses, also presents a reasonable biomass-carbon balance (6.8 t ha^{-1}; 2.7 tC ha^{-1}), making it favorable for agroforestry systems. On the lower end, species like Rubber (1.3 t ha^{-1}; 0.5 tC ha^{-1}), Simal (1.5 t ha^{-1}; 0.6 tC ha^{-1}), Teak (2.9 t ha^{-1}; 1.1 tC ha^{-1}), and Kadam (2.3 ; 0.9 tC ha^{-1}) demonstrate limited carbon storage capacity. These values fall significantly below the national forest average, where Nepal's mid-hill forests store around 100 t ha^{-1} biomass and 45 tC ha^{-1} on average. In summary, Ratuwamai's forest composition shows that native and site-suitable species like Sal, Bel, and Pithari offer higher ecological returns. The results emphasize the need to prioritize such species in reforestation and agroforestry initiatives to enhance biomass productivity and climate resilience across Nepal.

Table 8: Species wise biomass and carbon stock in Ratuwamai

Forest strata	**Mean Biomass (t ha^{-1})**	**Mean Carbon (tC ha^{-1})**
Bel	15.5	6.1
Eucalyptus	8.1	3.2
Kadam	2.3	0.9
Sindure	5.3	2.1
Pithari	9.2	3.6
Rubber	1.3	0.5
Sal	32.3	12.6
Simal	1.5	0.6
Sissoo	6.8	2.7
Teak	2.9	1.1
Total	**85.2**	**33.4**

4.6 Total vegetation carbon stock in Ratuwamai pentation forest

The Ratuwamai plantation forest exhibits significant variation in carbon storage across its tree species, with Sal (13.65 tC ha^{-1}) emerging as the dominant carbon sink, reflecting its ecological importance and high biomass accumulation. Eucalyptus (5.61 tC ha^{-1}) and Bel (6.1 tC ha^{-1}) also contribute substantially, while Teak (2.2 tC ha^{-1}), Sissoo (2.7 tC ha^{-1}), and Pithari (3.6 tC ha^{-1}) show moderate carbon stocks. Minor species like Kadam (0.9 tC ha^{-1}), Mixed species (2.1 tC/ha), Rubber (1.1 tC ha^{-1}), and Simal (0.84 tC ha^{-1}) play smaller but notable roles in the

plantation's carbon sequestration. The total mean forest carbon stock (without soil) in Ratuwamai collectively was found to be 38.8 tC ha^{-1}, demonstrating its potential for climate mitigation. The disparity in carbon stocks underscores the value of Sal and Eucalyptus for carbon-focused forestry, while the diversity of other species enhances ecological resilience. While comparing with the national average, the total carbon stock in Nepal's Forest has been estimated as 1,054.97 million tonnes i. e in an average the mean carbon was 176.95 t/ha with soil carbon. Out of this total, tree component (live, dead standing, dead wood and below-ground biomass), forest soils, and litter and debris constitute 61.53%, 37.80 %, and 0.67%, respectively.

Table 9: Species wise total carbon stock in Ratuwamai

Forest strata	**Vegetation carbon stock (tC ha^{-1})**
Bel	6.1
Eucalyptus	5.61
Kadam	0.90
Mixed species	2.1
Pithari	3.6
Rubber	1.10
Sal	13.65
Simal	0.84
Sissoo	2.7
Teak	2.20
Total Forest Carbon (tC ha^{-1})	**38.8**

4.7 Total carbon stock and Carbon dioxide equivalent in Ratuwamai pentation forest

The Ratuwamai plantation forest, covering 3,125.32 hectares, demonstrates significant carbon sequestration potential with a total carbon stock of 121,262.41 metric tons (38.8 tC ha^{-1}) and an equivalent carbon dioxide storage of 445,033.67 metric tons (calculated using the IPCC standard conversion factor of 3.67). This substantial carbon pool, equivalent to offsetting annual emissions of approximately 96,000 Nepalese citizens, is primarily driven by high-carbon species like Sal (13.65 tC ha^{-1}) and supplemented by *Eucalyptus* (5.61 tC ha^{-1}) and other mixed species. The forest's carbon density highlights its critical role in Nepal's climate mitigation efforts and suggests strong potential for participation in carbon credit mechanisms such as REDD+. These findings underscore the importance of maintaining and expanding such plantations to meet national carbon targets while promoting biodiversity conservation. For optimal carbon management, future strategies could focus on enhancing Sal-dominated stands and implementing regular carbon monitoring through advanced remote sensing technologies. The data provides a robust baseline for evaluating the plantation's contribution to Nepal's Nationally Determined Commitments under the Paris Agreement.

Table 10: Total carbon stock and carbon dioxide equivalent in the in Ratuwamai

Forest name	**Total Area of the plantation**	**Total Carbon Stock (tC ha^{-1})**	**Total carbon stock (tC)**	**Total carbon dioxide**

				equivalent stock (tCO_2e)
Ratuwamai forest area	3125.32	38.8	121,262.41	445,033.67
Total	**3125.32**	**38.8**	**121,262.41**	**445,033.67**

4.8 Decadal land use change pattern in the Ratuwamai plantation area

The land use change map of each studied district had been developed. The two-time series land use change maps (2010 and 2023) have been developed. The key results show that there has been increased in grassland in 2023- converging forest area to grassland (Figure 12a, 12b).

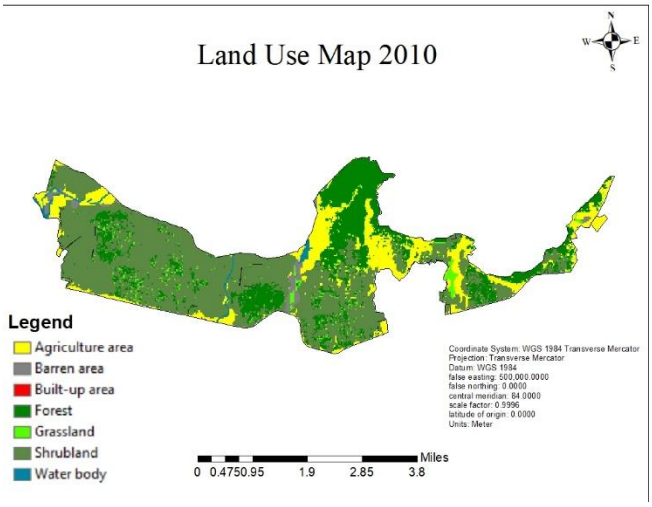


Figure 12a: Land use and land cover map of Ratuwamai plantation area 2010

Figure 12b: Land use and land cover map of Ratuwamai plantation area 2023

4.9 Encroachment areas in Ratuwamai Plantation Sites

The below figure 13 showed the key encroachment areas. The Encroachment Map of Ratuwamai Plantation presents a critical spatial assessment of human-induced pressures on this ecologically significant region, revealing distinct zones of unauthorized land use that threaten both biodiversity and sustainable land management. The map's legend clearly demarcates boundary lines, fire lines, football grounds, and encroachment areas, providing a visual representation of where human activities are infringing upon designated plantation limits.

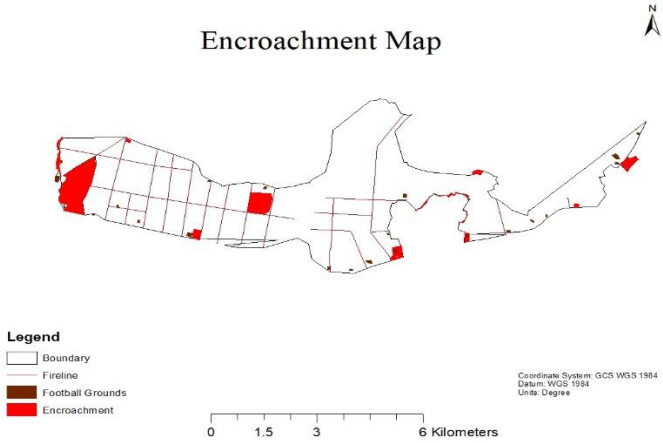


Figure 13: Encroachment are map of Ratuwamai plantation in 2025

The encroachment data from Ratuwamai Plantation reveals a complex and pressing land management challenge, with a total of 187.5 hectares (ha) of land being unlawfully occupied across various sectors.

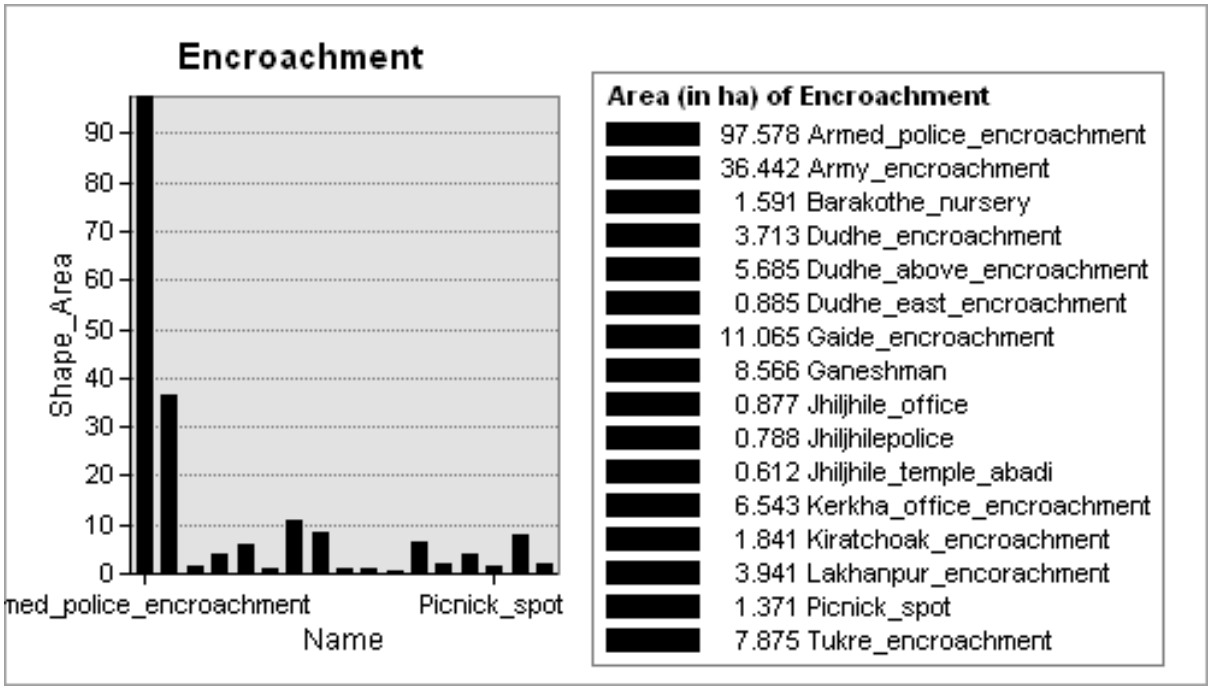


Figure 13a: Encroachment are map of Ratuwamai plantation by category in 2025

4.10 Flood plain areas in Ratuwamai Plantation Sites

The Flood Plain Map (figure 14) of Ratuwamai Plantation provides a critical spatial representation of areas vulnerable to seasonal inundation, delineating both the plantation's formal boundaries and the extent of flood-prone zones within its landscape.

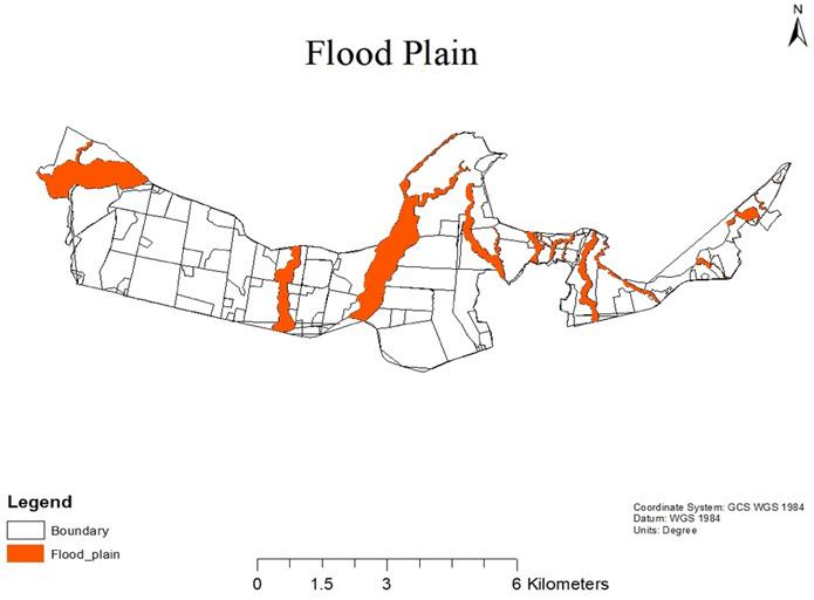


Figure 14: Flood plain area map of Ratuwamai plantation in 2025

The flood plains in Ratuwamai Plantation play crucial ecological roles as natural water reservoirs and erosion buffers, supporting biodiversity. However, without detailed data on human infrastructure within these areas, it's difficult to fully assess potential risks to people and property from flooding.

Flood plains in the Ratuwamai Plantation are vital for water management, flood control, and biodiversity. However, threats such as deforestation and unplanned development put their ecological functions at risk. Integrated management, including zoning, community monitoring, early warning systems, and restoration of native vegetation, is essential to preserve these important areas.

4.11 Elephant corridors in Ratuwamai

The below figure 15 highlights a crucial Asiatic Elephant Corridor near the Ratuwamai Plantation Project and Koshi Tappu Wildlife Reserve in Nepal's Eastern Lowlands. This corridor serves as a lifeline for elephants, enabling them to move between fragmented habitats, access water, and maintain genetic diversity. The region's dense forests and riverine ecosystems provide essential resources, but increasing human activities such as agriculture, settlements, and commercial plantations have encroached upon these pathways. The corridor's preservation is vital not only for elephant survival but also for maintaining ecological balance, as elephants play a key role in seed dispersal and forest regeneration. However, habitat shrinkage has intensified human-elephant conflict (HEC), with elephants frequently raiding crops in search of food, leading to economic losses for farmers and retaliatory actions such as electric fencing or even poisoning. The conflict is exacerbated by infrastructure projects that block traditional migration routes, forcing elephants into human-dominated areas. Without intervention, this cycle of habitat loss and conflict will worsen, threatening both wildlife and local livelihoods.

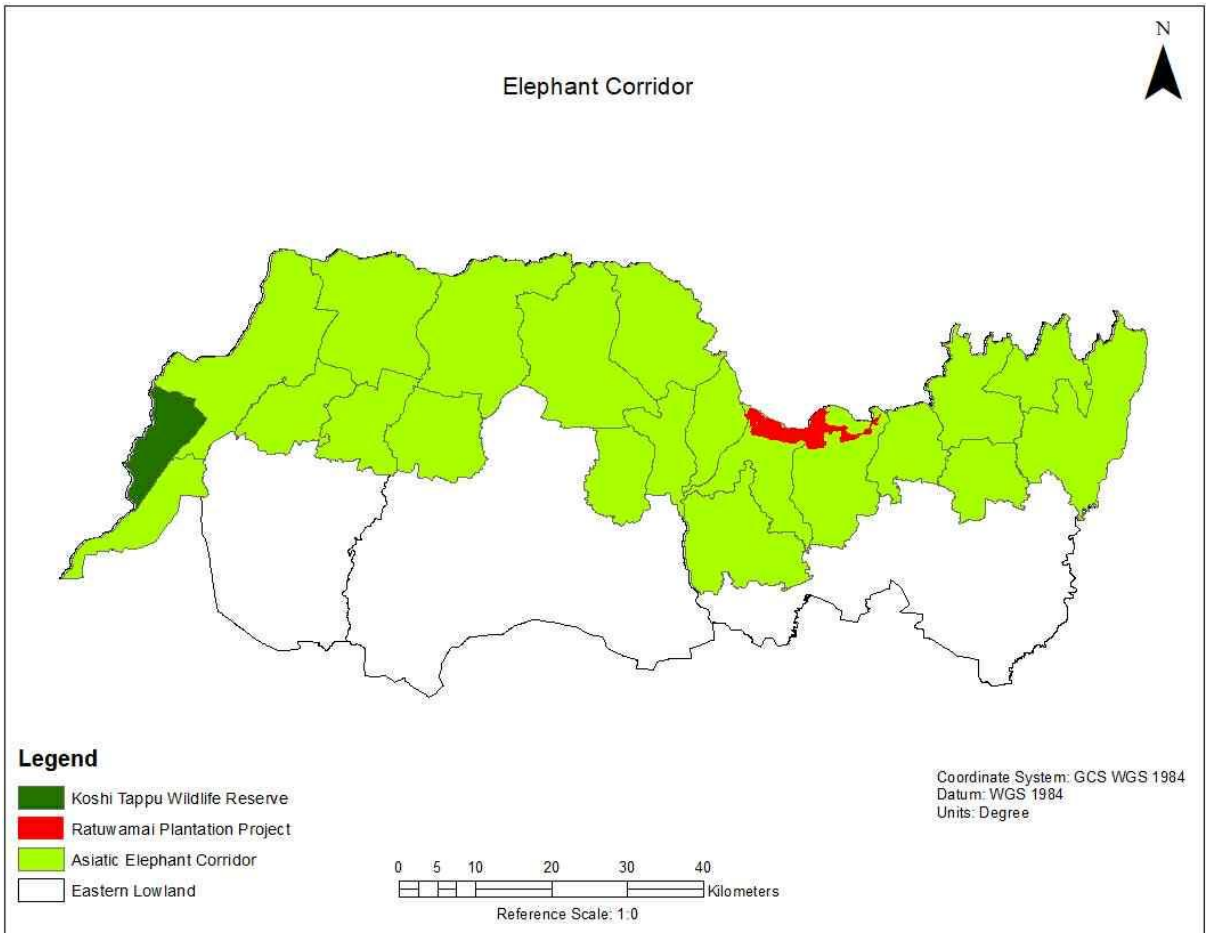


Figure 15: Elephant corridor area map of Ratuwamai plantation

Sustainable Solutions for Coexistence and Conflict Mitigation

Based on the intensive discussions with the local communities and key stakeholders to address these challenges, a multi-pronged, community-driven approach is essential. First, habitat restoration must be prioritized by securing the elephant corridor through legal protection and reforestation with native plant species. Buffer zones should be established between forests and

farmlands to minimize encounters. Second, community-based mitigation strategies, such as early warning systems using SMS alerts or drones, can help farmers prepare for elephant movements. Non-lethal deterrents like beehive fences and chili barriers have proven effective in steering Elephants away from crops without harm. Additionally, compensation schemes for crop damage can reduce hostility and foster tolerance. Third, promoting elephant-friendly farming such as cultivating crops like Mentha, Chamomile, Lemongrass, Turmeric, Ginger, or lemongrass that elephants avoid can reduce economic losses. Finally, education and alternative livelihoods, such as forest and NTFPs/MAPs based small and micro enterprise development, eco-tourism or handicraft production, can lessen dependence on forest resources while raising awareness about conservation. Collaboration between governments, NGOs, and local communities is critical to implementing these measures effectively. By adopting sustainable, win-win solutions, Nepal can protect its elephant populations while supporting the well-being of rural communities, ensuring long-term harmony between humans and wildlife.

