SUB-NATIONAL JURISDICTIONAL REDD+ PROGRAM FOR SIKKIM, INDIA

Prepared by

Sikkim Forest, Environment & Wildlife Management Department

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Abbreviations

ACoGS	Avoided Conversion of Grasslands and Shrublands
AFOLU	Agriculture, Forestry and Other Land Use
AGB	Above Ground Biomass
AH&VS	Sikkim Animal Husbandry Livestock, Fisheries and Veterinary Services
ALM	Agricultural Land Management
AM	Approved Methodology
ANR	Assisted Natural Regeneration
APDD	Avoided Planned Deforestation and Forest Degradation
AR-ACM	Afforestation Reforestation – Approved Consolidated Methodology
AR-AMS	Afforestation Reforestation – Approved Small Scale Methodologies
ARR	Afforestation Reforestation and Revegetation
AUDD	Avoiding Unplanned Deforestation and/or Degradation
AWiFS	Advanced Wide Field Sensor
BGB	Below Ground Biomass
CDM	Clean Development Mechanism
CFE	Cookstove and Fuel Efficiency
DBH	Diameter at Breast Height
Df	Deforestation
Dg	Forest Degradation
DoFC	Drivers of Forest Change
EF	Emission Factor
EVI	Enhanced Vegetation Index
FAO	Food and Agriculture Organization of the United Nations
FGD	Focal Group Discussion
Forest-PLUS	Partnership for Land Use Science (Forest-PLUS) Program
FRA	Forest Resources Assessment
FSI	Forest Survey of India
GIS	Geographic Information System
GHG	Green House Gas
GoI	Government of India
GoS	Government of Sikkim
GWP	Global Warming Potential
Ha	Hectare
IFM	Improved Forest Management
IPCC	Intergovernmental Panel on Climate Change
IRS	Indian Remote Sensing
ISFR	India State of Forest Report
JNR	Jurisdictional Nested REDD+
KML	Keyhole Markup Language
LASER	Light Amplification by Stimulated Emission of Radiation
LCM	Land Change Modeler
LIDAR	Light Detection and Ranging
LISS	Linear Imaging Self-Scanning System

LtPF	Logged to Protected Forest
LULC	Land Use Land Cover
MF	Methodology Framework
MMU	Minimum Mapping Unit
MSU	Michigan State University
MoEFCC	Ministry of Environment, Forests and Climate Change, Government of India
MSAVI	Modified Soil Adjusted Vegetation Index
NABARD	National Bank for Agriculture and Rural Development
NDVI	Normalized Difference Vegetation Index
NER	Net Emission Reduction
NTFP	Non Timber Forest Produce
PA	Project Area
PD	Project Document
PRA	Participatory Rural Appraisal
QA	Quality Assurance
QC	Quality Control
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RIL	Reduced Impact Logging
RR	Reference Region
RS	Remote Sensing
SAR	Synthetic Aperture Radar
FEWMD	Sikkim Forests, Environment and Wildlife Management Department
SIMFED	Sikkim State Co-operative Supply and Marketing Federation Limited
SOC	Soil Organic Carbon
SOP	Standard Operating Procedures
SREDA	Sikkim Renewable Energy Development Agency
tCO2e	Metric Tons of Carbon Dioxide Equivalents
tdm	Total Dry Matter
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United Stated Agency for International Development
VCS	Verified Carbon Standard
VCU	Verified Carbon Units
Ver.	Version
VM	Verified Methodology
Yr	Year

Executive Summary

The State of Sikkim in India, nestled in the Eastern Himalayas, hosts a unique biodiversity zone with many endemic species. A little over 47% of the total geographical area of the State is under forest cover, and over the last 20 years, the Government of Sikkim has taken up many measures and policy approaches to conserve and enhance the forest carbon stock in the State. However, it has been estimated that emissions still take place from forests in Sikkim due to various drivers leading to deforestation and forest degradation.

The vulnerability of the State to climate change can be seen in the significant changes in local ecosystems, biodiversity, and human population. This vulnerability is manifested as exposure (assessed through analysis of climate data), sensitivity (livelihoods, habitat) and adaptive capacity (social, economic and environmental aspects). Analysis from historical data reveals an increase in mean minimum temperature in the State by 1.95°C and increase in rainfall by 124 mm over 1981-2010. The global circulation model HadCM3 suggests that the Indian subcontinent is expected to undergo an average temperature increase of 4°C by 2085. In Sikkim, district-wise projections for the period 2021-2050 show increase in temperatures, ranging from 1.8°C in the East to more than 2°C in North and South Sikkim.

The predominantly moderate to dense forest cover throughout the State are an important source of carbon stock and provide opportunities towards climate change mitigation and adaptation. Illustrating the importance of forestry, it has been seen that since the Sikkim Government imposed a ban on grazing in 1998, carbon stock in the area in the Barsey Rhododendron Sanctuary has increased by about 585 thousand tonnes, thus providing carbon sequestration services.

Reducing Emissions from Deforestation and Forest Degradation (REDD) is an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to invest in low-carbon paths for sustainable development. Jurisdictional REDD+ is a recent innovation in REDD+, where a government is closely involved in, or may actually lead a REDD+ initiative in areas that lie under its jurisdiction. The advantage is that this enables better integration of the multiple sectors involved in climate change action. In practical terms, this approach blends local action with public policy more efficiently, and is effective in bringing a synergy between project goals and governance elements.
SFEWMD with assistance from Forest-PLUS has developed a Jurisdictional REDD+ project for the State of Sikkim, which involved the following steps over the last 2 years:

1. Institutional Framework: The project commenced with the creation of a REDD+ Steering Committee under the Chief Secretary of the State to coordinate all the convergence actions and a REDD+ Cell within the FEWMD under the PS-cum-PCCF for day-to-day management of the REDD+ project.
2. Reference Emission Level (REL): A historical reference level that analyses changes in forest cover over the period 2002-2013 has been constructed. The REL serves as the baseline against which future performance of the REDD+ project will be measured. The REL process involved extensive fieldwork to validate forest strata and to assess forest carbon. The forest department GIS and field staff, along with community members participated in the REL development.

3. Mapping of Drivers and Interventions: A thorough socio-economic survey across 62 wards including 639 interviews and 31 focus group discussions was carried out to identify drivers of deforestation and forest degradation. The survey was complemented with a 2-tier validation process at a division and state HQ level. The driver process also resulted in a participatory identification of interventions.
4. Safeguards and Benefit Sharing Mechanisms: A detailed safeguards system was developed with the officers of the SFEWMD for the Sikkim jurisdictional REDD+ project. 13 parameters will be monitored over the life of the project, and the results will be analysed and fed to the SIS to ensure no social or biological harm is brought about by the actions under the REDD+ project. A transparent benefit sharing mechanism also has been designed under the REDD+ project, where the SFEWMD will oversee incentives being channelized to the community through JFMCs. This mechanism will be built into existing finance routing channels so as not to increase overheads.
5. Communication campaigns: involved innovative themes such as 'monks for climate' focusing on Buddhist monasteries. Training of forest department personnel and community members was carried out on various subjects such as basic understanding of climate change, forest mensuration and MRV, Data Management System, advanced geospatial analysis etc.
6. Convergence actions also have been successfully initiated, such as workshops for Women Self Help Group members on leading bio-briquette manufacturing in the villages which was funded by NABARD.

As part of the project, drivers of deforestation and forest degradation were identified through detailed and multi-tiered surveys and an extensive validation process. The subsequent interventions proposed in this project are categorized into four main groups:

Category 1: Forest Management (FM)

Interventions under this category will be directly managed by the SFEWMD. These activities majorly include Assisted Natural Regeneration (ANR), Afforestation/Reforestation (AR), fire management, silvi-pastoral and horti-pastoral activities, bio-fencing, and grassland management.

Category 2: Energy Management (ENE)

This category of interventions focuses on decreasing the consumption of non-renewable biomass from forests for energy. Major activities under this category are – efficient alternatives for energy generation for cooking and heating purposes, smokeless bio-briquettes as substitute to fuelwood, and sustainable fuelwood management in religious places like monasteries.

Category 3: Agriculture and Land Management (ALM)

This category attempts to substitute extraction of resources from forests by growing them in alternative sources such as community land, private land etc. Activities under this category include fuelwood and fodder plantations, and alternate fodder sources through hydroponics and azolla cultivation.

Category 4: Other Supporting Activities

Activities other than the proposed interventions will also be looked into in order to provide additional support to the project efforts to enhance the socio-economic situation of the target stakeholders of the project. Some of the activities proposed for this purpose are:

- Construction of community halls, fodder storage rooms.

- Promotion of organic certifications.
- Promotion of solar thermal energy for cooking and heating water by using solar or biomass-solar hybrid models of cookers.

1. Introduction

1.1 Background and overview

The rate of climate change has accelerated in the last century and many of the observed changes since the 1950s were unprecedented. The Intergovernmental Panel on Climate Change (IPCC) has reported without any doubt that this change in climate is due to human induced actions[1]. A global scientific consensus has been reached that in order to limit the ill effects of the on-going climate change, emissions must be reduced so that by the end of the 21st Century, the global mean temperature does not increase by more than 2°C from pre-industrialization levels. Delaying in the high-impact and resilient climate change mitigation actions before 2030, will require substantially higher rates of emission reductions from 2030 – 2050 for limiting warming over the 21st Century to below 2°C. The United Nations Framework Convention on Climate Change (UNFCCC) estimates that beyond this level it will become too difficult to stabilize the global mean temperature.

Forests, being a major carbon sink, play a major role in combating climate change as they contribute towards both climate change mitigation and adaptation efforts. Forests cover one-third of the earth's total land surface[2], and play a major role in the carbon cycle by acting as carbon sinks as well as a major source of carbon stock. The conversion of forest land into other land use categories result in greenhouse gas (GHG) emissions into the atmosphere. From local to national or on a global scale, forests are vital in providing Ecosystem Services such as water cycling and flow management, watershed management, rainfall generation, nutrient cycling and carbon sequestration[3]. Forests also provide provisioning services in the form of NTFPs and are an integral part of culture of some of the communities across the world.

Reducing Emissions from Deforestation and Forest Degradation (REDD+) is an international instrument developed under the UNFCCC to combat climate change by mitigating emissions from forestry sector. Deforestation, as defined in the Marrakech Accords (Decision 11/CP.7, 2001[4]) is the direct human-induced conversion of forested land to non-forested land. Whereas, forest degradation is defined as the changes within the forest that negatively affect the structure or function of the forest stand or site, which lower the capacity of the forest to supply products and/or services. Apart from causing ecological damage resulting in the negative effects on the provision of ecosystem services, such deforestation and forest degradation also has negative social impacts, ranging from livelihood to cultural aspects of forest fringe communities.

REDD+ has been recognized under Article 5 of the Paris Agreement of 2015 at the 21st Conference of Parties (COP) to the UNFCCC, which calls on all member parties to actively initiate, implement and support activities related to the five-pronged goals under the REDD+ mechanism – (a) Reducing emissions from deforestation, (b) Reducing emissions from forest degradation, (c) Conservation of forest stock, (d) Enhancement of forest stock and (e)

[1] Climate Change 2014, Synthesis Report, Intergovernmental Panel on Climate Change (IPCC)
[2] FAO Global Forest Resource Assessment 2010. (pg no 20)
[3] The process of increasing the carbon content of a carbon pool other than the atmosphere.
[4] Decision 11/CP.7, 2001. Land use, land-use change and forestry. FCCC/CP/2001/13/Add.1, Marrakesh Accords

Sustainable Forest Management[5]. On 2nd October, 2016, India ratified the COP-21 Paris Agreement on 02/10/2016[6], thus legally adopting the Agreement once it entered into force.

The forests of Sikkim, a Himalayan State in north-east India, are vulnerable to the impacts of global climate change. The Sikkim landscape comes under the Eastern Himalayan Biodiversity Hotspot[7], one of the global biodiversity hotspots, due to its floral and faunal biodiversity. In order to reduce deforestation and forest degradation in Sikkim, India's first State-level Jurisdictional REDD+ project has been initiated in the State under the Partnership for Land-Use Science (Forest-PLUS) Program[8]. The Forest-PLUS Program is jointly implemented by the Ministry of Environment, Forest and Climate Change (MoEFCC)[9] and the United States Agency for International Development (USAID)[10] and technically assists government agencies to reduce emissions and increase carbon stock in forest lands.

The State-level Jurisdictional REDD+ project, titled 'Sub-National REDD+ Program in Sikkim, India' is implemented under the Forest, Environment and Wildlife Management Department (FEWMD) of Sikkim[11]. The project design was developed after field activities, interactions, consultations and validation exercises in the State, and is detailed in this Project Design Document (PDD).

About Sikkim

Sikkim is a hilly state in the Eastern Himalayas in the North Eastern region of India. It is bounded by vast stretches of the Tibetan Plateau and the People's Republic of China in the North, the Chumbi Valley and the Kingdom of Bhutan in the East, the Federal Democratic Republic of Nepal in the West and the district of Darjeeling in the state of West Bengal (India) in the South. The State of Sikkim has a total area of 7096 km^2, stretched over 112 km from North to South and 64 km from East to West, between 27º00´46´´ and 28º07´48´´ N, and 88º00´58´´ and 88º55´25´´ E[12].

[5] United Nations Framework Convention on Climate Change: Twenty-first Session of the Conference of the Parties (2015); Adoption of the Paris Agreement.
[6] http://unfccc.int/paris_agreement/items/9444.php
[7] http://bsienvis.nic.in/files/Biodiversity%20Hotspots%20in%20India.pdf (pg no 2)
[8] www.forestplus.org/index.html (Accessed 29th July 2017)
[9] www.envfor.nic.in (Accessed 29th July 2017)
[10] www.usaid.gov/ (Accessed 29th July 2017)
[11] www.sikkimforest.gov.in/ (Accessed 29th July 2017)
[12] Sikkim: A Statistical Journal 2013.