4.12 Cost and benefit analysis

The financial viability of the Ratuwamai Plantation Project was assessed through standard cost-benefit analysis, yielding positive NPV and BCR results as shown in below table 11, confirming the project's economic feasibility. Since the Net Present Value (NPV) is positive and the Benefit-Cost Ratio (BCR) exceeds one, this project can be profitably implemented based on financial analysis.

आर्थिक वर्ष	जम्मा वार्षिक आम्दानी	जम्मा वार्षिक खर्च	खूद नाफा
२०७५/७६	७७८६१२४५	४२८४५६०८	३५०१५६३७
२०७६/७७	८१७९४३०७	४०६९८६०८	४१०९५६९९
२०७७/७८	८५८८६०२३	४६८७४०५८	३९०१११६५
२०७८/७९	९०१८२५२४	३८७४९३५८	५१४३३१६६
२०७९/८०	९४६९४०७०	३८०६००५८	५६६३४०१२
२०८०/८१	९९४३१४३६	३५७५४८५८	६३६७६५७८
२०८१/८२	१०४४०५९३५	५६४२२५५८	४७९८३३७७
२०८२/८३	१०९६२९४५३	३५७५४८५८	७३८७४५९५

आर्थिक वर्ष	जम्मा वार्षिक आम्दानी	जम्मा वार्षिक खर्च	खूद नाफा
२०८३/८४	११५११४४६९	३७२१२५५८	७७९०१९११
२०८४/८५	१२०८७४०९०	४८३५४३५८	७२५१९७३२
कूल जम्मा	९७९८७३५५२	४२०७२६८८०	५५९१४६६७२
NPV at 10%	**५७९,५७०,५५७.५७**	**२५८,१४२,३१३.४८**	**३२१,४२८,२४४.०९**
B/C ratio	**२.२५**		

Source: Ratuwamai Planation Forest Management Plan 2075

4.12 Key threats to the forest and biodiversity in Ratuwamai plantation sites

Based on the field inventory and sample plot measurement the major threats to forests were identified and validated through the key informant interviews and focus group discussions: The key threats identified were Uncontrolled grazing; Encroachment; Lopping; Forest fire; Soil erosion; Invasive Alien Species (IAS), Illegal harvesting, Wild elephant movement and climate change. The field level data and information were triangulated and validated though the focus groups discussions and key informant interview (Figure 16). The figure indicates that open grazing, lopping, forest fire, and soil erosion were the highest in terms of its frequency and occurrence followed by the IAS and illegal harvesting.

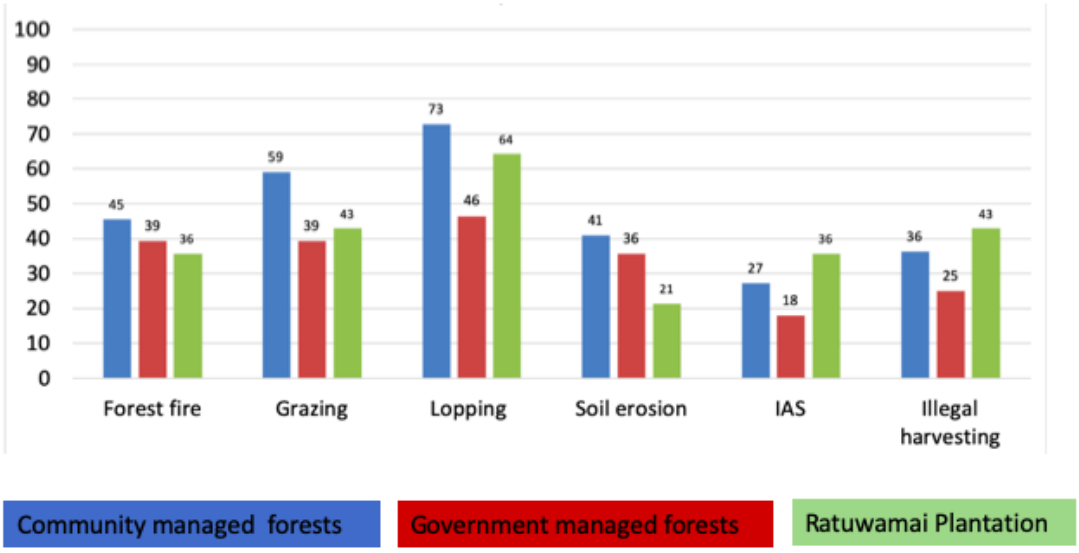


Figure 16: Key threats to the forest and biodiversity conservation in Ratuwamai plantation

5 RECOMMENDASTIONS ON SFM MODEL IN RATUEWAMAI

5.1 Project background

The Forest Products Development Committee was established in accordance with the Forest Produce Development Committee (Statute) Order 2033, under the Development Committee Act of 2013, by the Government of Nepal. Operating under the Ministry of Forest and Soil Conservation, the committee aims to cultivate wood, firewood, and other forest products through the effective management of rapidly growing tree species. It also focuses on overseeing the utilization, sale, and distribution of these forest products while creating employment opportunities for local communities surrounding the projects. Currently, the committee manages the Sagarnath Forest Development Project and the Ratuwamai Tree Plantation Project, the latter of which commenced in Jhapa district in the fiscal year 2035/36 BS, funded by the committee's own financial resources. The project office is situated in Kerkha, within Kamal Rural Municipality Ward No. 3. The Ratuwamai Tree Plantation Project encompasses an area of 3,125.31 hectares, bordered by the Kankaimai River to the east, Ratuwa Khola to the west, and extending north to Chulachuli and Mai municipalities in Ilam district, while the southern boundary includes Shivashatakshi, Kamal rural municipality, and Damak municipality in Jhapa district.

5.2 Types of forests of the area

The project area has both natural and plantation forests. The northern Satakshidham region hosts a natural forest predominantly composed of Sal species (*Shorea robusta*) covering 268 hectares. Additionally, naturally occurring Simal trees and shrubs populate the banks and surrounding regions. On the other hand, the plantation forest includes fast-growing Eucalyptus and Teak species, with rubber and agarwood trees introduced on a trial basis across five hectares in the Kerkha area during the fiscal year 2073/74 BS. The forests of the area have been divided into 26 compartments for management purposes. Compartment 4 covers the Sal natural forests of Sal. Other compartments are the plantation forests of fast-growing species, Eucalyptus and Teak. Four compartments (1, 2, 3 and 22) are Teak plantation sites whereas remaining 21 compartments include Eucalyptus plantations.

5.3 Major problems and issues of the project

There are several persistent problems and issues related to the forest management of the project area. These are:

a) **Open grazing**: Open grazing presents a significant challenge in the project area.

b) **Illegal cutting of trees**: Illegal harvesting of trees has emerged as a significant issue within the project area.

c) **Construction of cemetery in the forest area**: Graveyards have been established over an area of 26 hectares in the Eucalypts plantation sites Kirantchowk, Milanchowk, Dudhe village west, Jhiljheel village west, Sano Kerkha, and Lakhanpur, located on the western side of Kerkha Bazaar along the highway.

d) **Pig's den inside the forest**. It has been observed that about 5 hectares of land within the project area have been used for pig farming, with pig sheds established by communities residing on the south side of the highway illegally.

e) **Encroachments:** The Ratuwamai Tree Plantation Project is facing significant pressure from various encroachments on its forest area. Both institutional and individual entities have contributed to this issue, with encroachments reported from village development committees, tribal federations, and community forest user groups, among others, particularly in the Dudhe region. Additionally, illegal constructions of monasteries have been observed in the Shasakshidham and Jhiljheel areas, further exacerbating the situation.

f) **No specific management plans** have been developed, approved and implemented for the forests of the project area. Natural Sal forests have been just protected without any specific management plan resulting in the degradation of the forests. Even though the plantation forests were established to produce the different forest products and supply them to the market regularly, there is no specific harvesting plan with supporting silvicultural system and market link to supply the harvested forest products.

g) **No properly managed log yards:** There are two log yards, one at Kerkha and one at Jhiljheel of the project area. However, the log yards have not been properly managed.

h) **Lack of coordination** among the different institutions and stakeholders

i) **Staff Management**. The prolonged inactivity of the project, particularly in the management and sale of forest products, has resulted in employees going without salaries for an entire year. This situation underscores the severe repercussions of the project's operational difficulties, which directly affect the livelihoods of its workforce. Employees rely on income generated from the sale of forest products to receive their salaries and to sustain office operations.

j) **Harvested timber could not be sold because of the high price.** The policy that does not allow lowering the price as per the market demand is a problem.

k) **Human-wildlife conflict**. There is also a human-wildlife conflict in the project area as the project is within the elephant corridors of the region.

5.4 Insights from the KII and FGD

During the Key Informant Interviews (KII) and Focus Group Discussions (FGD) concerning the current challenges and issues, as well as the prospective Sustainable Forest Management (SFM) model for the Ratuwamai Plantation Project Area, several insights and recommendations were gathered. It was noted that most of the problems identified by participants were consistent with those outlined in Section 5.4. However, opinions regarding the future SFM model varied significantly among different individuals and groups involved in the discussions. These are discussed briefly below.

1. **Public Private Partnership (PPP)** should be the future SFM model for the project area. The main focus of the idea is that the project was established to plant the fast-

growing species to supply the forest products to the market for forest-based industries; and generate the local employment, which is still valid and appropriate for the project. In this context, it is imperative to involve the private sector in management of the forests of the project area (plantation, maintenance and harvesting and selling to the market). This will solve most of the problems and issues that the project is facing now.

2. The project area was occupied by settlers before BS 2032. This was cleared in 2032, which was really a good step taken and saved the area from being private property. Later in 2035/36, the project was developed and implemented replicating the concept of Sagarnath Forest Development Project. At that time, it could have been a good idea. However, now there is no relevancy to this project as it has not been generating local employment. In this context, this area should be handed over to the local bodies (Palikas) for fruit cultivation. This view was from a ward chairperson of Ward no 4 of Kamal Municipality.

3. Development of ecotourism could be one option as there are number wetland sites which can be developed as lakes. The government itself should not run the business as it will not be able to meet the cost of the business. With some condition, private sector should be given opportunity to do the business.

4. Because of Elephant problem, cultivation of fruit trees would be feasible. Fruit tree plantation along with ecotourism development is possible. Ther is also the possibility of developing a wildlife breeding center.

5. **Prasad Subba**, who was involved in NTFP/MAP plantation and extracting essential oil described a very interesting success story. According to him, there was a very good and effective practice of intercropping of NTFP/MAP about 12-15 years ago. He paid Rs 600/hectare as the rent for cultivating NTFP/MAP. He established a distillation plant for extraction of essential oil of different species including Babari and Tulsi plants. He was able to provide employment for a lot of people in the area. Employees would work in the plantation, harvesting and transporting NTFP/MAP to the distillation plants. He said, there was no loss for him from the business. However, he said he was not able to export the essential oils he produced himself directly because he did not have an export license. Therefore, he completed to export the essential oils through third party broker. Because of this he did not get as much benefits as it could have been from the business. He said the model could be re-started again as demand of essential oils is increasing and there is an ample opportunity to grow NTFPs/MAPs in the project area especially aligned with the harvesting and replanting of Eucalyptus and Teak trees. Now it would be best if the model could be re-established; otherwise, it should be handed over to the Jadibuti company (Herbs Production and Processing Co Ltd) to go for Tamagadi and Tarahara model.

6. Some also suggested that there should be a policy like Tea-Estate (Chiya Bagan).

7. Most of the participants said that Eucalyptus plantation has decreased the water table in the area.

8. There was also a consensus among the participants that because of some policy hurdles, the project could not sell the timber collected last year. Because of the new volume calculation formula prescribed, business who used to buy the timber from the project went for other options.

5.5 Recommended integrated SFM model for the project area.

Based on analysis of the project establishment and its objectives, field level observation and discussion with all stakeholders especially with the local people and project staff for this study and other literature, it is recommended that different forest types of the project area should be managed following the integrated forest managed principles as follows.

Silviculture-based active Sustainable Forest Management or Scientific Forest Management of natural Sal Forests. For this, detailed SFM plans for the Sal forests of the area (Figure 17) should be developed. The rotation period of the Sal needs to be revised after conducting research on the demand of size of the sawn timber in the market. We think the rotation period of Sal from 80 years can be reduced to 60 years. An irregular Shelterwood system may be the best for the area.

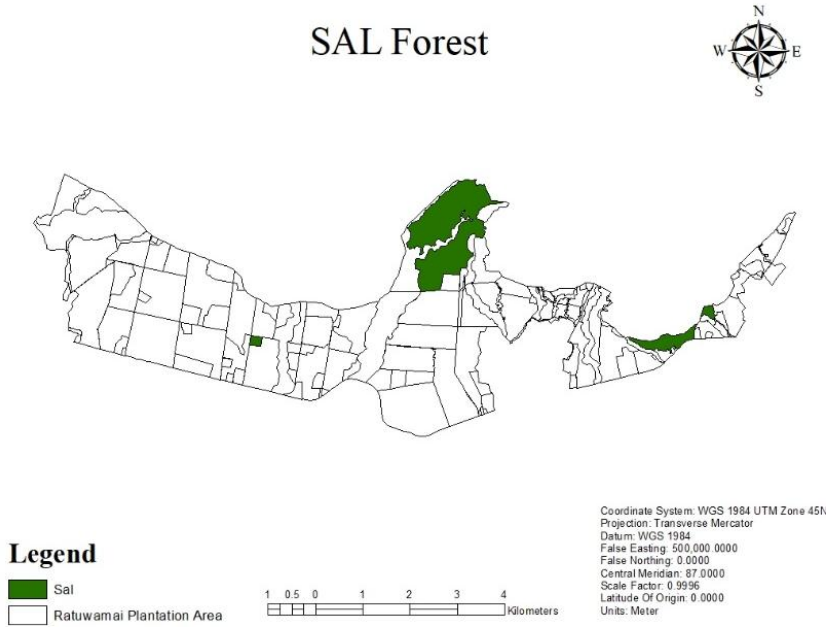


Figure 17: Sal dominant plot in Ratuwamai

Clear feeling of mature Eucalyptus and Teak plantation and re-planting new seedlings in the areas, with suitable rotation period – (about 10-15 years for Eucalyptus and 10-25 years for Teak). The area is not prone to landslide and heavy soil erosion and the project was established with objectives of supplying the forest products from fast growing short rotation species, which is still valid and appropriate for the project. Therefore, word **"Clear feeling"** should not be taken negatively for the project area (Figure 18,19 and 20).

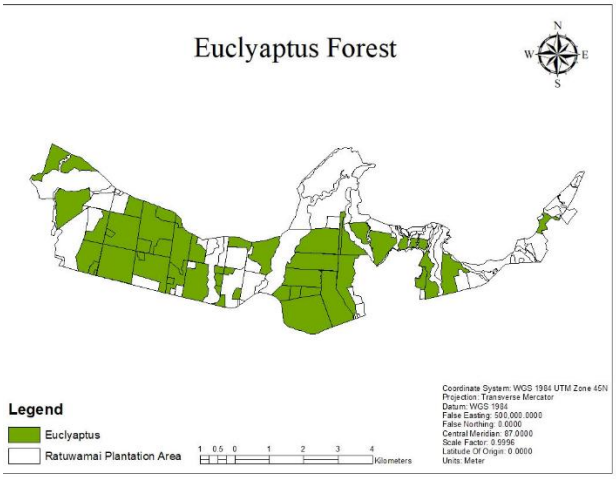


Figure 18: Eucalyptus dominant plot in Ratuwamai

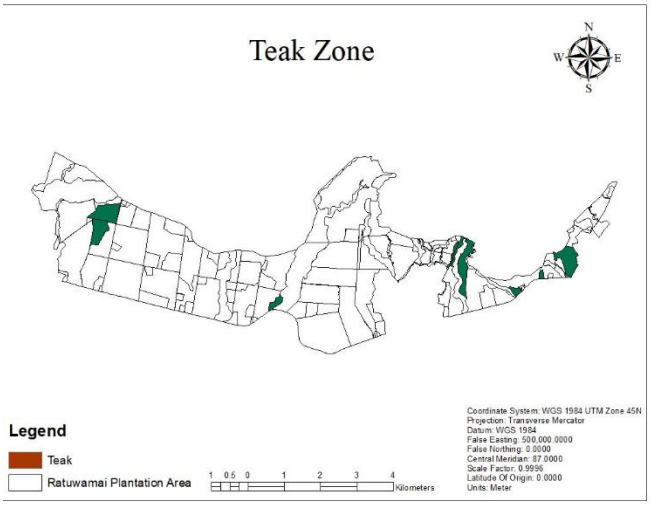


Figure 19: Teak dominant plot in Ratuwamai

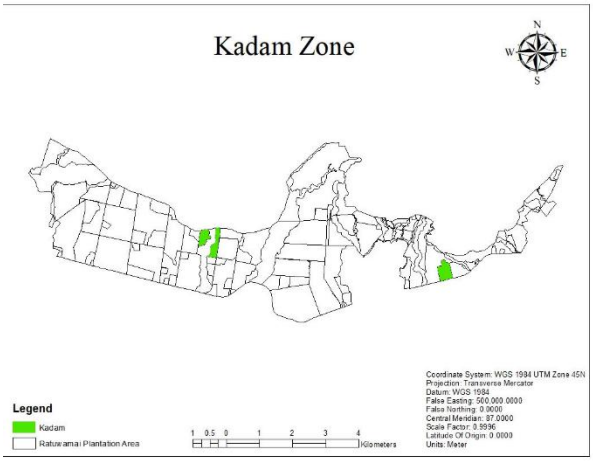


Figure 20: Kadam dominant plot in Ratuwamai

When clear feeling of mature Eucalyptus and Teak trees is done and new plantation will be started, a successful model previously used – intercropping of NTFP/MAP species should be re-established in collaboration with the private sector to produce essential oils. Even Eucalyptus leaves can be used in this process. It will generate local employment and local forest-based entrepreneurs will be actively involved in the management of plantation forests.

Since, market for timber harvested during the clear feeling could be uncertain and volatile, it would be good idea work with private sector especially forest-based industries and sign agreement for the PPP.

Local governments should also be involved in the process. For this, some areas can be allocated for ecotourism development. Palikas will invest, develop ecotourism and operate as per the agreed conditions. Revenue collected from the ecotourism will be shared between the Palikas and the project. The ecotourism areas will have also parks for children and some playgrounds for youngsters such as football grounds. This will help local people and youths actively involved in the forest management of the project area. This will also help solve the problem of graveyards in mutual understanding. The areas for ecotourism development needs to be selected considering different aspects of forest management, as well as other factors such as religious tourism in Satakshidham, for example. When ecotourism is developed, some artificial lakes could be created, which will help recharge the underground water in the area.

From the literature and field observation and interactions with the local stakeholders, it seems that active timber production-oriented management of Sal could be implemented in about 250-300 hectares. Similarly, clear feeling Eucalyptus and Teak plantation management area will be about 2400 ha. In this way, about 2700 ha of forest area will be managed sustainably. If about 200-300 ha of area is protected for conservation purposes, about 100 -200 ha of area will be available for ecotourism, parks and playgrounds for local people.

This is the best integrated SFM model recommended for the Ratuwamai Plantation Project area. A detailed description of this model is presented in the following section.

5. 6 Possible re-plantations of MAPs/NTFPs in Ratuwamai

The proposed re-plantation sites within the Ratuwamai plantation area represent key opportunities for ecological restoration, targeting around 720 hectares of degraded or vulnerable land. These locations were selected for their potential to restore ecosystem functions, protect watersheds, and connect habitats. The plan emphasizes scientific site selection, native species use, and robust monitoring, while stressing the importance of community involvement and resolving land tenure issues. Integrated with previous analyses, the approach aims to address both environmental and socioeconomic challenges, creating a replicable model for participatory forest management and sustainable landscape recovery (Figure 21).

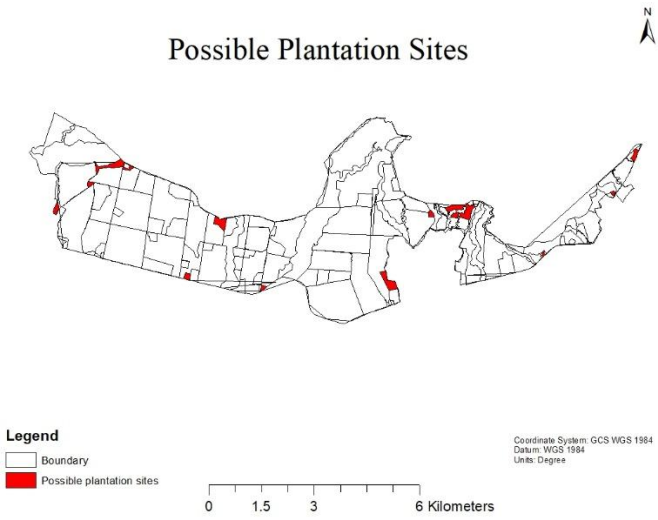


Figure 21: Potential re-plantation sites inside Ratuwamai plantation site

5.7 Private Sector Engagement and Livelihood Development Model

The Ratuwamai plantation has significant potential for cultivating essential oil-bearing plants like Lemongrass, Citronella, Palmarosa, and Mentha, which can boost local livelihoods and provide revenue for the project and government. Previously, about 1,000 hectares were cultivated under a lease system, but production halted due to risks like forest fires, market instability, limited technical knowledge, and lack of quality seeds. There are plans to allocate up to 720 hectares for future cultivation, with potential for further expansion if inputs and support improve.

Processing of Medicinal and Aromatic Plants for Essential oils

- **Present status of the processing enterprise**

Production of essential oils at the Ratuwamai site peaked at 10,000 kilograms in 2020 but has since halted, largely due to underutilization and operational challenges within the processing enterprise. The main issue is an insufficient and inconsistent supply of raw materials, preventing year-round operation. Experts suggest that a sustainable mix of perennial and annual plants is needed to ensure continuous processing and optimal use of the distillation unit.

• Technically the area is feasible to grow essential oil-bearing plants as there is irrigation facility and fertile soil. • There are many open areas in the forests that are suitable to cultivate lemongrass, citronella and Palmarosa. Additionally, there is a potentiality of cultivation under the electric grid lines. • Availability of DFOs, local government, FLBEH program for services; • Increasing local, national, and international markets of the essential oils and its products.	• Dependency in international markets and high fluctuation of price, mainly for Chamomile; • Labor shortage due to out-migration of youths; • There is a chance of crop failure due to the poor seed and seedling quality, and outbreak of diseases, insects and pests; • Occasional forest fire may damage Lemongrass, Citronella and Palmarosa grown in Ratuwamai plantation area.

Marketing of essential oils

Dharan, Biratnagar, Ithari, Nepalgunj and Kathmandu are growing major markets for essential oils from the project area. The buyers buy the oils from Ratuwamai directly or through their middlemen. The exporters in Kathmandu and Nepalgunj export the oils to India, Europe and North America. The schematic diagram of essential oils supply chain from Ratuwamai plantation in the past is presented below (Figure 22) and the sustainable MAPs/NTFPs based enterprise model is given in figure 23 respectively.

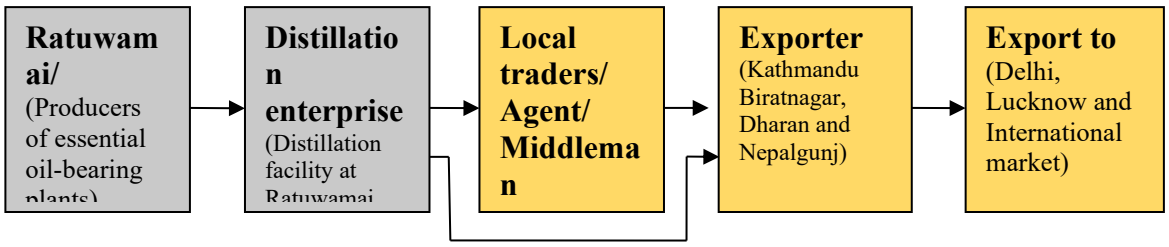


Figure 22: Supply chain of the essential oils from Ratuwamai plantation

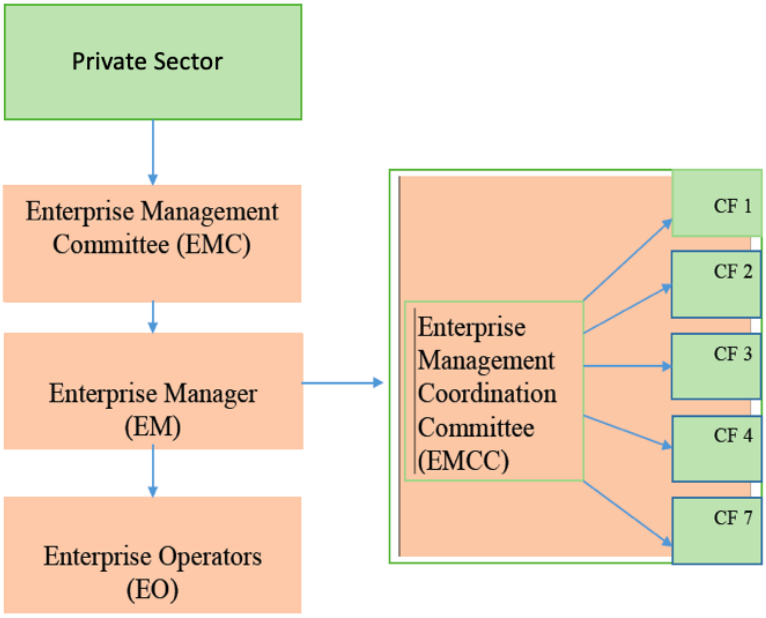


Figure 23: Sustainable MAPs/NTFPs enterprise model in Ratuwamai

Product development and marketing

The enterprise presently produces only essential oils, but there are opportunities to diversify products and improve marketing. Recommendations include developing new products like cleaning agents, providing training and equipment for staff, and enhancing marketing through business training, networking, and trade fairs.

Promoting Ecotourism and Environmental Education

- Guided forest tours, birdwatching, constructing artificial lake, and canopy walks.
- Awareness programs on biodiversity conservation.

5.8 Institutional frameworks for the management of the recommended model

Institutional framework for the management of the recommended model needs to be discussed with all stakeholders including federal government, provincial government and local governments as well as other stakeholders including private sectors. It is highly recommended that the recommended Integrated SFM Model for the Ratuwamai plantation project area should be managed by the Ministry of Forests and Environment of the Provincial government. A Multistakeholder Management Committee under the chairmanship of the Secretary – Ministry of Forests and Environment- Provincial government of Koshi should be formed for this purpose.

5.9 Key Recommendations for the biodiversity conservation

The study, based on the results concludes that diverse social, cultural and ecological settings and highly dependent on forest resources have invited different anthropogenic risks such as firewood collection, uncontrolled grazing and lopping, illegal timber extraction and deforestation. Thus, the Ratuwamai plantation project has an enormous potential to contribute to the maintenance and enhancement of forest biodiversity and other ecosystem services like forest carbon benefits and the co-benefits of biodiversity conservation, livelihood generation, and climate change adaptation and mitigation. This would be achieved through the conversion of shrubland into forests promoting natural regeneration and re-plantations; improving value chains for non-timber forest products, pastoralism, and improved grazing; and bringing all stakeholders at a common platform.

A) Build capacity of communities and other relevant stakeholders at the local level: Local communities and Other relevant stakeholders such as government line agencies (district forest office), forest user groups, district FECOFUN chapters and local NGOs working in conservation field could contribute to raising awareness, develop local capacity on SFM, Biodiversity conservation, Human-Elephant conflict management, entrepreneurship development, business planning and marketing and REDD+ and the establishment and maintain the database at the subnational level. Thus, periodic capacity building activities are crucial to enhancing and refresh the knowledge and skills of sustainable forest management units and other relevant stakeholders for participating in the REDD+ process.

B) Secure and Restore Critical Elephant Corridors

The Ratuwamai Plantation Forest serves as a vital Asiatic elephant corridor, connecting fragmented habitats between Koshi Tappu Wildlife Reserve and other forested areas. Immediate action is needed to halt encroachment, remove illegal settlements, and restore degraded sections of this corridor. This involves detailed demarcating boundaries with GPS mapping, replanting native vegetation, and creating buffer zones to minimize human interference. Collaboration with the Department of Forests, local communities, and conservation NGOs is essential to enforce anti-poaching laws and prevent further habitat loss. Restoring this corridor will reduce human-elephant conflicts (HEC), ensure genetic diversity among elephant populations, and maintain ecosystem balance.

1. Implement Community-Based Early Warning Systems for Human-Elephant Conflict (HEC) Mitigation

Crop raiding by elephants is a major livelihood threat for local farmers. Installing real-time early warning systems such as SMS alerts, motion-sensor cameras, or community drone patrols can help farmers prepare and deter elephants before they enter farmlands. Training local rapid response teams to safely guide elephants away using flares, noise makers, or trained elephants (kumkis) can prevent retaliatory killings. Additionally, compensation schemes for crop damage must be streamlined to ensure timely payouts, reducing hostility toward wildlife. This approach protects both livelihoods and elephants, fostering coexistence.

2. Promote Elephant-Friendly Farming and Agroforestry

Encouraging farmers to shift from elephant-attractive crops (rice, sugarcane) to deterrent crops (turmeric, chili, lemongrass, ginger) can drastically reduce HEC. Introducing beehive fences (elephants fear bees) and chili-grease barriers as natural repellents can further safeguard fields. Agroforestry models—integrating fruit trees, medicinal plants, and timber species—can diversify income while maintaining forest cover. Government and NGOs should provide subsidies, training, and market linkages to incentivize this transition, ensuring economic resilience and ecological sustainability.

C) Strengthen Forest Governance Through Participatory Conservation

Current forest management often excludes local voices, leading to illegal logging and weak enforcement. Establishing Community Forest User Groups (CFUGs) with legal authority to monitor and protect forests can improve governance. Joint patrols involving forest officials, police, and locals can curb illegal activities. Additionally, revising land-use policies to prioritize conservation-compatible livelihoods (e.g., eco-tourism, handicrafts) over destructive practices (e.g., monoculture plantations) is critical. Transparent benefit-sharing mechanisms (e.g., ecotourism revenue) will enhance local support for conservation.

D) Develop Eco-Tourism and Nature-Based Livelihoods

Ratuwamai's biodiversity offers untapped eco-tourism potential. Developing guided wildlife tours, birdwatching trails, and homestays can generate income while promoting conservation awareness. Training locals as nature guides, craftsmen (using sustainable NTFP products), and hospitality workers ensures equitable benefits. Partnerships with travel agencies and conservation NGOs can market these initiatives. A portion of tourism revenue should fund community conservation projects, creating a self-sustaining conservation economy.

E) Conduct Scientific Research and Adaptive Management

Long-term conservation requires data-driven strategies. GPS collaring elephants to track migration patterns, biodiversity surveys, and soil/water quality assessments will inform adaptive management. Establishing a local research station in collaboration with universities can facilitate ongoing monitoring. Findings should guide policy adjustments, ensuring interventions remain effective amid climate change and land-use shifts.

F) Enhance Policy Coordination and Funding Mechanisms:

Fragmented governance undermines conservation. A dedicated multi-stakeholder task force (government, NGOs, communities) should oversee Ratuwamai's management. Increased funding from conservation grants, carbon credits, and corporate CSR programs must be secured. Policies should incentivize private sector involvement in restoration projects (e.g., biodiversity offsets for industries). Legal recognition of Indigenous and local knowledge in forest policies will ensure culturally appropriate solutions.

These urgent, actionable recommendations integrate ecological, social, and economic benefits, ensuring Ratuwamai's forests thrive while supporting local communities. Immediate implementation with government leadership, community participation, and scientific backing can transform Ratuwamai into a model of sustainable forest management in Nepal.

Bibliography

Aukland, L., Coasta, P. M., & Brown, S. (2003). A conceptual framework and its application for addressing leakage; the case of avoided deforestation. *Climate Policy 3*, 123-136.

Brown, S. G. (1989). Biomass methods fortropicalforest with applications to forest inventory data. *Forest science*4*, 35*, 881-902.http://www.winrock.org/ecosystems/files/Brown_Gillespie_et_al_1989.pdf [last accessed 28/06/ 2010]

Chave, J., Andalo, C., Brown, S., Cairns, M. A., Chambers, J. Q., Eamus, D., et al. (2005). Tree allometry and improved estimation of carbon stocks. *Oecologia*145, 87-99.

DFRS, 2015. State of Nepal's Forests. Forest Resource Assessment (FRA) Nepal, Department of Forest Research and Survey (DFRS). Kathmandu, Nepal.