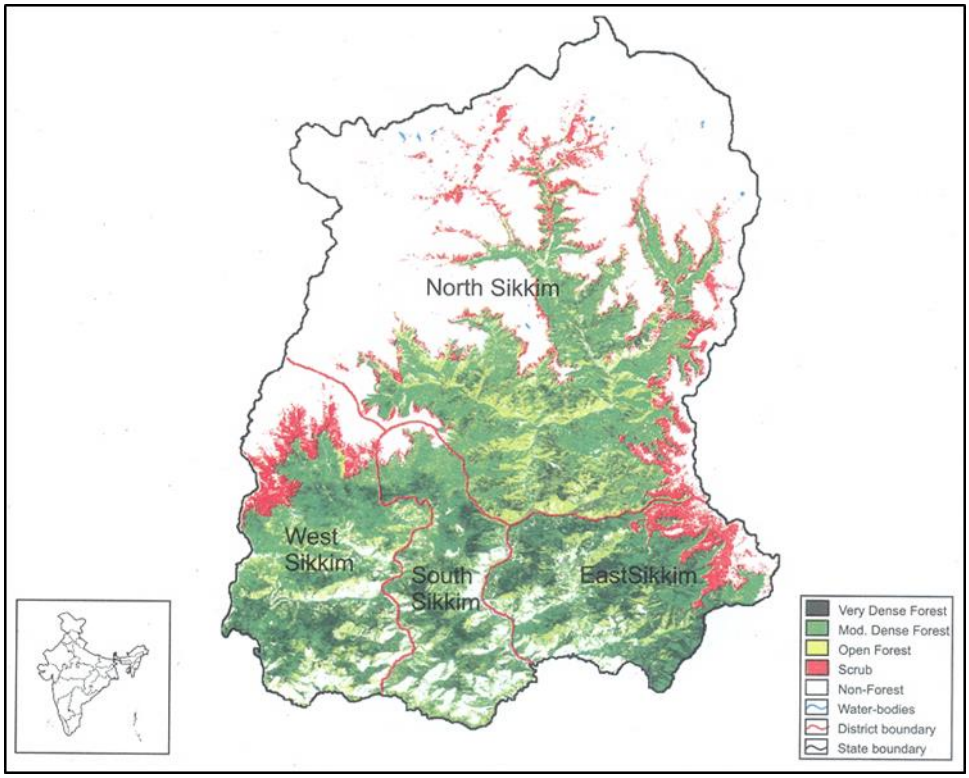

Figure 1: Sikkim, and its tree cover[13]

Eastern Himalayas form a unique biodiversity zone, with many endemic species found in this region. Sikkim, nestled in the eastern Himalayas has little over 47% of its total geographical area under forest cover[14], and over the last 20 years, the Government of Sikkim has taken up many measures and policy approaches to conserve and enhance the forest carbon stocks in the State. However, it has been estimated that emissions still take place from forests in Sikkim due to degradation of forests owing to various drivers. Sikkim has all four of its districts categorised as tribal districts.

An overview of the Sikkim's demographic characteristics is given in Table 1[15].

Table 1: General administrative characteristics of Sikkim

Attributes	Value
Geographical Area	7096 km^2
Population (Census 2011)	Total - 0.61 million (6.1 lakh)
	Urban - 0.15 million (25.2%)
	Rural - 0.46 million (74.8%)
	Tribal - 0.21 million (33.72%)
Average Population Density	86 persons per sq. km
Livestock Population (18th Livestock Census)	0.27 million (2.7 lakh)
No. of Districts	4 (These 4 districts are categorised as hill and tribal districts also)

[13] http://www.sikkimforest.gov.in/images/sikkim-forest-FSI.gif
[14] India State of Forests Report 2015; Forest Survey of India.
[15] India State of Forests Report 2015, Forest Survey of India.

The State has a total forested area of 3,357 km^2 which comprises 500 km^2 of Very Dense Forests, 2,160 km^2 of Moderately Dense Forests and 697 km^2 of Other Forests. The total forest and tree cover of Sikkim is 3392 sq. km (47.80% of the total geographical area of the State).[16]

Climate Change and Forests in Sikkim

Climatic change is basically driven by anthropogenic activities apart from natural disasters like volcanos, earthquakes, etc., and is expected to significantly impact forests health as climate is one of the fundamental determinants of vegetation. Forest ecosystems adversely affected by climate change have corresponding effects on biodiversity and biomass growth[17].

Global assessments have shown that forest ecosystems will be extremely vulnerable to the impacts of climate change. In India, analysis of climate models and climate projections suggest that forests are expected to undergo significant changes, including shifts in forest types. Under the A2 and B2 climate scenarios, 77% and 68% of the forested grids in India are vulnerable to such effects[18].

The fundamental role of the Forestry sector in climate change mitigation is seen from the fact that forest sector can contribute at least 8.2% to 13.5% to global mitigation efforts[19]. This involves restoring carbon stocks in degraded forests, afforestation and reforestation activities and curbing deforestation. Forests have a pivotal role to play in climate change adaptation as well.

The Himalayan State like Sikkim is vulnerable to these effects of climate change. Climate change is already having significant impacts on local ecosystems, biodiversity and human populations. This vulnerability is manifested as exposure (assessed through analysis of climate data), sensitivity (livelihoods, habitat) and adaptive capacity (social, economic and environmental aspects). Analysis from historical data reveals an increase in mean minimum temperature in the state by 1.95°C and increase in rainfall by 124 mm over 1981-2010[20]. While the global circulation model HadCM3 suggests that the Indian subcontinent is expected to undergo an average temperature increase of 4°C by 2085, district-wise projections for the period 2021-2050 show increase in temperatures, ranging from 1.8°C in East Sikkim to more than 2°C in North and South Sikkim[21]. The State of Sikkim has one of the highest percentages of land under forest and tree cover (47.8%) among the States of India[22]. With predominantly moderate to dense forest cover throughout the state, these forests are an important source of carbon stock. These forests provide opportunities towards climate change mitigation and adaptation. Justifiably, the Forestry sector should be an integral part of the evolution of strategies to tackle climate change. Illustrating this importance, it has been seen that since

[16] ENVIS Centre (MoEFCC) - http://sikenvis.nic.in/Database/ForestResource_786.aspx?format=Print (Accessed 31st July 2017)
[17] Ravindranath, N.H., Sharma, M., Sagadevan, A., Jayaraman, M., and Munsi, M.; Climate Change and Its Impacts on Forests in Sikkim; in Climate Change in Sikkim: Patterns, Impacts and Initiatives, Government of Sikkim (2012).
[18] Ravindranath, H.R., Joshi, N.V., Sukumar, R., and Saxena, A. (2006); Impact of Climate Change on Forests in India; Current Science 90(3). (pg no 1)
[19] Ravindranath, N.H. et al. (2012); Deforestation and Forest Degradation in India: Implications for REDD+; Current Science 102(8).
[20] Bawa, K.S. and Ingty, T.; Climate Change in Sikkim: A Synthesis; in Climate Change in Sikkim: Patterns, Impacts and Initiatives, Government of Sikkim (2012).
[21] Ravindranath, N.H., Sharma, M., Sagadevan, A., Jayaraman, M., and Munsi, M.; Climate Change and Its Impacts on Forests in Sikkim; in Climate Change in Sikkim: Patterns, Impacts and Initiatives, Government of Sikkim (2012).
[22] India State of Forests Report 2015, Forest Survey of India.

the grazing ban was imposed in the Barsey Rhododendron Sanctuary, carbon stocks have increased by about 585 thousand tonnes, thus providing carbon sequestration services[23].