Geider, et. al. (2001). Primary productivity of planet earth: biological determinants and physical constraints in terrestrial and aquatic habitats. *Global Climate biology* 7, 849-882.

IPCC. (2006). *Good Practice Guidance for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry, and Other Land Uses (AFOLU).* Geneva, Switzerland: Intergovernmental Panel On Climate Change.http://www.ipcc-nggip.iges.or.jp/public/2006gl/vol4.html [last accessed 12/05/ 2010]

MacDicken, K. G. (1997). *A Guide to Monitoring Carbon Storage in Forestry and Agro-forestry Projects.* Arlington, USA: Winrock International.http://www.winrock.org/clean_energy/files/carbon.pdf [last accessed 27/05/ 2010]

MPFS. (1988). *Master Plan for the Forestry Sector Nepal*. Appendix Table 2.2 Forest types, representative species, uses and wood density. Ministry of Forests and Soil Conservation, His majestry Government of Nepal (HMGN), Kathmandu.

Pearson, T. R., Brown, S. L., Birdsey, R. A. (2007). *Measurement guidelines for the sequestration of forest carbon.* US: Northern research Station, Department of Agriculture.http://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs18.pdf [last accessed 27/05/2010]

R Development Core Team. (2009). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.http://www.R-project.org[last accessed 25/06/ 2010]

Subedi B. P., Pandey, S. S., Pandey A., Rana, E. B., Bhattarai, S., Banskota T. R., Charmakar S., Tamrakar R. (2010). *Guidelines for measuring carbon stocks in community-managed forests*. ANSAB, FECOFUN, ICIMOD, NORAD ISBN: 978-9937-2-2612-7. Pp 69+10. http://www.ansab.org/wp-content/uploads/2010/08/Carbon-Measurement-Guideline-REDD-final.pdf [last accessed 20/09/2010]

Tamrakar, P. R. (2000). *Biomass and Volume Tables with Species Description for Community Forest Management.* Kathmandu: MoFSC, NARMSAP-TISC.

UNFCCC. (2009). *Calculation of the number of sample plots for measurements with A/R CDM project activities version 02.*activities (Version 02). http://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.pdf[last accessed 07/ 07/ 2010]

Forest Agency. 2011. Manual for baseline survey of forest ecosystem diversity. Tokyo, Forest Agency of Japan.

Forest Resource Assessment. 2010. Field manual. Nepal, Forest Resource Assessment, Department of Forest Research and Survey, Ministry of Forests and Soil conservation, Nepal.

Forest Resource Assessment.2014. Terai Forests of Nepal, Forest Resource Assessment, Department of Forest Research and Survey, Ministry of Forests and Soil conservation, Nepal.

Forest Resource Assessment.2014. Siwalik Forests of Nepal, Forest Resource Assessment, Department of Forest Research and Survey, Ministry of Forests and Soil conservation, Nepal.

Miura, S. 2000. Proposal for a new definition to evaluate the status of forest floor cover and floor cover percentage (FCP) from the viewpoint of the protection against raindrop splash. Journal of Japanese Forest Society, 82: 132–140.

Miura, S., Hirai, K. & Yamada, T. 2002. Transport rates of surface materials on steep forested slopes induced by raindrop splash erosion. Journal of Forest Research, 7: 201–211.

Miura, S., Yoshinaga, S. & Yamada, T. 2003. Protective effect of floor cover against soil erosion on steep slopes forested with Chamaecyparis obtusa (hinoki) and other species. Journal of Forest Research, 8: 27–35.

MoFSC/CPFD. 2000. Guideline for Inventory of Community Forests, Ministry of Forest and Soil Conservation/ Community and Private Forest Division , Kathmandu, Nepal.

Annexes:

Annex I: Data collection sheet

Plot No.: _____

Strata: _____

District: _____

Measurement started at: _____ (time e.g. hour : minute)

Date: / /2010 (dd/mm/yyyy)

Team leader: _____

Team members: _____

Rough sketch showing the plot:	**References for the plot centre:**

1. Background information

CFUG Name: _____

Forest Name: _____

Block number: _____

GPS co-ordinates

UTM-X _____ m

UTM-Y _____ m

Altitude _____ m

2. Plot informantion

Please give a brief reason if the plot has been relocated from the originally given GPS position.

	Please circle one
Forest type:	natural / plantation
Aspect:	N, S, E, W, NE, NW, SE, SW, Flat
Soil type:	clayey, loam, sandy, boulder
fire:	Yes / No
fodder collection:	Yes / No
grazing:	Yes / No
fuelwood collection:	Yes / No
timber harvesting:	Yes / No
encroachment:	Yes / No
wildlife:	Yes / No
soil erosion:	Yes / No

Vegetation type: _____

Slope: _____ degree (average)

Soil colour: _____

Soil depth: _____ m

Crown cover: _____ %

Shrub cover: _____ %

Grass cover: _____ %

Any additional information

District: Strata: Plot No.:

3. Form for herbs and grass, litter, and soil samples

1. **Herbs and grass** - measure within a 0.56m core circular plot (all vegetation below 5DBH diameter)

total weight of all herbs and grass			**weight of sample grass**			**number on the sample packet**
		gram			**gram**	
bag	cloth	plastic	**bag**	cloth	plastic	

2. **Litter** - measure within a 0.56m core circular plot

total weight of all litter			**weight of sample litter**			**number on the sample packet**
		gram			**gram**	
bag	cloth	plastic	**bag**	cloth	plastic	

3. **Soil** - measure within a 1m circular plot

	0 cm	**sample no.**	**Composite soil sample (for carbon)**
0 cm - 10 cm	10 cm		**total weight of the soil**
			gram
		sample no.	**bag** white plastic / black plastic
10 cm - 20 cm	20 cm		**number on the sample packet**
		sample no.	
20 cm - 30 cm	30 cm		

4. Regeneration (below 1 cm DBH) - measure within a 1 m circular plot

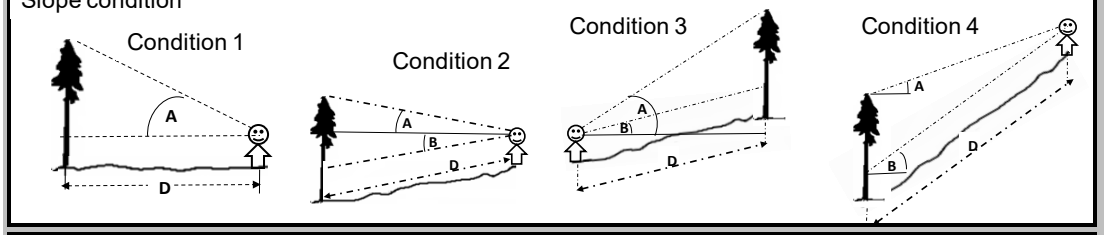
SN	Species	Total count	SN	Species	Total count
1			6		
2			7		
3			8		
4			9		
5			10		

5. Sapling (1 cm to 5 cm) - measure within 5.64 m circular plot

SN	Species	DBH (cm)	SN	Species	DBH (cm)
1		.	11		.
2		.	12		.
3		.	13		.
4		.	14		.
5		.	15		.
6		.	16		.
7		.	17		.
8		.	18		.
9		.	19		.
10		.	20		.

6. Tree - DBH and height measurements District: _____ Strata: _____ Plot No.: _____

Slope condition



SN	Species	DBH (cm) measured at breast height (1.3m)	Angles formed by top and base of the tree		Distance to the tree (m)	Slope condition (see figure above)	Tree height (m)	Remarks
			top (**A**)	base (**B**)	(**D**)			
1		.	0	0	.		.	
2		.	0	0	.		.	
3		.	0	0	.		.	
4		.	0	0	.		.	
5		.	0	0	.		.	
6		.	0	0	.		.	
7		.	0	0	.		.	
8		.	0	0	.		.	
9		.	0	0	.		.	
10		.	0	0	.		.	
11		.	0	0	.		.	
12		.	0	0	.		.	
13		.	0	0	.		.	
14		.	0	0	.		.	
15		.	0	0	.		.	
16		.	0	0	.		.	
17		.	0	0	.		.	
18		.	0	0	.		.	
19		.	0	0	.		.	
20		.	0	0	.		.	

*** Appropriate slope correction has been applied and measurements are done within circular plot with horizontal diameter 8.92 m (area 250 sq.m.)**

*** All trees within the plot with DBH ≥ 5 cm have been measured**

*** The species of unidentified trees have been recorded as Sp 1...Sp 2 likewise and distinguishable characterstics are noted as comment**

Annex II: List of instruments and equipment and their purpose

S.N.	Particulars	Purpose
1.	GPS	Boundary survey, stratification and locating plots
2.	Base map	Plot navigation
Permanent plot establishment		
3.	Rope	For plot boundary delineation
4.	Linear tape	For locating plot boundary and distance measurement
5.	Chalk	For marking the trees within the boundaries temporarily before permanent tagging and ensure that it is measured.
6.	Metal tags for tree	For permanent marking of trees
7.	Metal tag for plot	For showing the direction to the permanent plot from vantage point
8.	Enamel	For numbering metal tags
9.	Brush	For numbering metal tags
10.	Hammer	For fixing metal tags in tree
11.	Cemented pillar	For setting up the plot center
12.	Nails	For placing the tags
Leaf litters and herb/grasses collection		
13.	Plastic bags	White plastic bags to collect samples and big plastic bags to collect and weigh herbs, grasses and leaf litters
14.	Clothes bag for leaflets and twigs	Since, plastic bags may get tore herbs, grasses and leaf litters should be collected in clothes.
15.	Knife or sickle	For cutting herbs and grasses
16.	Weighing machine	For weighing herbs, grasses and leaf litters
17.	Scissors	For cutting herbs and grasses
Soil sample collection		
18.	Metal scale	For measuring soil depth
19.	Soil sample core	For collecting soil samples from various depths
20.	White clothes or masking tape	For tightening the soil core so that no soil comes out of the soil core
21.	Soil sample hammer	For bear down on the soil core while collecting sample
22.	Weighing machine	For weighing sample
23.	Kuto	For taking out soil core from soil depth
Height and diameter measurement		
24.	Linear tape	For measuring distance between tree and measurer
25.	Diameter tape	For measuring diameter of the tree at breast height
26.	Clinometer	For measuring the ground slope, top and bottom angle to the tree
27.	Vertex IV and Transponder	For measuring tree height and establishing circular plots without the use of tapes and clinometers.
28.	Callipers	Can be used instead of diameter tape to measure diameter of trees.

Annex III: Seasonal Calendar for MAPs

Species	Flowering	Fruiting	Seed collection	Nursery	Transplantation/seed sowing	Irrigation	Weeding	Harvesting	Processing
Mentha	May-June	Aug-Oct		Oct-Nov	Jan-Feb	(15 to 20 days interval	Monthly	100-120 days of Transplantation (May-June)	After 20-24 hour drying in shade
Chamomile	Jan-April	Mar-May	Apr-May	Oct-Dec	Oct-Dec	4-5 times (as required)	3-4 times (as required)	March-May	2-3 days drying in shade in 20-24 ^{0}C
Lemongrass	Dec-Feb	Feb-Apr	Apr-May	Apr-June	May-July	3-4 times in a year	3-4 times	3-4 times in a year	24- hours of drying in shade
Palmarosa	June-Sep	Aug-Oct	Oct-Nov	Apr-June	May-July	2-3 times (As per need)	2-3 times (as required)	3-4 times in a year	24- hours of drying in shade
Citronella	Sep-Nov	Nov-Jan	Dec-Feb	Apr-June	May-July	2-3 times (As per need)	2-3 times (as required)	3-4 times in a year	24- hours of drying in shade
Kadipatta	Feb-April	May-June	July-Aug	Mar-Apr	May-July	--	--	Mar-May and Aug-Oct	24- hours of drying in shade

Annex IV: List of mammals found in Ratuwamai

S.N	English Name	Scientific Name	CITES	IUCN	NPWC Act
1	Indian Pangolin	*Manis crassicaudata*	I	CI	P
2	Indian Short-nosed Fruit Bat	*Cynopterus sphinx*		LC	
3	Indian Flying Fox	*Pteropus giganteus*		LC	
4	Indian pipistrelle	*Pipistrellus coromandra*		LC	
5	Greater Asiatic Yellow Bat	*Scotophilus heathi*		LC	
6	Lesser Asiatic Yellow Bat	*Scotophilus kuhlii*		LC	
7	Round-eared Tubenosed Bat	*Murina cyclotis*		LC	
8	Rhesus Macaque	*Macaca mulatta*		LC	
9	Terai Gray Langur	*Semnopithecus hector*	I	NT	
10	Golden Jackal	*Canis aureus*		LC	
11	Masked Palm Civet	*Paguma larvata*		LC	
12	Large Indian Civet	*Viverra zibetha*		NT	
13	Small Indian Civet	*Viverricula indica*		LC	
14	Indian Grey Mongoose	*Herpestes edwardsii*		LC	
15	Jungle Cat	*Felis chaus*		LC	
16	Three-striped Palm Squirrel	*Funambulus palmarum*		LC	
17	Five-striped Palm Squirrel	*Funambulus pennantii*		LC	
18	Red Flying Squirrel	*Petaurista petaurista*		LC	
19	Lesser Bandicoot Rat	*Bandicota bengalensis*		LC	
20	Large Bandicoot Rat	*Bandicota indica*		LC	
21	Lesser Bamboo Rat	*Cannomys badius*		LC	
22	Brown Spiny Mouse	*Mus saxicola*		LC	
23	Earth-colored Mouse	Mus terricolor		LC	
24	Indian Bush Rat	*Golunda ellioti*		LC	
25	Roof Rat	*Rattus rattus*		LC	
26	Indian Crested Porcupine	*Hystrix indica*		LC	

27	Indian Hare	*Lepus nigricollis*		LC	
28	Asian Elephant	*Eliphus Maximus*		Vu	P

LC– Least Concern, EN- Endangered, VU-Vulnerable, NT- Not Threatened and P-Protected

Annex V: List of fishes found in Ratuwamai

S.N	Nepali name	Scientific Name
1	Katle macha	*Acrossocheilus sp.*
2	Phageta or Poti	*Barilius sp.*
3	Bhakur katla	*Catla catla*
4	Malagudi	*Chela laubuca*
5	Naini or Jhilke	*Cirrhinus mrigala*
6	Nepti	*Danio dangila*
7	Chitthar	*Danio devario*
8	Rahu	*Labeo dero*
9	Sidre	*Puntius sp.*
10	Singi	*Botia dayi*
11	Getu	*Botia lohachata*
12	Junge	*Mystus cavasius*
13	Mungri	*Clarias sp.*
14	Bhoti	*Channa barca*
15	Garahi	*Channa punctatus*
16	Hile	*Channa stewartii*
17	Chuchhe bam	*Amphipnous sp.*
18	Buduna	*Garra annandalei*
19	Gandule	*Schistura beavani*
20	Bam	*Monopterus cuchia*
21	Jhinge macha	*Palaemon malcolmsoni*
22	Rohu	*Labeo coeruleus*

Annex VI: List of snakes found in Ratuwamai

SN	English name	Scientific Name
1	Common blind snake	*Ramphotyphlops braminus*
2	Diard's blind snake	*Typhlops diardii*
3	Common vine snake	*Ahaetulla nasuta*
4	Buff striped keelback	*Amphiesma stolatum*
5	Olivaceous keelback	*Atretium schistosum*
6	Common tawny cat snake	*Boiga ochracea*
7	Common cat snake	*Boiga trigonata*
8	Bronzeback tree snake	*Dendrelaphis tristis*
9	Common trinket snake	*Elaphe helena*
10	Common smooth water snake	*Enhydris enhydris*
11	Common wolf snake	*Lycodon aulicus*

12	Twin-spotted wolf snake	*Lycodon jara*
13	Common kukri snake	*Oligodon arnensis*
14	Asiatic rat snake	*Ptyas mucosa*
15	Chequered keelback water snake	*Xenochrophis piscator*
16	St.Jhon's keelback water snake	*Xenochrophis sanctijohannis*
17	Common krait	*Bungarus caeruleus*
18	Banded krait	*Bangarus fasciatus*
19	Spectacled cobra	*Naja naja*
20	Russell's viper	*Daboia russelii*
21	Rock Python	*Python* molurus

Annex VII: List of Retiles found in Ratuwamai

S.N	English name	*Scientific name*
1	Black-spined Toad	*Bufo melanostictus*
2	Assam toad	*Bufo stomaticus*
3	bull frog	*Hoplobatrachus crassus*
4	Tiger Forg/Indian Bull Frog	*Hoplobatrachus tigerinus*
5	Indian Black Turtle	*Melanochelys trijuga*
6	Common Garden Lizard	*Calotes versicolor*
7	Bengal Monitor	*Varanus bengalensis*
8	Yellow Monitor	*Varanus flavescens*

Annex VIII: List of Birds found in Ratuwamai

SN	English name	Scientific name
1	Black Francolin	*Francolinus francolinus*
2	Red Junglefowl	*Gallus gallus*
3	Indian Peafowl	*Pavo cristatus*
4	Lesser Whistling-duck	*Dendrocygna javanica*
5	Common Merganser	*Mergus merganser*
6	Barred Buttonquail	*Turnix suscitator*
7	Grey-capped Pygmy Woodpecker	*Dendrocopos canicapillus*
8	Fulvous-breasted Woodpecker	*Dendrocopos macei*
9	Rufous Woodpecker	*Celeus brachyurus*
10	Greater Yellownape	*Picus flavinucha*
11	Grey-headed Woodpecker	Picus canus
12	Himalayan Flameback	*Dinopium shorii*
13	Greater Flameback	*Chrysocolaptes guttacristatus*
14	Lineated Barbet	*Megalaima lineata*
15	Blue-throated Barbet	*Megalaima asiatica*
16	Blue-eared Barbet	*Megalaima australis*
17	Oriental Pied Hornbill	*Anthracoceros albirostris*
18	Common Hoopoe	*Upupa epops*
19	Indian Roller	*Coracias benghalensis*
20	Dollarbird	*Eurystomus orientalis*

21	White-throated Kingfisher	*Halcyon smyrnensis*
22	Green Bee-eater	*Merops orientalis*
23	Chestnut-headed Bee-eater	*Merops leschenaulti*
24	Chestnut-winged Cuckoo	*Clamator coromandus*
25	Common Hawk Cuckoo	*Hierococcyx varius*
26	Indian Cuckoo	*Cuculus micropterus*
27	Asian Koel	*Eudynamys scolopacea*
28	Green-billed Malkoha	*Phaenicophaeus tristis*
29	Greater Coucal	*Centropus sinensis*
30	Alexandrine Parakeet	*Psittacula eupatria*
31	Rose-ringed Parakeet	*Psittacula krameri*
32	Plum-headed Parakeet	*Psittacula cyanocephala*
33	Red-breasted Parakeet	*Psittacula alexandri*
34	Asian Palm Swift	*Cypsiurus balasiensis*
35	House Swift	*Apus affinis*
36	Crested Treeswift	*Hemiprocne coronata*
37	Asian BaITed Owlet	*Glaucidium cuculoides*
38	Jungle Owlet	*Glaucidium radiatum*
39	Spotted Owlet	*Athene brama*
40	Brown Hawk Owl	*Ninox scutulata*
41	Oriental Turtle Dove	*Streptopelia orientalis*
42	Spotted Dove	*Streptopelia chinensis*
43	Red Collared Dove	*Streptopelia tranquebarica*
44	Eurasian Collared Dove	*Streptopelia decaocto*
45	Emerald Dove	*Chalcophaps indica*
46	Orange-breasted Green Pigeon	*Treron bicincta*
37	Thick-billed Green Pigeon	*Treron curvirostra*
48	Yellow-footed Green Pigeon	*Treron phoenicoptera*
49	White-breasted Waterhen	*Amaurornis phoenicurus*
50	Common Sandpiper	*Actitis hypoleucos*
51	Great Thick-knee	*Burhinus recurvirostris*
52	Ibisbill	*Ibidorhyncha struthersii*
53	Little Ringed Plover	*Charadrius dubius*
54	River Lapwing	*Vanellus duvaucelii*
55	Red-wattled Lapwing	*Vanellus indicus*
56	Black Baza	*Aviceda leuphotes*
57	Black Kite	*Milvus migran*
58	Brahminy Kite	*Haliastur indus*
59	Crested Serpent Eagle	*Spilornis cheela*
60	Crested Goshawk	*Accipiter trivirgatus*
61	Shikra	*Accipiter badius*
62	Common Buzzard	*Buteo buteo*
63	Collared Falcone	*Microhierax caerulescens*

64	Common Kestrel	*Falco tinnunculus*
65	Little Cormorant	*Phalacrocorax niger*
66	Little Egret	*Egretta garzetta*
67	Cattle Egret	*Bubulcus ibis*
68	Indian Pond Heron	*Ardeola grayii*
69	Cinnamon Bittern	*Ixobrychus cinnamomeus*
70	Black Ibis	*Pseudibis papillosa*
71	Asian Openbill	*Anastomus oscitans*
72	Woolly-necked Stork	*Ciconia episcopus*
73	White Stork	*Ciconia ciconia*
74	Lesser Adjutant	*Leptoptilos javanicus*
75	Long-tailed Broadbill	*Psarisomus dalhousiae*
76	Golden-fronted Leafbird	*Chloropsis aurzfrons*
77	Brown Shrike	*Lanius cristatus*
78	Long-tailed Shrike	*Lanius schach*
79	Grey-backed Shrike	*Lanius tephronotus*
80	Red-billed Blue Magpie	*Urocissa erythrorhyncha*
81	Rufous Treepie	*Dendrocitta vagabunda*
82	House Crow	*Corvus splendens*
83	Large-billed Crow	*Corvus macrorhynchos*
84	Ashy Woodswallow	*Artamus fuscus*
85	Black-hooded Oriole	*Oriolus xanthornus*
86	Maroon Orio le	*Oriolus traillii*
87	Large Cuckoo shrike	*Coracina macei*
88	Rosy Minivet	*Pericrocotus roseus*
89	Long-tailed Minivet	*Pericrocotus ethologus*
90	Scarlet Minivet	*Pericrocotus flammeus*
91	Bar-winged Flycatcher-shrike	*Hemlpus picatus*
92	Black Drongo	*Dicrurus macrocercus*
93	Ashy Drongo	*Dicrurus leucophaeus*
94	White-bellied Drongo	*Dicrurus caerulescens*
95	Bronzed Drongo	*Dicrurus aeneus*
96	Lesser Racket-tailed Drongo	*Dicrurus remifer*
97	Spangled Drongo	*Dicrurus hottentottus*
98	Greater Racket-tailed Drongo	*Dicrurus paradiseus*
99	Black-naped Monarch	*Hypothymis azurea*
100	Asian Paradise-flycatcher	*Terpsiphone paradisi*
101	Common Iora	*Aegithina tiphia*
102	Common Woodshrike	*Tephrodornis pondicerianu*
103	Blue-capped Rock Thrush	*Monticola cinclorhynchus*
104	Blue Rock Thrush	*Monticola solitarius*
105	Blue Whistling Thrush	*Myophonus caeruleus*
106	Dark-sided Thrush	*Zoothera marginata*

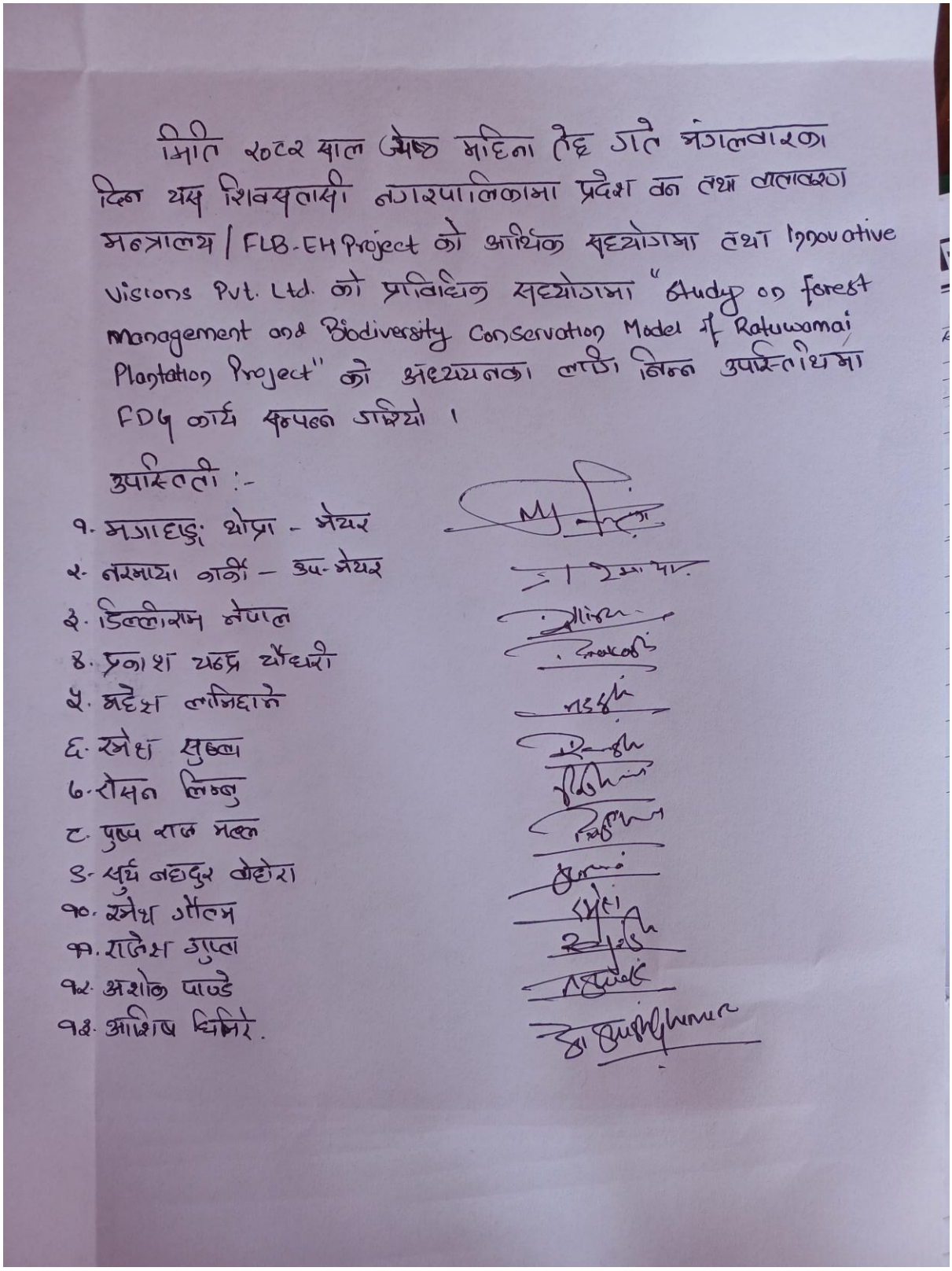
107	Dark-throated Thrush	*Turdus ruficollis*
108	Red-throated Flycatcher	*Ficedula (parva) albicilla*
109	Snowy-browed Flycatcher	*Ficedula hyperythra*
110	Verditer Flycatcher	*Eumyias thalassina*
111	Small Niltava	*Niltava macgrigoriae*
112	Pale-chinned Flycatcher	*Cyornis poliogenys*
113	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*
114	Oriental Magpie Robin	*Copsychus saularis*
115	White-rumped Shama	*Copsychus malabaricus*
116	White-capped Water Redstart	*Chaimarrornis Leucocephalus*
117	Black-backed Forktail	*Enicurus immaculatus*
118	Common Stonechat	*Saxicola torquata*
119	Chestnut-tailed Starling	*Sturnus malabaricus*
120	Asian Pied Starling	*Sturnus contra*
121	Common Myna	*Acridotheres tristis*
122	Jungle Myna	*Acridotheres fuscus*
123	Hill Myna	*Gracula religiosa*
124	Chestnut-bellied Nuthatch	*Sitta castanea*
125	Velvet-fronted Nuthatch	*Sitta frontalis*
126	Great Tit	*Parus major*
127	Red-rumped Swallow	*Hirundo daurica*
128	Black-crested Bulbul	*Pycnonotus melanicterus*
129	Himalayan Bulbul	*Pycnonotus leucogenys*
130	Red-vented Bulbul	*Pycnonotus cafer*
131	White-throated Bulbul	*Alophoixus jlaveolus*
132	Oriental White-eye	*Zosterops palpebrosus*
133	Common Tailorbird	*Orthotomus sutorius*
134	Greenish Warbler	*Phylloscopus trochiloides*
135	Dusky Warbler	*P hylloscopus fuscatus*
136	Yellow-vented Warbler	*Phylloscopus cantator*
137	Grey-hooded Warbler	*Seicercus xanthoschistos*
138	Lesser Necklaced Laughingthrush	*Garrulax monileger*
139	Puff-throated Babbler	*Pellorneum rujiceps*
140	White-browed Scimitar Babbler	*Pomatorhinus schisticeps*
141	Striped Tit Babbler	*Macronous gularis*
142	Jungle Babbler	*Turdoides striatus*
143	Nepal Fulvetta	*Alcippe nipalensis*
144	Sand Lark	*Calandrella ray tal*
145	Ruby-cheeked Sunbird	*Anthreptes singalensis*
146	Crimson Sunbird	*Aethopyga siparaja*
147	Streaked Spiderhunter	*Arachnothera magna*
148	House Sparrow	*Passer domesticus*
149	White Wagtail	*Motacilla alba*

150	Yellow Wagtail	*Motacilla flava*
151	Paddyfield Pipit	*Anthus rufulus*
152	Olive-backed Pipit	*Anthus hodgsoni*
153	Baya Weaver	*Ploceus philippinus*

Annex IX: List of protected flora and fauna in Ratuwamai

English name	***Scientific name***	**IUCN Red list**	**CITES**
Mammals			
Indian Pangolin	*Manis crassicaudata*	EN	II
Leopard Cat	*Felis Bengalensis*	VU	I
Asian Elephant	*Elephas Maximus*	EN	I
Birds			
Gaint Hornibill	*Buceros bicornis*	R	I
Black Strok	*Ciconia nigra*	WV	II
Reptiles			
Asiatic Rock Python	*Python Molurus*	VU	I
Golden Monitor Lizard	*Varanus Flavescens*	I	I
Plants/Flora			
Serpentine	*Rauvolfia Serpentina*	VU	II
Rose Wood	*Dalbergia latifolia*		
Sal	*Shorea Robusta*		

Annex X: Sample of meetings with key informants and FGDs in Ratuwamai Area

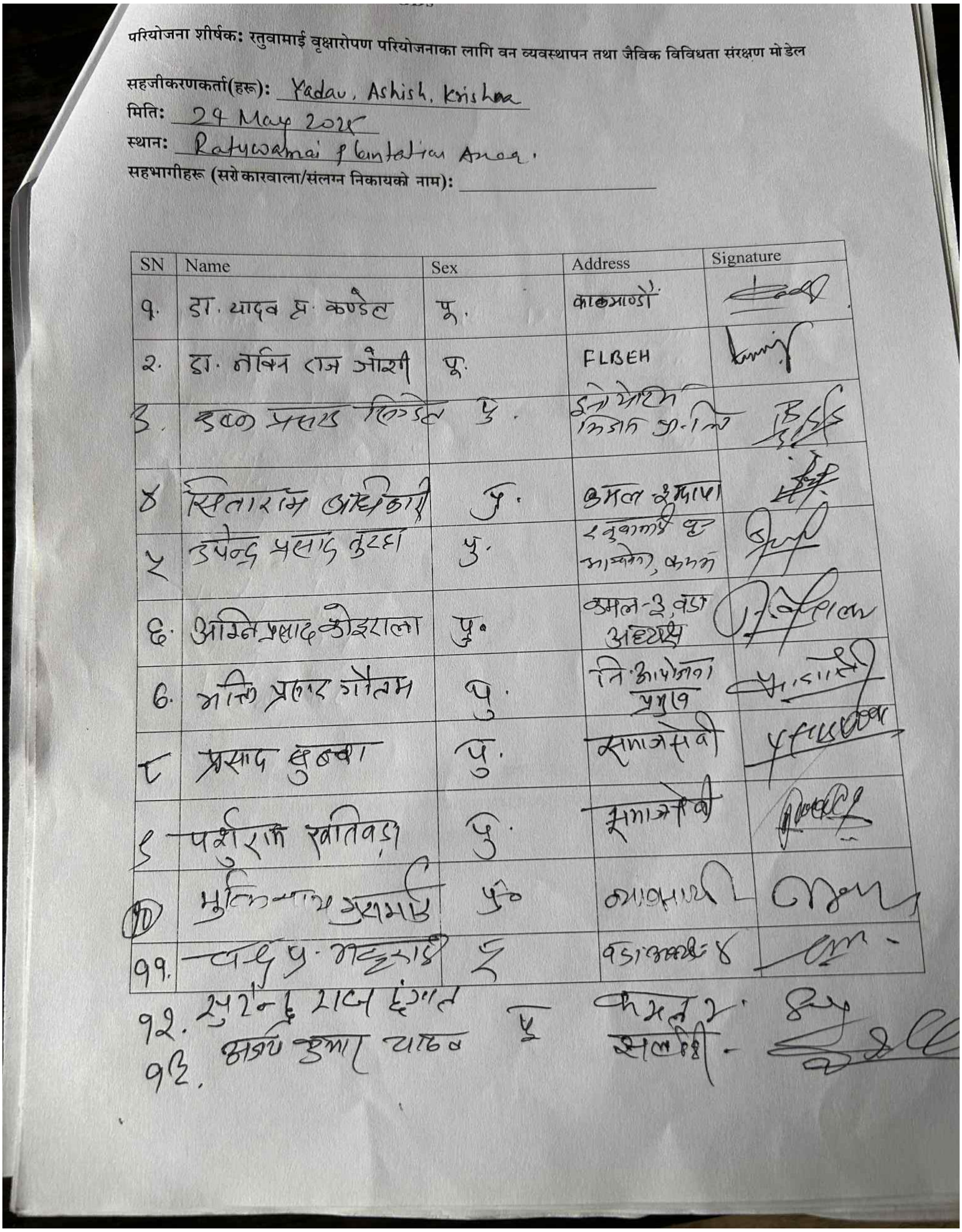


मिति २०८२ साल जेष्ठ महिना ३१ गते मंगलवारका दिन यस शिवसतासी नगरपालिकामा प्रदेश वन तथा वातावरण मन्त्रालय / FLB-EM Project को आर्थिक सहयोगमा तथा Innovative Visions Pvt. Ltd. को प्राविधिक सहयोगमा "Study on forest Management and Biodiversity Conservation Model of Ratuwamai Plantation Project" को अध्ययनका लागि विभिन्न उपस्तिथिमा FDG कार्य सम्पन्न गरियो ।

उपस्तिती :-

१. मजादङ्ग थोप्रा - मेयर
२. नरमाया गर्ती - उप-मेयर
३. डिल्लीराम नेपाल
४. प्रकाश चन्द्र चौधरी
५. महेश लामिछाने
६. रमेश सुब्बा
७. रोशन लिम्बु
८. पुष्प राज मल्ल
९. सुर्य बहादुर बोहोरा
१०. रमेश गौतम
११. राजेश गुप्ता
१२. अशोक पाण्डे
१३. आशिष घिमिरे.