Out of the State's total population of 0.61 million, a majority is based in rural areas (0.46 million). The rural population is dependent on forest resources for its sustenance and livelihoods. The drivers of forest change that have been identified include unsustainable fuelwood extraction, extraction for fodder, as well as requirements towards the provision of mulching material and green manure. In addition, natural events like forest fires and landslides make the State vulnerable to further depletion in its forest cover. The prolonged winter droughts in Sikkim make the State particularly vulnerable to forest fires and little more than 62 forest fires were identified in Sikkim in 2014[24], while the hilly terrain makes landslides common. In this background, it is evident that there exist some drivers responsible for forest change in the landscape that if unchecked, in the state can contribute towards the loss of potential carbon resource in the state.

Overview of REDD+ Project

This REDD+ project seeks to supplement existing governmental programs working towards environmental conservation in the State in such a way that emissions from forests are minimised, and carbon stock in forests are further enhanced. Some of the interventions planned under the REDD+ program is integrated with some of the schemes mentioned above as a part of the interdepartmental convergence efforts undertaken by the Government of Sikkim.

The State of Sikkim has already established several climate-friendly regulations over the years, including the ban on green felling and the ban on grazing. Examples of some of such efforts include:

1. State Green Mission to help efforts towards implementation of the state-wide REDD+ mechanism envisaged under this project.
2. Expanding protected areas throughout Sikkim – sanctuaries and national parks now cover more than 32% of the total geographical area of the state.
3. Banning green felling and grazing in forests to protect forest resources in the state.
4. Promoting responsible and zero-waste eco-tourism on the popular trekking trails in KNP.
5. Encouraging participation of JFMCs and EDCs towards conservation of upper hill forests, which are important watersheds and a habitat for important wildlife.
6. Strengthening environmental education in schools through the Green Schools program.
7. Initiating plantation activities through the 'Ten Minutes to Earth' program.
8. Establishing plantations of fast-growing indigenous species like *Terminalia myriocarpa* and *Alnus nepalensis*.
9. Provision of climate-resilient alternate livelihoods like poultry farming and ecotourism.
10. Making Sikkim India's first fully organic state under the Sikkim Organic Mission.

As a part of the proposed REDD+ project, reduction of CO_2 emissions will be estimated with a reference baseline developed for the State of Sikkim. The reference baseline has taken into account average deforestation and forest degradation rates over the last 15 years. Project monitoring of emission levels would similarly be developed to estimate Green House Gas

[23] Bawa, K.S. and Ingty, T.; Climate Change in Sikkim: A Synthesis; in Climate Change in Sikkim: Patterns, Impacts and Initiatives, Government of Sikkim (2012).
[24] http://www.sikkimforest.gov.in/Forest-Fires-Sikkim.asp

(GHG) emissions reductions over the project lifetime. This makes Sikkim the first State in India to embark on a State level sub-national jurisdictional REDD+ pathway in the country.

To isolate the drivers and agents of deforestation and forest degradation, as well as to better understand the ground scenario, several meetings with local stakeholders, key informant interviews, social and ecological surveys in the State have been conducted. After analysing the outcomes of these activities, it is clear that there exists considerable anthropogenic pressure on the forests of Sikkim. From the RS/GIS analysis, annual emissions have been observed to take place from the forest lands.

Intervention activities have been planned as a part of the project activities to bring down emissions from forests. These interventions will be implemented across the State through the Joint Forest Management Committees (JFMCs) and with the help of all stakeholders. The project will be managed through a REDD+ Project Management Unit (PMU) at the Forests, Environment and Wildlife Management Department (FEWMD), Govt. of Sikkim. Overall guidance will be provided by the REDD+ Steering Committee, in which the Chief Secretary of Sikkim is the Chair and the PCCF-cum-PS is the Member Secretary.

The annual average emission savings and projected increase in the forest carbon stocks of Sikkim over the project life of 20 years has been estimated to be at **123,548 tCO_2e/year**.

1.2 Objective

The proposed REDD+ project is initiated to mitigate the emissions from forests and enhance carbon sequestration in forests of Sikkim. The project aims to establish a first-of-its-kind State-level Jurisdictional REDD+ program in India. The FEWMD would be the project proponent for this project.

The primary objective of the project is to conserve the existing forest carbon stock in the State of Sikkim and enhance the degraded forests in a participatory manner so that forest resource dependent communities of the State are also benefitted. Through the success of this REDD+ project, Sikkim aims to establish a people-centric forest conservation and climate resilience model.

The project seeks to meet three objectives:

- to mitigate carbon emissions by reducing deforestation and forest degradation, and by reducing the pressure on forests which are already degraded and avoid further deforestation in the project area
- to contribute towards biodiversity conservation including High Conservation Value (HCV) species, and
- to strengthen community building and contribute to livelihoods generation of communities residing in forest fringe areas.

The majority stakeholders in this project will be the residents of forest fringe villages along with the JFMCs, range officers and other officers from the FEWMD, as well as officers from other line departments of the Sikkim Government which could provide assistance in the project activities. The project seeks to meet the above mentioned objectives through the following activities.

- ✓ Capacity building programs to forest department personnel as well as communities
- ✓ Better management of natural resources involving communities
- ✓ Improve market linkages

- ✓ Foster strategic alliances with all stakeholders

The project emphasizes on community-based implementation and monitoring systems deployed in this proposed REDD+ project.

1.3 Project Executing Entity

The Executing Entity (EE) for the proposed project is the Forests, Wildlife and Environment Management Department (FEWMD), Government of Sikkim.

The FEWMD came into existence in 1909 and is one of the oldest departments in the Government of Sikkim. Out of the total geographical area of 7,096 square kilometers, more than 84% is under the administrative control of Forest Department[25]. FEWMD is responsible for the comprehensive management of Sikkim's forests, biodiversity and the environment, including aspects related to the promotion of ecotourism in the state as well as the maintenance of the state's land and water resources.

The FEWMD has the following functions and associated legal authority:

- Formulate and implement policies promoting forestry development, industry, trade, services, and industrial incentives in consultation with the MoEFCC.
- Promote and coordinate the production, processing, manufacturing and marketing of timber and non-timber forest products in the State.
- Administer, directly or indirectly, the State's public forests;
- Promote sustainable forest development programs in the State.
- Support the development of community forest management plans.
- Support socio-economic studies in the state and periodically disseminate this information.
- Promote the building of public-private partnerships to carry out sustainable development activities in the State.

Under this project, the FEWMD has assumed the role of the project proponent and executing entity (EE). It will be responsible for the implementation and monitoring of the program, and ensuring the equitable distribution of benefits arising from the program eventually. The FEWMD will serve as the nodal agency for the dissemination of information from the project.

[25] 15 Years Achievements: Forests, Environment and Wildlife Management Department, Government of Sikkim (2010).

Organization name	**Sikkim Forests, Environment and Wildlife Management Department**
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2. Scope of the Program

2.1 Geographical Scope

The proposed REDD+ program considers the whole geographical area of the State of Sikkim as its jurisdiction. The scope of this program will be used to develop the REDD+ Baseline, design intervention plans, quantify emission reductions, implement the monitoring, reporting and evaluating structures as well as institutionalise the Safeguards and Benefit Sharing Mechanisms developed. There is no overlap with other jurisdictions. The jurisdiction is an administrative boundary and not an ecoregion.