Annex XI: Sample of minutes of workshops with stakeholders at local communities at local levels



परियोजना शीर्षक: रतुवामाई वृक्षारोपण परियोजनाका लागि वन व्यवस्थापन तथा जैविक विविधता संरक्षण मोडेल

सहजीकरणकर्ता(हरू): Yadav, Ashish, Krishna

मिति: 24 May 2025

स्थान: Ratuwamai Plantation Area.

सहभागीहरू (सरोकारवाला/संलग्न निकायको नाम):

SN	Name	Sex	Address	Signature
१.	डा. यादव प्र. कण्डेल	पु.	काठमाण्डौं	
२.	डा. नबिन राज जोशी	पु.	FLBEH	
३.	[illegible] प्रसाद [illegible]	पु.	[illegible]	
४	सिताराम अधिकारी	पु.	कमल [illegible]	
५	उपेन्द्र प्रसाद [illegible]	पु.	रतुवामाई [illegible]	
६.	अमिन प्रसाद कोइराला	पु.	कमल-३, वडा अध्यक्ष	
७.	[illegible] प्रकाश गौतम	पु.	नि. आयोजना प्रमुख	
८	प्रसाद सुब्बा	पु.	समाजसेवी	
९	परशुराम खतिवडा	पु.	समाजसेवी	
१०	मुक्तिनाथ [illegible]	पु.	[illegible]	
११.	चन्द्र प्र. [illegible]	पु.	वडा [illegible] ४	
१२.	सुरेन्द्र राज [illegible]	पु.	कमल २	
१३.	अर्जुन कुमार यादव		सलाही	

परियोजनाको शीर्षक: रातुवामाई वृक्षारोपण परियोजनाको लागि
वन व्यवस्थापन र जैव विविधता संरक्षण मोडेल
सञ्चालक(हरु): सूर्य, सेलय गौतम
मिति: २०८२।१२।१५
स्थान: कमल व.प.-५

SN	Name	Sex	Address	Signature
1	सिताराम अधिकारी	पु	कमल, झाफा	
2	शान्ति प्रसाद गौतम	पु	झाफा	शान्ति
3	अनुजा पौडेल	म	"	अनुजा
4	नमुना शाक्य	म	"	नमुना
5	Sahayog khadka	पु	"	Sahayog
6	सुरज लिम्बु	पु	"	Suraj
7	सीता राई	म	"	सीता
8	समिक्षा राई	म	"	Samiksha
9	दिलमाया राई	म	"	दिलमाया
10	सरोज मगर	पु	"	सरोज
11	अनिश मगर	पु	"	Anish

Annex II-Checklist for the FGDs

परियोजनाको शीर्षक: रातुवामाई वृक्षारोपण परियोजनाको लागि वन व्यवस्थापन र जैव विविधता संरक्षण मोडेल

सञ्चालक(हरु): संजय, सुर्य, गौतम, पुष्प।

मिति: 2082/02/08

स्थान: केर्खा अफिस परिसर

SN	Name	Sex	Address	Signature
१	धनिराम सिंह	पु	गोरङ्ग	
२	Yangji Sherpa	F	Damak	
३	रोनिष मगर	पु	झापा	रोनिष
४	सेरचन थापा	पु	झापा	
५	पुष्प थापा	पु	झापा	पुष्प
६	Rakesh Yadav	Male	Saptari	
6	Nirajan Shahi	m	Kerkha	
८	Sahayog Malla Thakuri	m	jhapa	
९	रमेश साह	m	झापा	रमेश
१०	दिपक भंडारी	पु	"	दिपक
११	सुयोग लुइटेल	पु	"	सुयोग

Annex II-Checklist for the FGDs

परियोजनाको शीर्षक: रातुवामाई वृक्षारोपण परियोजनाको लागि वन व्यवस्थापन र जैव विविधता संरक्षण मोडेल

सञ्चालक(हरु): संजय, शुर्य, मोतम,

मिति: १०८२।२।१०

स्थान: भद्रपुर, झापा

SN	Name	Sex	Address	Signature
①	Kamal buddha	m	Sunsari	
②	सलनी बस्नेत	म	झापा	
③	Prabin thapa	m	Kerkha	
④	भाविन पराजुली	म	मोरङ	
⑤	Sita Sharma	F	Sunsari	
⑥	पिंका मगर	F	केर्खा	
⑦	Dipak bhandari	M	Jhapa	
⑧	सुयोग लुइटेल	M	11	
⑨	Rakesh yadav	m	11	
⑩	Pushpa thapa	F	11	
⑪	भक्त कार्की	y	11	

Annex II-Checklist for the FGDs

परियोजनाको शीर्षक: रातुवामाई वृक्षारोपण परियोजनाको लागि वन व्यवस्थापन र जैव विविधता संरक्षण मोडेल

सञ्चालक(हरु): Surya Chaulam, Sanjay

मिति: 2082/2/9

स्थान: Kerkha

SN	Name	Sex	Address	Signature
①	Sujan bhattrai	male	Kerkha	
2	भक्त बहादुर काकी	म	मोरङ	
3	रोनिसा बोक्षोरा	म	झापा	
4	Sobekshamalla	म	morang	
5	प्रविन शाक्षी	पु	दमक	
6	सर्व थापा	पु	झापा	
7	Sudip Magar	m	morang	
8	परशुराम खतिवडा	पु	सामारेखी	
9	Rajan Magar	M	Jhapa	
10	राजेस थापा	म	केरकि	
11	साक्षम खड्का	प	केरकी	

Annex II-Checklist for the FGDs

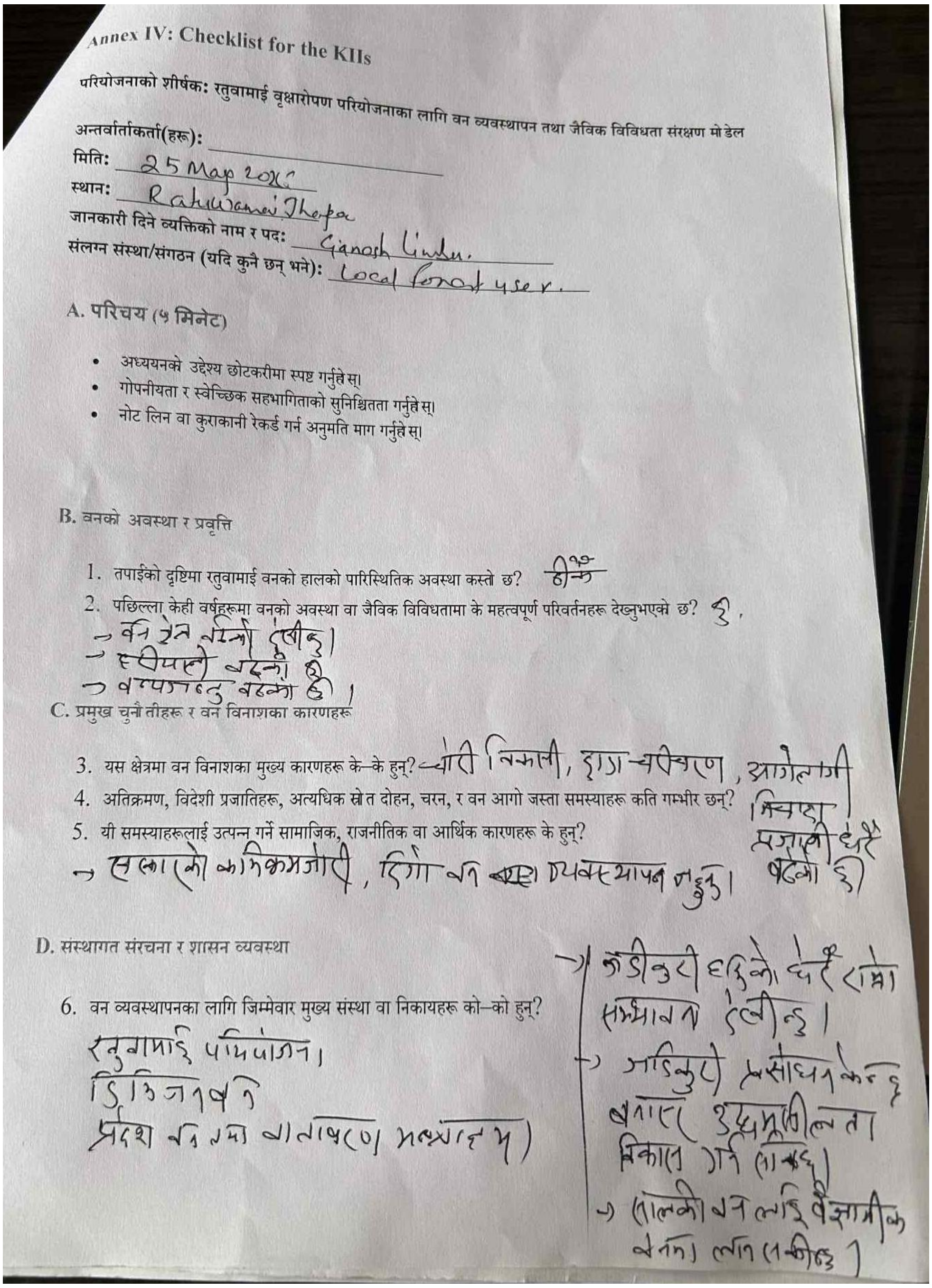
परियोजनाको शीर्षक: रातुवामाई वृक्षारोपण परियोजनाको लागि वन व्यवस्थापन र जैव विविधता संरक्षण मोडेल

सञ्चालक(हरु): पुष्पराज, गौतम, सुर्य, संजय

मिति: 2082/02/11

स्थान: कमल न. प. - ४

SN	Name	Sex	Address	Signature
१	सुदिप साक्य	पु	झापा	Sudip
२	मोहन याक्व	पु	"	Mohan
३	शंकर याक्व	पु	"	Sankar
४	संजय सिंह	पु	"	संजय
५	सौरभ	"	"	Saurav
६	मोनिष चौधरी	"	"	Monish
७	पुरन्च चौधरी	"	लोरङ	पुरन्च
८	निर्माण खडका	"	झापा	निर्माण
९	अमित भण्डारी	"	"	अमित
१०	सुरज लिम्बु	"	"	सुरज
११	प्रविन लोहोरा	"	"	Probin
१२	आशा अधिकारी	महिला	"	आशा



Annex IV: Checklist for the KIIs

परियोजनाको शीर्षक: रतुवामाई वृक्षारोपण परियोजनाका लागि वन व्यवस्थापन तथा जैविक विविधता संरक्षण मोडेल

अन्तर्वार्ताकर्ता(हरू): ____________

मिति: 25 May 2025

स्थान: Ratuwamai Jhapa

जानकारी दिने व्यक्तिको नाम र पद: Ganesh Limbu.

संलग्न संस्था/संगठन (यदि कुनै छन् भने): Local forest user.

A. परिचय (५ मिनेट)

- अध्ययनको उद्देश्य छोटकरीमा स्पष्ट गर्नुहोस्।
- गोपनीयता र स्वेच्छिक सहभागिताको सुनिश्चितता गर्नुहोस्।
- नोट लिन वा कुराकानी रेकर्ड गर्न अनुमति माग गर्नुहोस्।

B. वनको अवस्था र प्रवृत्ति

1. तपाईंको दृष्टिमा रतुवामाई वनको हालको पारिस्थितिक अवस्था कस्तो छ? ठीक
2. पछिल्ला केही वर्षहरूमा वनको अवस्था वा जैविक विविधतामा के महत्वपूर्ण परिवर्तनहरू देख्नुभएको छ? छ।
→ वन क्षेत्र बढेको देखिन्छ।
→ हरियाली बढेको छ।
→ वन्यजन्तु बढेको छ।

C. प्रमुख चुनौतीहरू र वन विनाशका कारणहरू

3. यस क्षेत्रमा वन विनाशका मुख्य कारणहरू के–के हुन्? चोरी निकासी, हाडा अतिक्रमण, आगलागी
4. अतिक्रमण, विदेशी प्रजातिहरू, अत्यधिक स्रोत दोहन, चरन, र वन आगो जस्ता समस्याहरू कति गम्भीर छन्? मिचाहा प्रजाति धेरै बढेको छ।
5. यी समस्याहरूलाई उत्पन्न गर्ने सामाजिक, राजनीतिक वा आर्थिक कारणहरू के हुन्?
→ सरकारको कमजोरी, दिगो वन व्यवस्थापन नहुनु।

D. संस्थागत संरचना र शासन व्यवस्था

6. वन व्यवस्थापनका लागि जिम्मेवार मुख्य संस्था वा निकायहरू को–को हुन्?
रतुवामाई परियोजना।
डिभिजन वन
प्रदेश वन तथा वातावरण मन्त्रालय

→ झाडीकुरी हटाएको, धेरै राम्रो सम्भावना देखिन्छ।
→ जडिबुटी प्रशोधन केन्द्र बनाएर उद्यमशीलता विकास गर्न सकिन्छ।
→ हालको वनलाई वैज्ञानिक वन लागू गरिनुपर्छ।

Annex IV: Checklist for the KIIs

परियोजनाको शीर्षक: रतुवामाई वृक्षारोपण परियोजनाका लागि वन व्यवस्थापन तथा जैविक विविधता संरक्षण मोडेल

अन्तर्वार्ताकर्ता(हरू): _____
मिति: 2082-02-13
स्थान: केरुङ
जानकारी दिने व्यक्तिको नाम र पद: याङजन धीमिरे
संलग्न संस्था/संगठन (यदि कुनै छन् भने): _____

A. परिचय (५ मिनेट)

- अध्ययनको उद्देश्य छोटकरीमा स्पष्ट गर्नुहोस्।
- गोपनीयता र स्वेच्छिक सहभागिताको सुनिश्चितता गर्नुहोस्।
- नोट लिन वा कुराकानी रेकर्ड गर्न अनुमति माग गर्नुहोस्।

B. वनको अवस्था र प्रवृत्ति

1. तपाईंको दृष्टिमा रतुवामाई वनको हालको पारिस्थितिक अवस्था कस्तो छ? ठिकै
2. पछिल्ला केही वर्षहरूमा वनको अवस्था वा जैविक विविधतामा के महत्वपूर्ण परिवर्तनहरू देख्नुभएको छ? छैन

C. प्रमुख चुनौतीहरू र वन विनाशका कारणहरू

3. यस क्षेत्रमा वन विनाशका मुख्य कारणहरू के–के हुन्? चरीचरन, चोरी चट्टकरी, हाति आतंक
4. अतिक्रमण, विदेशी प्रजातिहरू, अत्यधिक स्रोत दोहन, चरन, र वन आगो जस्ता समस्याहरू कति गम्भीर छन्? मिचाहा प्रजाति चरन गम्भिर छ
5. यी समस्याहरूलाई उत्पन्न गर्ने सामाजिक, राजनीतिक वा आर्थिक कारणहरू के हुन्?
समस्या उत्पन्न गर्ने प्रमुख कारण पहिचान करना

D. संस्थागत संरचना र शासन व्यवस्था

6. वन व्यवस्थापनका लागि जिम्मेवार मुख्य संस्था वा निकायहरू को–को हुन्? प्रधान कार्यालय वन कार्यालय दमुवाढुंगी वन विकास परियोजना

7. हालको वन शासन व्यवस्था (नीति, कार्यान्वयन, समन्वय) कति प्रभावकारी छ? प्रभावकारी नै छ
8. विभिन्न संस्थाहरूबीच भूमिका दोहोरोपन, खडल वा द्वन्द्व छ कि? छैन

E. जैविक विविधता र संरक्षण

9. वनभित्र जैविक विविधता संरक्षणका लागि के प्रयासहरू भएका छन्? रुखको हाइपा वृक्षारोपण, पानी
10. के कुनै प्रजाति वा वासस्थानहरू संकटग्रस्त वा लोप हुने अवस्थामा छन्? जोगा झाऊ उनाउने

7. हालको वन शासन व्यवस्था (नीति, कार्यान्वयन, समन्वय) कति प्रभावकारी छ?

8. विभिन्न संस्थाहरूबीच भूमिकामा दोहोरोपन, खाडल वा द्वन्द्व छ कि?

E. जैविक विविधता र संरक्षण

9. वनभित्र जैविक विविधता संरक्षणका लागि के प्रयासहरू भएका छन्? (लेख्न नाद्धिको)

10. के कुनै प्रजाति वा वासस्थानहरू संकटग्रस्त वा लोप हुने अवस्थामा छन्? पानी सौंक, बवयर, सिस्नो

F. सामाजिक समावेशीकरण र सहभागिता

11. हालको वन व्यवस्थापन अभ्यास कति समावेशी छन्? (पहिलो भन्दा काम घटेको छ)

12. के महिला, दलित, आदिवासी जनजाति वा अन्य सीमान्तकृत समूहहरू योजना निर्माण र निर्णय प्रक्रियामा सार्थक रूपमा संलग्न छन्? (छैन)

13. समावेशी सहभागितामा के अवरोधहरू छन्?

G. निगरानी र डेटा व्यवस्थापन

14. वन र जैविक विविधताको मूल्याङ्कनका लागि कस्ता निगरानी प्रणालीहरू (यदि छन् भने) प्रयोगमा छन्?

15. के अतिक्रमण वा वन स्वास्थ्यको डिजिटल नक्साङ्कन गरिँदैछ?

H. सिफारिसहरू र सम्भावनाहरू

16. वन र जैविक विविधता संरक्षण सुधार गर्नका लागि तपाईंले के हस्तक्षेपहरू सिफारिस गर्नुहुन्छ?

17. के वैकल्पिक व्यवस्थापन मोडेल वा नवीन उपायहरू छन् जसको प्रयोग गरिन सक्छ?

18. स्थानीय जीविकोपार्जनलाई वन संरक्षण प्रयाससँग कसरी एकीकृत गर्न सकिन्छ?

(सेक्टर हटाउने, पहिलाई आधार बनाएर चाहिँ हैन)
माथामा कमि, २०वर्ष, सितापुरे पुरै बन्द)

E. जैविक विविधता र संरक्षण

9. वनभित्र जैविक विविधता संरक्षणका लागि के प्रयासहरू भएका छन्? खाली ठाउँमा वृक्षारोपण, पानी [illegible] बनाइने

10. के कुनै प्रजाति वा वासस्थानहरू संकटग्रस्त वा लोप हुने अवस्थामा छन्?
सालका केही प्रजाति हरू कम हुँदै गएको

F. सामाजिक समावेशीकरण र सहभागिता

11. हालको वन व्यवस्थापन अभ्यास कति समावेशी छन्? सामावेशी नै छ

12. के महिला, दलित, आदिवासी जनजाति वा अन्य सीमान्तकृत समूहहरू योजना निर्माण र निर्णय प्रक्रियामा सार्थक रूपमा संलग्न छन्? सबै संलग्न छन

13. समावेशी सहभागितामा के अवरोधहरू छन्? छैन

G. निगरानी र डेटा व्यवस्थापन

14. वन र जैविक विविधताको मूल्याङ्कनका लागि कस्ता निगरानी प्रणालीहरू (यदि छन् भने) प्रयोगमा छन्? स्थानिय समूहलाई व्यवस्थापन गर्न लगाएर

15. के अतिक्रमण वा वन स्वास्थ्यको डिजिटल नक्साङ्कन गरिँदैछ? छ

H. सिफारिसहरू र सम्भावनाहरू

16. वन र जैविक विविधता संरक्षण सुधार गर्नका लागि तपाईंले के हस्तक्षेपहरू सिफारिस गर्नुहुन्छ?

17. के वैकल्पिक व्यवस्थापन मोडेल वा नवीन उपायहरू छन् जसको प्रयोग गरिन सक्छ?

18. स्थानीय जीविकोपार्जनलाई वन संरक्षण प्रयाससँग कसरी एकीकृत गर्न सकिन्छ?

Annex IV: Checklist for the KIIs

परियोजनाको शीर्षक: रतुवामाई वृक्षारोपण परियोजनाका लागि वन व्यवस्थापन तथा जैविक विविधता संरक्षण मोडेल

अन्तर्वार्ताकर्ता(हरू): _____
मिति: 13/02/2082
स्थान: _____
जानकारी दिने व्यक्तिको नाम र पद: भोला नाथ पौरखेल (9821395701)
संलग्न संस्था/संगठन (यदि कुनै छन् भने): _____

A. परिचय (५ मिनेट)

- अध्ययनको उद्देश्य छोटकरीमा स्पष्ट गर्नुहोस्।
- गोपनीयता र स्वेच्छिक सहभागिताको सुनिश्चितता गर्नुहोस्।
- नोट लिन वा कुराकानी रेकर्ड गर्न अनुमति माग गर्नुहोस्।

B. वनको अवस्था र प्रवृत्ति

1. तपाईंको दृष्टिमा रतुवामाई वनको हालको पारिस्थितिक अवस्था कस्तो छ? ठिकै
2. पछिल्ला केही वर्षहरूमा वनको अवस्था वा जैविक विविधतामा के महत्वपूर्ण परिवर्तनहरू देख्नुभएको छ? छैन

C. प्रमुख चुनौतीहरू र वन विनाशका कारणहरू

3. यस क्षेत्रमा वन विनाशका मुख्य कारणहरू के–के हुन्? आगलागी
4. अतिक्रमण, विदेशी प्रजातिहरू, अत्यधिक स्रोत दोहन, चरन, र वन आगो जस्ता समस्याहरू कति गम्भीर छन्? छैन
5. यी समस्याहरूलाई उत्पन्न गर्ने सामाजिक, राजनीतिक वा आर्थिक कारणहरू के हुन्? आर्थिक

D. संस्थागत संरचना र शासन व्यवस्था

6. वन व्यवस्थापनका लागि जिम्मेवार मुख्य संस्था वा निकायहरू को–को हुन्?

7. हालको वन शासन व्यवस्था (नीति, कार्यान्वयन, समन्वय) कति प्रभावकारी छ? छ
8. विभिन्न संस्थाहरूबीच भूमिकामा देखिने गरेको दोहोरोपन, खडेल वा द्वन्द्व छ कि? छैन

E. जैविक विविधता र संरक्षण

9. वनभित्र जैविक विविधता संरक्षणका लागि के के प्रयासहरू भएका छन्? छैन
10. के कुन प्रजाति वा वासस्थानहरू संकटग्रस्त वा लोप हुने अवस्थामा छन्? छैन

अन्तर्वार्ताकर्ता(हरू): _____

मिति: २०८२/०१/१३

स्थान: रतुवामाई

जानकारी दिने व्यक्तिको नाम र पद: रत्न कुमार राई

संलग्न संस्था/संगठन (यदि कुनै छन् भने): _____

A. परिचय (५ मिनेट)

- अध्ययनको उद्देश्य छोटकरीमा स्पष्ट गर्नुहोस्।
- गोपनीयता र स्वेच्छिक सहभागिताको सुनिश्चितता गर्नुहोस्।
- नोट लिन वा कुराकानी रेकर्ड गर्न अनुमति माग गर्नुहोस्।

B. वनको अवस्था र प्रवृत्ति

1. तपाईको दृष्टिमा रतुवामाई वनको हालको पारिस्थितिक अवस्था कस्तो छ? राम्रो छ
2. पछिल्ला केही वर्षहरूमा वनको अवस्था वा जैविक विविधतामा के महत्वपूर्ण परिवर्तनहरू देख्नुभएको छ? केही परिवर्तन छ

C. प्रमुख चुनौतीहरू र वन विनाशका कारणहरू

3. यस क्षेत्रमा वन विनाशका मुख्य कारणहरू के–के हुन्? पशुचरण, बदकरी, वन डढेलो
4. अतिक्रमण, विदेशी प्रजातिहरू, अत्यधिक खोत दोहन, चरन, र वन आगो जस्ता समस्याहरू कति गम्भीर छन्? एक मा गम्भीर छ
5. यी समस्याहरूलाई उत्पन्न गर्ने सामाजिक, राजनीतिक वा आर्थिक कारणहरू के हुन्?
   आर्थिक कारण

D. संस्थागत संरचना र शासन व्यवस्था

6. वन व्यवस्थापनका लागि जिम्मेवार मुख्य संस्था वा निकायहरू को–को हुन्? रतुवामाई वन विभाग प्रोफेसर
   आपा डिभिजन वनकार्यालय

9. के कुनै स्थानीय रूपमा चिनिएका वनस्पति वा जनावर प्रजातिहरू हराउँदैछन् वा संकटमा छन्? हालको प्रजाति
10. जैविक विविधता संरक्षणका उपायहरू के वर्तमानमा अभ्यासमा छन्? यदि छन् भने, ती कति प्रभावकारी छन्? वर्तमान
    अभ्यास धेरै खाडी प्रभावकारी छैन

F. सामाजिक समावेशिता र सहभागिता

11. के वन सम्बन्धी निर्णय प्रक्रियामा महिला र सीमान्तकृत समुदायहरू सक्रिय रूपमा संलग्न छन्? वन सबै संलग्न
12. समावेशी सहभागिता रोक्ने प्रमुख अवरोधहरू के–के छन्? छैन

G. निगरानी र शासन व्यवस्था

13. वनको स्वास्थ्य र जैविक विविधताको निगरानी प्रणाली के अवलम्बन गरिएको छ?
14. अवैध गतिविधिहरू (जस्तै: अवैध काठ कटानी, अतिक्रमण) विरुद्धको कार्यान्वयन कति प्रभावकारी छ? धेरै प्रभावकारी
    छैन

Annex IV: Checklist for the KIIs

परियोजनाको शीर्षक: रतुवामाई वृक्षारोपण परियोजनाका लागि वन व्यवस्थापन तथा जैविक विविधता संरक्षण मोडेल

अन्तर्वार्ताकर्ता(हरू): _____
मिति: _____
स्थान: _____
जानकारी दिने व्यक्तिको नाम र पद: Rajkumar Pokheral (9842658202)
संलग्न संस्था/संगठन (यदि कुनै छन् भने): _____

A. परिचय (५ मिनेट)

- अध्ययनको उद्देश्य छोटकरीमा स्पष्ट गर्नुहोस्।
- गोपनीयता र स्वेच्छिक सहभागिताको सुनिश्चितता गर्नुहोस्।
- नोट लिन वा कुराकानी रेकर्ड गर्न अनुमति माग गर्नुहोस्।

B. वनको अवस्था र प्रवृत्ति

1. तपाईंको दृष्टिमा रतुवामाई वनको हालको पारिस्थितिक अवस्था कस्तो छ? (राम्रो अवस्थामा छ)
2. पछिल्ला केही वर्षहरूमा वनको अवस्था वा जैविक विविधतामा के महत्वपूर्ण परिवर्तनहरू देख्नुभएको छ? (केही छैन) धेरै घटेको छ)

C. प्रमुख चुनौतीहरू र वन विनाशका कारणहरू

3. यस क्षेत्रमा वन विनाशका मुख्य कारणहरू के–के हुन्? (encroachment, अधिकारको सम्बन्धमा कानुनी मानेको काम)
4. अतिक्रमण, विदेशी प्रजातिहरू, अत्यधिक स्रोत दोहन, चरन, र वन आगो जस्ता समस्याहरू कति गम्भीर छन्?
5. यी समस्याहरूलाई उत्पन्न गर्ने सामाजिक, राजनीतिक वा आर्थिक कारणहरू के हुन्? (सामाजिक परिचरणको कारणले धेरै छैन)

D. संस्थागत संरचना र शासन व्यवस्था

6. वन व्यवस्थापनका लागि जिम्मेवार मुख्य संस्था वा निकायहरू को–को हुन्? (रतुवामाई, नेपाल, प्रदेश सरकार)
7. हालको वन शासन व्यवस्था (नीति, कार्यान्वयन, समन्वय) कति प्रभावकारी छ? (राम्रो र एकदम प्रभावकारी छ)
8. विभिन्न संस्थाहरूबीच भूमिकामा देखिने गरेको दोहोरोपन, खाडल वा द्वन्द्व छ कि? (छैन)

E. जैविक विविधता र संरक्षण

9. वनभित्र जैविक विविधता संरक्षणका लागि के प्रयासहरू भएका छन्? (छैन)
10. के कुनै प्रजाति वा वासस्थानहरू संकटग्रस्त वा लोप हुने अवस्थामा छन्? (Si800)

Annex IV: Checklist for the KIIs

परियोजनाको शीर्षक: रतुवामाई वृक्षारोपण परियोजनाका लागि वन व्यवस्थापन तथा जैविक विविधता संरक्षण योजना

अन्तर्वार्ताकर्ता(हरू): _____

मिति: 13/02/2082

स्थान: रतुवामाई

जानकारी दिने व्यक्तिको नाम र पद: रनबहादुर थापा (9844674942)

संलग्न संस्था/संगठन (यदि कुनै छन् भने): _____

A. परिचय (५ मिनेट)

- अध्ययनको उद्देश्य छोटकरीमा स्पष्ट गर्नुहोस्।
- गोपनीयता र स्वेच्छिक सहभागिताको सुनिश्चितता गर्नुहोस्।
- नोट लिन वा कुराकानी रेकर्ड गर्न अनुमति माग गर्नुहोस्।

B. वनको अवस्था र प्रवृत्ति

1. तपाईंको दृष्टिमा रतुवामाई वनको हालको पारिस्थितिक अवस्था कस्तो छ? जङ्गलको
2. पछिल्ला केही वर्षहरूमा वनको अवस्था वा जैविक विविधतामा के महत्वपूर्ण परिवर्तनहरू देख्नुभएको छ? जैविकजन्तु हराएको

C. प्रमुख चुनौतीहरू र वन विनाशका कारणहरू

3. यस क्षेत्रमा वन विनाशका मुख्य कारणहरू के-के हुन्? आगलागी, चोरी, कर्मचारीलाई परेको परिचारण
4. अतिक्रमण, विदेशी प्रजातिहरू, अत्यधिक स्रोत दोहन, चरन, र वन आगो जस्ता समस्याहरू कति गम्भीर छन्? धेरै
5. यी समस्याहरूलाई उत्पन्न गर्ने सामाजिक, राजनीतिक वा आर्थिक कारणहरू के हुन्? राजनीतिक, सामाजिक कारणहरू।

D. संस्थागत संरचना र शासन व्यवस्था

6. वन व्यवस्थापनका लागि जिम्मेवार मुख्य संस्था वा निकायहरू को-को हुन्? स्थानीयस्तर र जैक्षाल

7. हालको वन शासन व्यवस्था (नीति, कार्यान्वयन, समन्वय) कति प्रभावकारी छ? सुन्य तहको प्रभावकारी
8. विभिन्न संस्थाहरूबीच भूमिकामा दोहोरोपन, खाडल वा द्वन्द्व छ कि? छैन

E. जैविक विविधता र संरक्षण

9. वनभित्र जैविक विविधता संरक्षणका लागि के प्रयासहरू भएका छन्? छैन
10. के कुनै प्रजाति वा वासस्थानहरू संकटग्रस्त वा लोप हुने अवस्थामा छन्? (कुसुम, धतिउन) र रतरायो लुङ्चे, मयुर

परियोजनाको शीर्षक: रातुवामाई वृक्षारोपण परियोजनाको लागि वन व्यवस्थापन र जैव विविधता संरक्षण मोडेल

अन्तर्वार्ता लिने व्यक्ति(हरू): ____________

मिति: 2082/2/14

स्थान: कैरिबा

सूचक व्यक्तिको नाम र पद: हरिप्रसाद घिमिरे

संस्था/संगठन (यदि छ भने): ____________

A. परिचय (५ मिनेट)

- [illegible]
- [illegible]
- [illegible]

B. वनको अवस्था र प्रवृत्ति

1. [illegible]? राम्रो
2. [illegible]? त्यस्तो हैन

C. प्रमुख खतरा र विनाशका कारकहरू

3. [illegible]? लापरवाही र चोरी सिकारी
4. [illegible]? निकै गम्भीर विषय
5. [illegible]? गरिबी र नराम्रो राजनीति

D. [illegible]

6. [illegible]? जानकारी नभएको तर परियोजना र
7. [illegible]? नेपाल सरकारी त्यस्तो हैन
8. [illegible]? छ

E. जैव विविधता र संरक्षण

9. [illegible]? हैन
10. [illegible]? हैन (हात्तीको मौसमी बसोबास)

F. सामाजिक [illegible] र सहभागिता

11. [illegible]? त्यस्तो हैन
12. [illegible]? हैन
13. [illegible]? स्वराज राजनीति र परियोजनाको लापरवाही

G. [illegible]

14. [illegible]? जस्ती
15. [illegible]? हैन

H. सुझाव र [illegible]

16. [illegible]? प्रणालीमा सुधार।
17. [illegible]? हुनु छ।
18. [illegible]? अफ रोजगार मुलक बनाएर।

Annex IV-Checklist for the KIIs

परियोजनाको शीर्षक: [illegible] वन व्यवस्थापन र जैव विविधता संरक्षण मोडेल

अन्तर्वार्ता लिने व्यक्ति(हरू): ____________________

मिति: 2082।02। 14

स्थान: ____________________

सूचक व्यक्तिको नाम र पद: [illegible]निराम सिंह

संस्था/संगठन (यदि छ भने): ____________________

A. परिचय (५ मिनेट)

- [illegible]
- [illegible]
- [illegible]

B. वनको अवस्था र प्रवृत्ति

1. [illegible]? खराब अवस्था
2. [illegible]? छैन ।

C. प्रमुख खतरा र विनाशका कारणहरू

3. [illegible]? चोरी शिकारी र लापरवाही
4. [illegible]? [illegible] गम्भीर विषय
5. [illegible]? आर्थिक र राजनीतिक