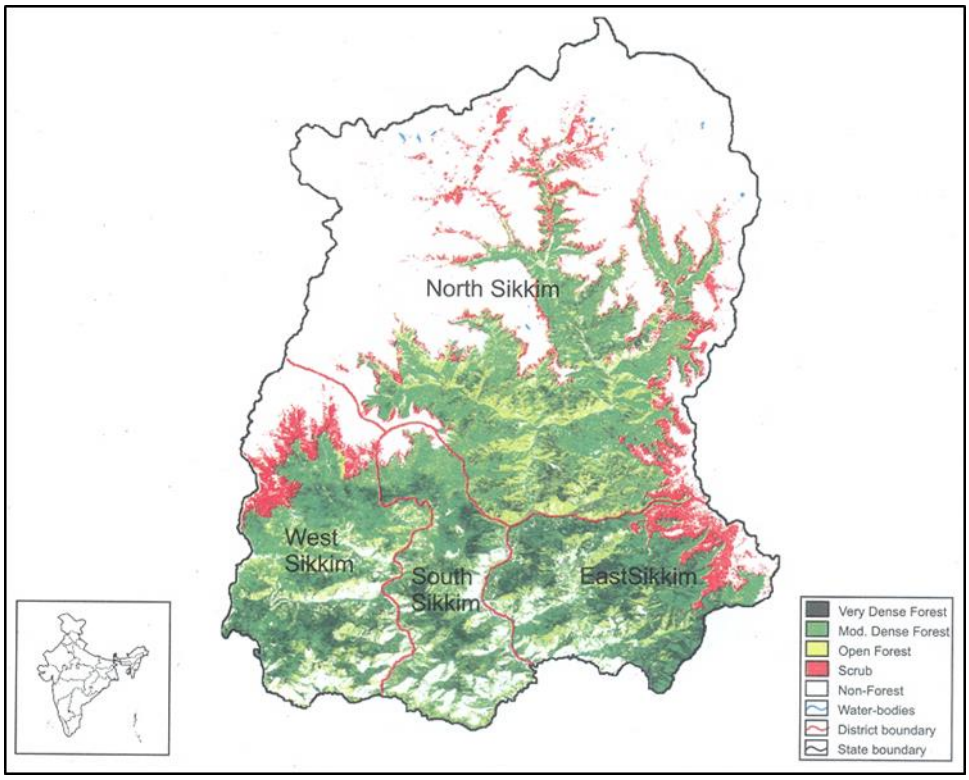


Figure 2: The geographical boundary of Sikkim State and its four districts

2.2 Temporal Scope

The program crediting period is 20 years 00 months. It will be renewed every 10 years.

2.3 Implementation

The key areas of implementation under the Jurisdictional REDD+ Program in Sikkim include:

- Baseline development for REDD+ in Sikkim
- Training and capacity building of various stakeholder groups in Sikkim
- Identification of drivers of deforestation and forest degradation in Sikkim
- Developing TTMs for forest carbon measurement in Sikkim
- Developing specific convergence models which will be helpful for leveraging funds for implementation of REDD+ activities in Sikkim

2.4 Carbon Pools

A rigorous assessment of the carbon stock of the forests in Sikkim has been undertaken through spatial analysis and extensive field surveys. The carbon pools considered as part of carbon stock assessment and baseline development, along with their justification, has been given below.

Table 2: Carbon pools considered for jurisdictional baseline

Carbon pools/ sources	Gas	Included	Justification/explanation
Aboveground tree or woody biomass	CO_2	**Yes**	Major carbon pool affected by project activities
Aboveground non-tree or non-woody biomass	CO_2	**No**	Time and resource limitations
Belowground biomass	CO_2	**Yes**	Major carbon pool affected by project activities
Litter	CO_2	**Yes**	Carbon pool affected by Project activity
Dead wood	CO_2	**No**	Dead wood contribution to the Carbon pool is negligible (1% approx.)[26]
Soil organic carbon	CO_2	**Yes**	Major carbon pool affected by project activities

2.5 Stakeholder Mapping

Multiple stakeholders have been identified in the landscape, each having their own unique influence on the project. In view of this, all important stakeholders in the landscape have been mapped in this project[27]. The mapping has been performed after analysis of multiple criteria, enabling a clear understanding of their influence on implementing the project in the state. The stakeholders have been categorized as **Veto** and **Key** stakeholders based on their extent of influence. The categorization is described as under:

Veto stakeholders — Principal stakeholders with decision making powers having a direct impact on the project, with authority to direct the direction of the project.

Key stakeholders — Stakeholders that directly affect demand-supply scenarios of forest resources or have a strong influence on Forestry project activities. They contribute significantly through their direct participation in the project, and are expected to be involved with the project throughout. Their support is crucial in achieving the objectives of the project.

2.6 Baseline Sources and Project Sources of GHG

Source		Gas	Included?	Justification/Explanation
Baseline	Baseline Deforestation and Forest Degradation	CO_2	Yes	Emissions are related to changes in carbon pools.
		CH_4	Yes	Included only in the case of certain intervention activities such as cook stove and fuel efficiency activities (CFE). In baseline if biomass is burnt during land preparation in the case of ARR, CH_4 is included. In baseline if grazing and animal management is involved, CH_4 is not counted for reasons of conservativeness.

[26] Carbon Stock in India's Forests, Forest Survey of India 2009.

[27] The methodology that has been used for stakeholder mapping has been adapted from the GIZ Capacity Works tool.

Source		Gas	Included?	Justification/Explanation
		N_2O	Yes	Included as cook stove and fuel efficiency activities (CFE) are involved. In baseline or project if biomass is burnt, N_2O is included. If baseline involves application of fertilizers N_2O is not considered for reasons of conservativeness.
	Baseline ARR	CO_2	Yes	Emissions are related to changes in carbon pools.
		CH_4	No	Emissions are expected to be negligible. Hence excluded.
		N_2O	No	Emissions are expected to be negligible. Hence excluded.
Project	Biomass burning from unplanned large and small scale fires and biomass burnt in cook stoves	CO_2	No	Emissions are excluded as they are a part of the changes in carbon pools.
		CH_4	Yes	CH_4 emissions of burning woody biomass from unplanned fires are to be accounted. If the fires are catastrophic, CH_4 emissions must be estimated and demonstrated negligible or otherwise accounted for.
		N_2O	Yes	N_2O emissions of burning woody biomass from unplanned fires are to be accounted, If the fires are catastrophic, N_2O emissions must be estimated and demonstrated negligible, or otherwise accounted for.
	Fossil fuel used during operations	CO_2	No	Emissions from fossil fuel combustion is considered *de minimis* for REDD and ARR. Excluded.
		CH_4	No	Insignificant
		N_2O	No	Insignificant
	Removal of woody biomass during assisted natural regeneration (ANR and ARR) activities	CO_2	Yes	Emissions related to changes in carbon pools are taken into account. But woody biomass will not be removed during assisted natural regeneration activities.
		CH_4	Yes	CH_4 emissions from removal of woody biomass are significant when fire is used in preparing the land for ANR activities. But woody biomass will not be removed during assisted natural regeneration activities.
		N_2O	No	N_2O emissions from burning woody biomass during ANR activities are assumed negligible and conservatively excluded.
	Fertilizer used during enrichment planting for assisting natural regeneration and ARR	CO_2	No	Assumed negligible
		CH_4	No	Assumed negligible
		N_2O	No	Assumed negligible
	Increased fertilizer use	CO_2	No	Not Applicable
		CH_4	No	Not Applicable
		N_2O	No	N2O emissions related to increased fertilizer use are *de minimis*.

3. Project Area Details

Physical Features of Sikkim

Description of the landscape

The State of Sikkim receives an annual rainfall of 2,000mm to 4,000mm. Tista & Rangit, originating from Cholamu Lake and Rathong Glacier respectively, are the two major rivers of Sikkim. The profiles of land elevation in Sikkim include low-lying hills, alpine zones and snow-bound landscapes as elevation increases. Important mountains falling within Sikkim's administrative zone include Mt. Khangchendzonga (28,156 feet) and Mt. Kabru (24,215 feet)[28].

Climatically, Sikkim can be divided into 5 climatic zones[29] –

1. Tropical - Below 610 m
2. Sub-tropical – 610 m to 1524 m
3. Temperate – 1524 m to 2743 m
4. Sub-alpine – 2743 m to 3962 m
5. Alpine – 3962 m to 5182 m

Sikkim has a total area of 7,096 km^2. The state of Sikkim consists of 4 administrative districts, namely South Sikkim, West Sikkim, East Sikkim and North Sikkim. These administrative boundaries of the revenue districts are synchronous with the 4 Forest Divisions in the state.

Total Forest and tree cover in the state is 47.8%, and the per capita forest and tree cover is 0.556 ha[30]. This assumes even greater significance since a large proportion of the geographical area of Sikkim comes under Eastern Himalayan snow-capped peaks, glaciers and alpine meadows. The State has 10 mountain peaks that rise above 7,000 meters, 84 glaciers and 315 glacial lakes (including the Tsomgo, Gurudongmar and Khecheopalri). Mount Khangchendzonga (8,586 meters), the world's third-highest mountain peak and revered as a guardian deity, is situated on the border between Sikkim and Nepal. Table 3 below gives a list of these geological features[31].

[28] Sikkim: A Statistical Journal (2013).
[29] Ibid.
[30] India State of Forest Report 2015, Forest Survey of India.
[31] Sikkim: A Statistical Journal (2013).

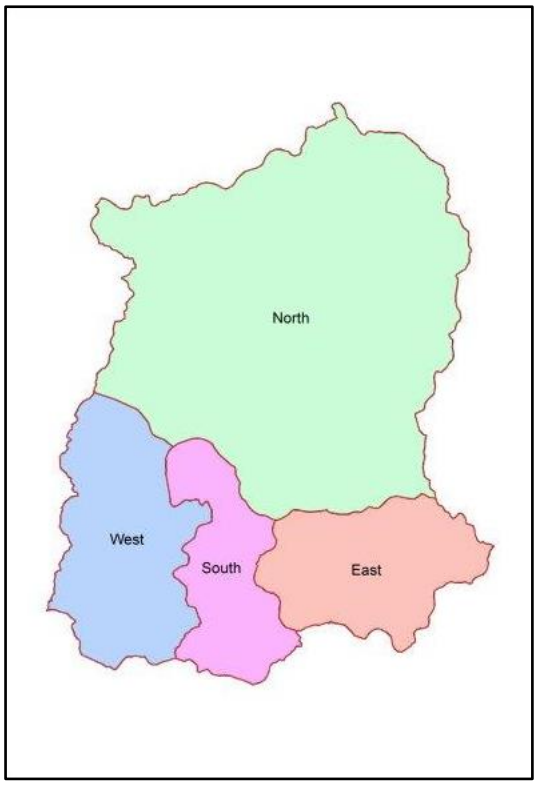


Figure 3: Four districts of Sikkim

Table 3: Important physical features in Sikkim

Major Glaciers	Zemu, Rathong, Lonak, Hidden and Talung
Major Lakes	Khecheoperi, Gurudungmar, Changu, Lam Pokhari and Laxmi Pokhari
Ranges	Singalila (separates Sikkim from Nepal) Chola (seprates Sikkim from Tibet and Bhutan) Pangolia (separates Sikkim from Bhutan)
Passes	Nathu-La (14,400 ft) Jelep-La (14,500 ft) Batang-La (13,000 ft) Chorten Nyima-La (19,000 ft)

The major environmental conditions existing in Sikkim at the initiation of the project have been described on a Forest Division-wise basis. There are 4 Forest Divisions in Sikkim, which overlap with the district administrative boundaries.

South District/Forest Division

The South Sikkim District/South Forest Division lies between longitude 88º 17' 30" E, to 88º 32' 30" E, and latitude 27º 05' N, to 27º 30' N. The division is bounded on the North by the West Forest Division and in the South by the Darjeeling district of West Bengal, in the Southeast by Kalimpong sub-division of Darjeeling district and in the East by the East Sikkim Forest Division. The Rangphap Chu separates the area from the North district, the landscape is separate from the East District by the Tista River and from the West district by the Rangit River and Rangdung Chu.

The South Forest Division contains 256.64 sq. km. of Reserved Forest area and 59.52 sq. km. of unreserved forest areas[32].

Topography[32]

[32] Working Plan for the Forests of South Forest Division, Sikkim.

The whole district is highly mountainous, with a high variation in altitudes: less than 300 meters at Melli to about 5,825 meters at Narsing Peak. Other important peaks in the tract are Paki Lhu (4,934m), Nampuk Phuk (4,401 m) and Karsing peak (3,720m).

Geology

The major rock types in the district include Gneissose Series and Daling Series. In the region of higher elevations, the Daling Series have been gradually changed into mica schists. The boundaries between the Daling and Gneissose series are irregular due to the interplay of various geological processes. The Gneissose Series present also has a high mica content. The rocks are well foliated and the crystalline complex consists both of igneous and sedimentary rocks. Dolomites quartzites are also common and in the transitional zone, micaceous schists are common too.

Soil[32]

Most areas have medium to deep soil depths. Brown forest soil is predominant in the district. The soil varies in texture from sandy loam to clayey loam with most of the area having sandy loam to clayey loam soil. Soil erosion is mild in about 80% of the area, while 5% of the district is affected by heavy soil erosion.

Temperature[32]

Temperature in the lower zones varies from 4.5ºC to 18.5ºC whereas at high altitudes it varies between 1.5ºC to 9.5ºC. The maximum temperature in the lower areas may go as high as 35ºC, while higher elevations experience sub-zero temperatures in winter. Maximum temperature is experienced during June and July, while minimum temperature has been recorded during January.

Rainfall[32]

The rains start around May (pre-Monsoon showers) in the higher altitudes above Rabongla, while it starts from June in the lower areas like Melli and continues till middle of October in high altitude areas. The South Asian Monsoon is active normally from the 1st week of June and continues till the 1st week of October. The average rainfall ranges between 2,000 mm to 2,500 mm.

Distribution of Area[32]

Forests found above the elevation of 2,400m are kept as protection forests. Clear felling is prohibited in these types of forests. For description purposes, forests in the district have been divided into various strata[33] (Table 4).

Table 4: Forests classification in the South Sikkim District.