D. संस्थागत संरचना र सुशासन

6. [illegible]? परियोजना, वन कार्यालय ।
7. [illegible]? खासै छैन
8. [illegible]? छ

E. जैव विविधता र संरक्षण

9. [illegible]? छैन
10. [illegible]? छैन

F. सामाजिक समावेशिता र सहभागिता

11. [illegible]? छैन
12. [illegible]? छैन
13. [illegible]? कर्मचारीको लापरवाही

G. अनुगमन र तथ्यांक व्यवस्थापन

14. [illegible]? छैन
15. [illegible]? छैन

H. सुझाव र अवसरहरू

16. [illegible]? प्रणालीका अनुसार
17. [illegible]? छ
18. [illegible]? रोजगार मूलक बनाएर ।

Annex IV-Checklist for the KIIs

परियोजनाको शीर्षक: रतुवामाई [illegible] परियोजनाको लागि वन व्यवस्थापन र जैव विविधता संरक्षण मोडेल

अन्तर्वार्ता लिने व्यक्ति(हरू): ______

मिति: 2082/2/14

स्थान: Korkha

सूचक व्यक्तिको नाम र पद: Ran Krishna Thapa

संस्था/संगठन (यदि छ भने): ______

A. परिचय (५ मिनेट)

- [illegible]
- [illegible]
- [illegible]

B. वनको अवस्था र प्रवृत्ति

1. [illegible]? राम्रो छ
2. [illegible]? केही परिवर्तन भएको छैन

C. प्रमुख खतरा र विनाशका कारणहरू

3. यहाँको वन विनाशका प्रमुख कारणहरू के-के हुन्? ⇒ तस्करी, वन डढेलो
4. [illegible]? एकदमै गम्भीर छ
5. [illegible]? = आर्थिक कारण, राजनीतिक कारणहरू हुन्

D. संस्थागत संरचना र सुशासन

6. कुन-कुन संस्था वा निकायहरू वन व्यवस्थापनमा जिम्मेवार छन्? ⇒ रतुवामाई, आफ्नो डिभिजन वन कार्यालय
7. [illegible]? प्रभावकारी छैन
8. [illegible]? छैन

E. जैव विविधता र संरक्षण

9. [illegible]? खाली ठाउँमा वृक्षारोपण गर्ने कामहरू
10. [illegible]? साल, खयर,

F. सामाजिक समावेशिता र सहभागिता

11. [illegible]? पहिलेको भन्दा काम र धेरै भएको छ
12. [illegible]? छैन
13. [illegible]? खराब राजनीति परिचालनको लापरवाही

G. अनुगमन र तथ्यांक व्यवस्थापन

14. [illegible]? छैन
15. [illegible]? छैन

H. सुझाव र अवसरहरू

16. वन र जैव विविधता संरक्षण सुधार गर्न तपाईं के उपायहरू सिफारिस गर्नुहुन्छ? – रुखहरू रोपने,
17. [illegible]? सकिन्छ
18. [illegible]? जनचेतना

Annex IV-Checklist for the KIIs

परियोजनाको शीर्षक: रतुवामाई वृक्षारोपण परियोजनाको लागि वन व्यवस्थापन र जैव विविधता संरक्षण मोडेल

अन्तर्वार्ता लिने व्यक्ति(हरू): ____________________

मिति: 2082/12/14

स्थान: Kerkha

सूचक व्यक्तिको नाम र पद: Sita poudel

संस्था/संगठन (यदि छ भने): ____________________

A. परिचय (५ मिनेट)

- [illegible]
- [illegible]
- [illegible]

B. वनको अवस्था र प्रवृत्ति

1. [illegible]? राम्रो छ
2. [illegible] के-के हुन्? पहिले जस्तो छ त्यस्तै छ

C. प्रमुख खतरा र विनाशका कारणहरू

3. [illegible] के-के हुन्? चोरी सिकारी, वन डढेलो,
4. अतिक्रमण, [illegible]? एक दमै गम्भीर छ
5. [illegible] सामाजिक, राजनीतिक वा आर्थिक [illegible] के हुन्? आर्थिक कमीको कारण र सामाजिक चलनचलती को का[illegible]

D. संस्थागत संरचना र सुशासन

6. कुन-कुन [illegible]? रतुवामाई वृक्षारोपण, र प्रदेश सरका[illegible]
7. [illegible]? प्रभावकारी नै छ
8. [illegible]? छैन

E. जैव विविधता र संरक्षण

9. [illegible] के-के छन्? वृक्षारोपण को कामहरू गर्ने
10. [illegible]? छैन

F. सामाजिक समावेशिता र सहभागिता

11. [illegible]? खासै छैन
12. [illegible]? छैन
13. [illegible] के-के हुन्? स्पष्ट राजनीति को कारण

G. [illegible]

14. वन र जैव विविधता [illegible]? यस्तै जस्ता कामहरू
15. [illegible]?

H. सुझाव र [illegible]

16. [illegible]? प्रणालीमा सुधार गर्ने
17. [illegible]? छ
18. [illegible]? रोजगार मुलक बनाएर

Annex XII: List of Photographs

Photograph 1: FGD with Stakeholders in Ratuwamai

Photograph 2: Consultation meeting and discussion on the SFM model of Ratuwamai

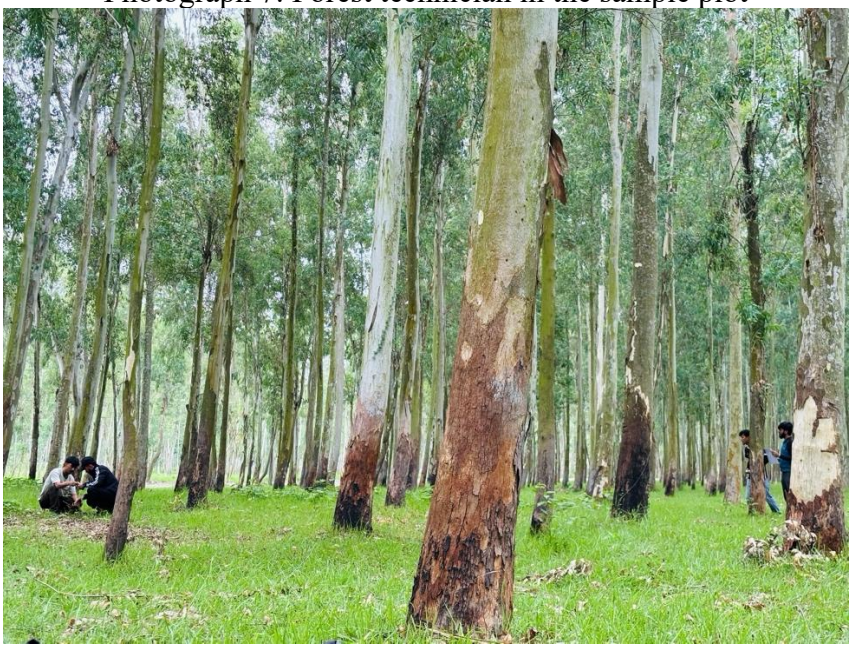
Photograph 3: Open grazing in Ratuwamai

Photograph 4: Eucalyptus plot in Ratuwamai

Photograph 5: Field technician navigating sample plot in Eucalyptus plot

Figure 6: Natural Sal forest in Ratuwamai

Photograph 7: Forest technician in the sample plot



Photograph 8: Forest technician measuring the sample plot

Photograph 9: Nearby settlement in Ratuwmai

Photograph 10: Measurement in Teak Plantation

Photograph 11: Local women collecting fire wood from the Ratuwamai plantation area

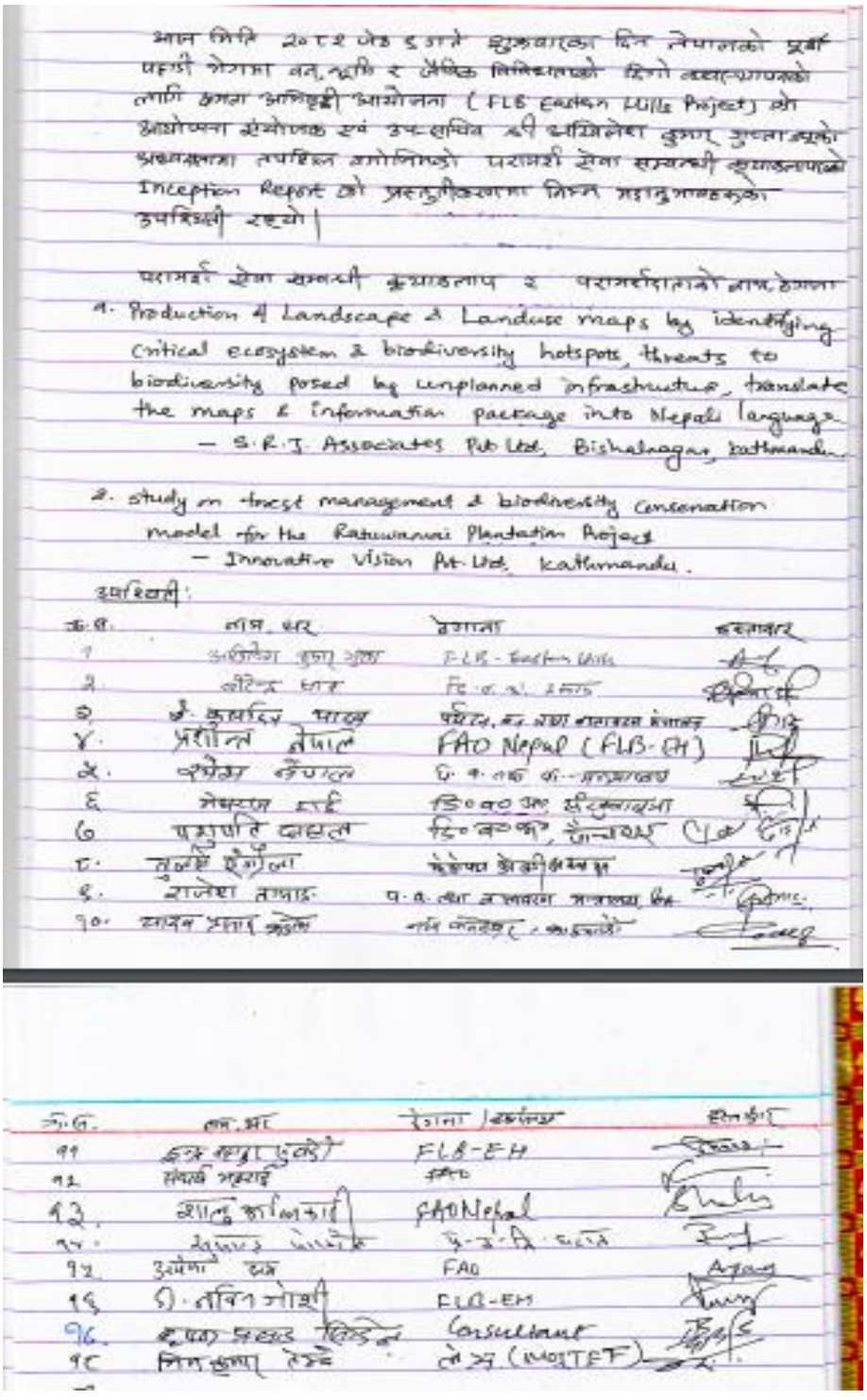
Photograph 12: KII with Mayor

Photograph 13: Measuring DBH of Sal tree in natural Sal forest of Ratuwamai

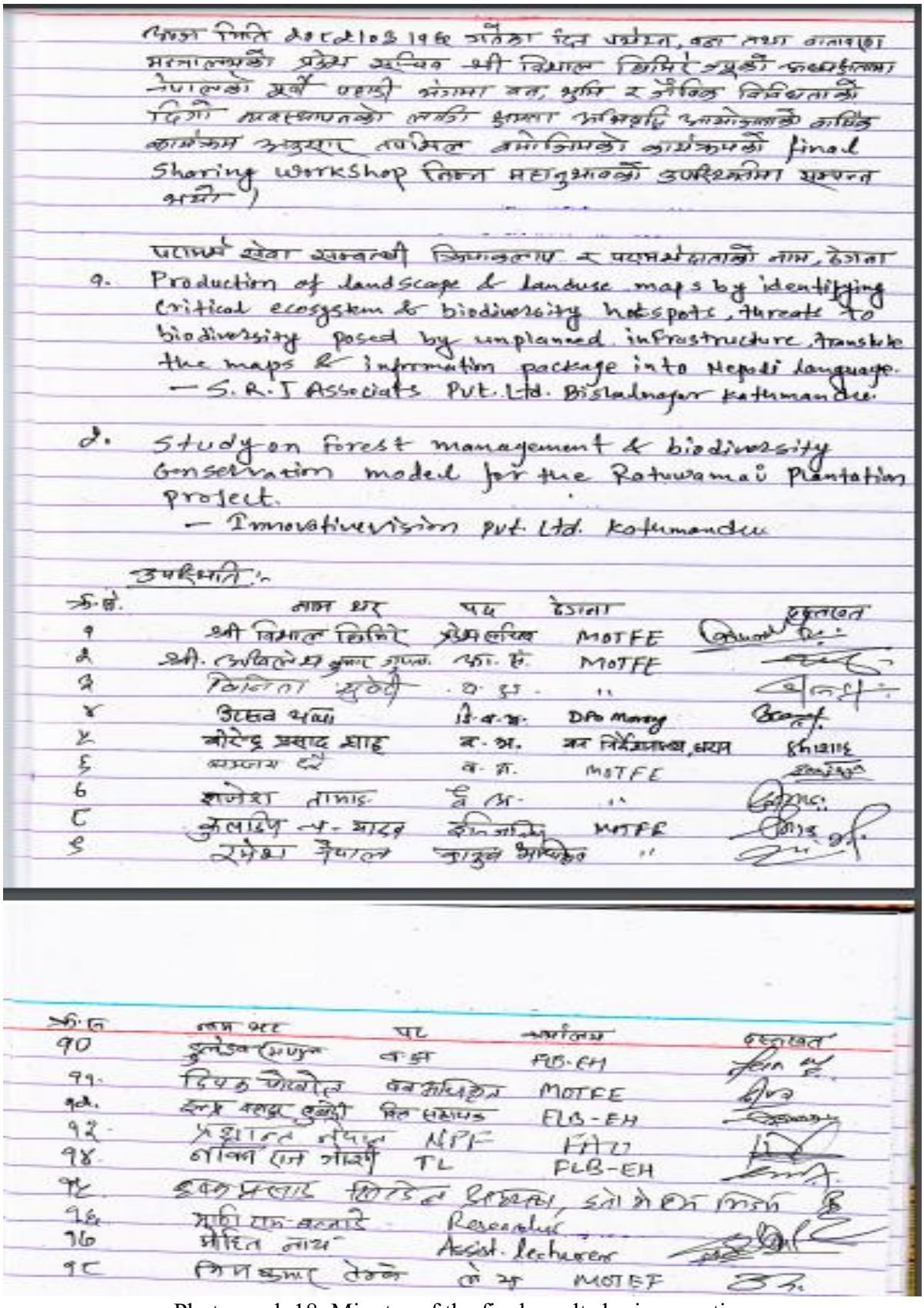
Photograph 14: Establishing plot in the Eucalyptus plantation

Photograph 15: Timber collection and sale in Ratuwamai

Photograph 16: Consultation meeting with Stakeholders in Ratuwamai



Photograph 17: Minutes of the inception meeting



Photograph 18: Minutes of the final result sharing meeting

Annex XIII: Experts Work Details and Key Roles

SN	Position and Name (Thematic expertise proposed)	Key roles and responsibilities on the assignment
1	**Team Leader-** **Dr. Yadav Kandel**	Plan and oversee the forest and biodiversity surveys and ecological studies and develop the technical repot and presentation and overall quality assurance and control
2	**Forest Management Expert-** **Mr. Rajendra Kafle**	Support on the sustainable forest management activities and designing of the sustainable forest management model for the Ratuwamai.
2	**Sociologist-** **Dr. Anita Shrestha**	Support the socio-economic analysis and assure the quality of the report
3	**GIS Expert-** **Dr. Binod Kutu**	Having intensive experience in the field of natural resources management and DRR. Particularly in the GIS mapping and analysis.
4	**Forest Technicians and Crews-6** **1.** Mr. Ashish Ghimire, **2.** Mr. Pushpa Raj Malla **3.** Mr. Surya Bahadur Bohara, **4.** Mr. Ramesh Gautam, **5.** Mr. Rajesh Gupta and **6.** Mr. Ashok Pandey	Field inventory, data and information collection, data cleaning and entry, conduct FGDs and KIIs

Team Composition Update for the Task

The above is the initial team composition proposed for the task. However, due to time constraints and the need to enhance work efficiency, we additionally hired the following experts:

- **Forest Management Expert**: **Mr. Megh Dhoj Adhikari**, Supported to critically review, analyze and develop the sustainable forest managent model of the Ratuwamai plantation forest as presented in the study.
- **Sociologist**: **Mr. Bhola Bhattarai,** helped to interpreted socio-economic analysis and impact assessments, study the relationship between local communities and forest resources in the Ratuwamai.
- **GIS Expert**: **Mr. Suraj** Gautam supported to verify, process, and analyze geospatial data using GIS tools and developed the relevant GIS maps presented in the study

The inclusion of these experts significantly improved our workflow, allowing us to complete the task within the given timeframe while maintaining the expected quality of work.