S.No.	Zone	Altitudinal Range
1	Lower Hill Forests	Below 900m
2	Middle Hill Forests	Between 900m and 1800m
3	Upper Hill Forests	Between 1800m and 2400m
4	Rhododendron Forests	Between 2400m and 3600m

Lower Hill Forests (Champion's Group 3B): Three main types are present in the landscape:

- *Sal Forests (Champion's subtype 3b/C2-D1a):* Sal is found only in ridges and some well-drained flats at the foothills. Principal associates of Sal are Dabdabe (Garuga

[33] Champion, H.G. and Seth, S.K. (2005); A Revised Survey of the Forest Types of India; Natraj Publishers.

pinnata), Pakhasaj (Terminalia grenulata), Chelaune (Schima wallichii) and Burra (Terminalia chebula). The Sal forests extend up to Lingkhim in the Tista valley and Legship in Rangeet valley.

- *Dry Mixed Forests (Champion's type 3b/E-6):* Occur only on the drier slopes as this type is mainly deciduous. Sal occurs as isolated trees. Common species are Dabdabe and Siris (Albizzia spp.). Forests near Legship, Dong, Lower Kamrang and inner subsidiary valleys of lower Rangeet valley exhibit these types of forests.

- *Wet Mixed Forests (Champion's type 3b/25, 5):* These comprise the evergreen valley forests. In drier areas, Schima bauhinia, and other species include Schima wallichii, Bauhinia purpurea, Gmelina arborea, Tetrameles nudiflora and Dysoxylem spp.

Middle Hill Forests (Champion's type 7b/C I): The altitude here varies from 900m to 1800m. Some common species found are Castanopsis hystrix (Katus), Quercus lineate (Phalant), Quercus lamelossa (Buk), Quercus lanceafolia (Patle katua), Shorea robusta (Sal) and Schima wallichii (Chelaune).

Upper Hill Forests: These forests are located in Namchi and Rabongla Ranges, and are mostly broad leaved with main species as Machilus spp. and Quercus spp.

West District/Forest Division

The West District has a forest area of 297.53 sq. kms of territorial reserve forests, 191.57 sq. kms of *Khasmal* and 31.11 sq. kms of *Gorucharan*[34] forests falling within the Territorial jurisdiction of the West Forest Division, as well as 316.55 sq. kms of wildlife reserve forests in the Khangchendzonga National park and 134.17 sq. kms of reserve forests in the Barsey Rhododendron Wildlife Sanctuary. It lies between the longitudes 88º20' and 88º55' E and latitudes 27º7' and 27º25' N.

The district is bounded in the North by Mt. Kabru (7,318m), in the East by Rangit river from Malong to the confluence of Rangeet and Ramam rivers near Jorethang-Nayabazar, in the South by Ramam river up to Phalut (3,598 m) and the Singhalila Range along the Sikkim – Nepal Border up to Mt. Kabur (Thayabala) in the West[35].

Topography[35]

The major portion of the Division is mountainous with varying altitudes. In general, the topography can be described as hilly with steep slopes bounding the ridges.

There are 4 main ridges, which support vast forestlands. These ridges rise from altitudes as low as 305m and as high as to 7,318m. These ridges have further branches, which diverge in different directions and support significant forestlands.

Geology[35]

The main geological formations consist of two main groups, Darjeeling Gneiss and Daling Series. Daling occurs in the South-Eastern part of this Division and is predominantly made up of hyalites. This acts as the boundary between these two groups, and further passes into mica

[34] Forest land in Sikkim has been classified into – Khasmal (Access allowed for communities), Gorucharan (Right to free grazing and fuelwood collection, but no tree cutting) and Gumpa/Monastery (Extraction only for religious rituals).
[35] Working Plan for the Forests of West Forest Division, Sikkim.

schist and then into Darjeeling Gneiss. Phyllites, slates, quartzite and schists are also found in the region, mostly along the River Rangeet.

Soil[35]

The depth, profile, mineral content and organic constituents of the soil varies regionally. The forest soil found in the district has adequate depth and supports significant forestlands. The soil formation of valleys is due to decomposition of the Daling rocks. The resulting soil is sandy loam and dark gray in colour with considerable amount of sand, thus supporting Sal and its associates. A greater portion of the Division has gneissic rocks, giving rise to different types of soil. Soil erosion is one of the major degradation processes in hills. Steep lands with high rainfall are often subjected to soil loss by water erosion and landslides or landslips in the region.

Temperature[35]

Average maximum and minimum temperatures of the Division are 24º to 27ºC in the summer and 5º to 7ºC in the winter. The daily range of temperature is the least during the period from June to October. The coldest months are December - January and the hottest are the months of April – June. Snowfall usually takes place from the month of December at higher altitudes in the North and North-West region of the area, above altitudes of 3,600m and occasionally till altitudes of 2,000m.

Rainfall[35]

The average annual rainfall in lower elevations is 250 cm to 375 cm and at the higher hills up to 2,744m is 375 cm to 575 cm. The rainfall decreases beyond the altitudes of about 3,000 m. Above 3,000 m, the average annual rainfall is somewhere between 125 cm to 150 cm.

Distribution of Area[35]

Large tracts of forestlands are also found in the higher elevations on top of the ridges and slopes. Sal, either pure or mixed with other dry species, extend in the valleys of Rangeet and Raman Rivers. The diversity of forestlands is due to the different climate zones found in the landscapes (Table 5).

Table 5: Climatic zonation in the West District of Sikkim.

Sub-Tropical Climate Zone	Below 1,524m
Wet Temperate Climate Zone	Between 1,524 and 3,963m
Alpine Climate Zone	Above 3,963m

For description purpose the forests can be divided mainly into a number of strata, according to the Champion and Seth classification[36] (Table 6).

Table 6: Forests classification in the West District.

S.No.	Forest Types	Altitudinal Range
1	Lower Hill Forest (3b), includes (1) Eastern Hills Sal Forests (3b/C2-D1a), (2) Dry Mixed Forests (3b/E6) and (3) Wet Mixed Forest(3b/2)	Between 305m and 1,067m
2	Middle Hill Forests	Between 1,067 m and 1,524 m
3	Upper Hill Forest/ East Himalayan Wet Temperate Forest (11B/C1)	Between 1,677 m and 2,744 m

[36] Champion, H.G. and Seth, S.K. (2005); A Revised Survey of the Forest Types of India; Natraj Publishers.

4	East Himalayan Mixed Conifer Forest (12/C-3a)	Above 2,744 m

East District/Forest Division

The East District/Forest Division lies in the south-east of Sikkim, between the coordinates 88º26'26" and 88º54'25" N, and 27º08'2.88" and 27º25'32.28" E and spread over an area of 954 sq. km. This includes 282.12 sq. km of territorial Reserved Forests, 132.01 sq. km of *Khasmal* forestlands and 25.33 sq. km of *Gorucharan* forestlands. In addition, the Fambong Lho Wildlife Sanctuary comprises of 54.72 sq. km, Kyongnosla Alpine Sanctuary comprises of 31.95 sq. km and Pangolakha Wildlife Sanctuary comprises of 127.33 sq. km[37].

The division is bound in the north by the Dikchu River, in the south by the Kalimpong Division of West Bengal, in the west by the Teesta River and in the east by the Chola Range sharing its boundaries with Bhutan and China.

Topography[37]

The District consists of a series of ridges and valleys, with an altitudinal variation of about 340 m (at Rangpo) to about 4,649 m (at Nathula). Flat lands are generally absent as mountains and ridges rise abruptly from the drainage channels. Teesta River and Rangpo Chhu are the main rivers which have number of seasonal and perennial tributaries.

Geology[37]

The geological formation of the landscape is predominantly that of Darjeeling gneiss and Daling Series. In higher elevations, the Daling series are present as mica schists. The Division is endowed with rich mineral resources, especially Copper ores. Besides zinc, lead and dolomite deposits are also reported in the division.

Soil[37]

The soil found in the District mostly brown clay (generally shallow and poor in nutrients) or dark grey (porous, rich and adaptable to most species), depending on source rocks. The soils support significant forestlands, including forests comprising of sal and associates. The soil formation of valleys is due to decomposition of the Daling rocks. In higher reaches of steep slopes where the soil is predominantly of the gneissic group, which holds good for growth of numerous species of commercial importance. The soil on the ridges is shallow and poor due to over-exposure caused by natural calamities and biotic interferences.

Temperature[37]

The temperature in the lower elevations (Rangpo, Singtam and Dikchu) begins to increase rapidly from the beginning of February and continues till the onset of the South Asian Monsoon in late May to June. The maximum temperature is usually recorded during May and June and the minimum during December and January. The mountain ranges of Nathula, Zelepla and Tamzey remains under snow cover from December till late May.

The mean maximum temperature of the District Headquarters (and the State capital), Gangtok, ranges from 18º to 20ºC and the mean minimum temperature ranges between 12ºC and 13ºC.

Rainfall[37]

[37] Working Plan for the Forest of East Forest Division, Sikkim.

Rainfall is heavy and well distributed during the months from May to September. Dikchu, Gangtok, Karponang, Rongli, Ganathang etc. are the maximum rainfall areas while the regions near Rangpo and Singtam get comparatively low rainfall. The intensity of rainfall may vary from drizzle to torrential rain. The mean rainfall in Gangtok generally varies between 300 mm to 400 mm.

Distribution of Area[37]

For description purposes, the forests of this Division can be divided into 6 broad forest types, according to the Champion and Seth classification[38] (Table 7).

Table 7: Forests classification in the East Sikkim District.

S. No.	Forest Types	Altitudinal Range
1	Lower Hill Tropical Semi-Evergreen Forests (3C/C1)	Between 300 m and 900 m
2	Middle Hill Sub-Tropical Mixed Broadleaf Forests (8B/C1)	Between 900 m and 1,800 m
3	Upper Hill Himalayan Wet Temperate Forests (11B/C1)	Between 1,800 m and 2,400 m
4	Sub-Alpine Forests	Between 2,400 m and 3,000 m
5	Moist Alpine Forests	Between 2,700 m and 3,700 m
6	Dry Alpine Forests	Between 3,700 m and 4,500 m

North Sikkim District/Division

The District lies in the northern part of Sikkim, between the coordinates 88º8'N to 88º53'N, and 27º25'E to 28º8'E. The jurisdiction is spread over a geographical area of 4,226 sq. km of Reserved Forests and 80.95 sq. km of *Khasmal* and *Gorucharan* forestlands. Further, the Khangchendzonga National Park (KNP) comprises of 1351.76 sq. km and the Shingba Rhododendron Wildlife Sanctuary comprises of 44.3 sq. km[39].

The District is bound in the south by Dikchu River and Rate Chu, in the south-west by the River Teesta and in the East by the Chola Ranges sharing its boundaries with Bhutan and China. The headquarters of the division is located at Mangan.

Topography[39]

The North District is a mountaineous landscape, and is covered with steep hills and deep valleys, ranging from a low of 538 m (at the confluence of the River Teesta with Dikchu) to about 5,980 m (at Tso-Lhamo). Flat land is generally absent due to the abrupt rise of mountains and ridges from valleys. River Teesta River and Rangpo Chhu are the main rivers which have number of seasonal and perennial tributaries.

Geology[39]

The predominant formation of the District is of the Daling Group, consisting of schists, quartzites, limestones and gneisses. The District also has abundant mineral resources. Copper deposits are found at Dikchu, marble at Chungthang and graphite at Chungthang and Lachen.

Soil[39]

[38] Champion, H.G. and Seth, S.K. (2005); A Revised Survey of the Forest Types of India; Natraj Publishers.
[39] Working Plan for the Forest of North Forest Division, Sikkim.

The soil found in the District is similar in character to the one found commonly in East Sikkim. The soil found in the District is mostly, depending on source rocks, brown clay (generally shallow and poor in nutrients) or dark grey (porous, rich and adaptable to most species). The soil formation of valleys is due to decomposition of the Daling rocks and supports Sal and associates. In higher reaches of steep slopes where the soil is predominantly of the gneissic group, which holds good for growth of numerous species of commercial importance. The soil on the ridges is shallow and poor due to over-exposure caused by natural calamities and biotic interference (grazing).

Temperature[39]

The temperature in the lower elevations increases from February and continues till July and August. The maximum temperature is usually recorded during July and August and the minimum during November to February. The mountain ranges remains under snow cover from December till late May.

Rainfall[39]

Rainfall mostly occurs between the months of March and October. Dikchu and Mangan are the maximum rainfall areas while the regions near Thangu, Lachen and Lachung receive low rainfall. Showers in December and February assist snowfall at altitudes higher than 3,500m. The permanent snowline in Sikkim is above 4,500 m and considerable tracts of North Sikkim are above this height.

Distribution of Area[39]

For description purposes, the forests of this Division can be divided into 9 broad forest types, according to the Champion and Seth classification[40] (Table 8).

Table 8: Forests classification in the North Sikkim District.

S.No.	Forest Types	Altitudinal Range
1	East Himalayan Sub-Tropical Wet Hill Forests (8B/C1)	Between 900 m and 1,700 m
2	Alder Forests (12/IS1)	Between 1,500 m and 2,000 m
3	East Himalayan Wet Temperate Forests (11B/C1)	Between 1,700 m and 2,800 m
4	Montane bamboo brakes (12/DS1)	Between 2,600 m and 3,100 m
5	East Himalayan moist temperate forest (12/C3)	Between 2,700 m and 3,100 m
6	East Himalayan Dry Temperate Coniferous Forests, Larch Forests, East Himalayan Sub-Alpine Forests (13/C6 and 14/C2)	Between 2,800 m and 3,700 m
7	Birch/Rhododendron scrub (15/C1)	Between 3,500 m and 4,500 m
8	Dwarf Rhododendron scrub, Dry Alpine scrub, Dwarf Juniper scrub (15/C2, 16/C1 and 16/E1)	Between 4,000 m and 5,500 m
9	Alpine pastures (15/C3)	Between 4,000 m and 5,500 m

The following maps showing the various political and physical aspects of the state of Sikkim have been included in **Annexure 2: Thematic Maps** for reference:

- Geological map of Sikkim
- Aspect map of Sikkim
- Soil map of Sikkim
- Map of the Wildlife Sanctuaries (WLS) and National Parks in Sikkim

[40] Champion, H.G. and Seth, S.K. (2005); A Revised Survey of the Forest Types of India; Natraj Publishers.

- Watershed map of Sikkim
- Drainage map of Sikkim

Socio-economic Profile of Sikkim

Population

With a population of 610,577 as per Census 2011, Sikkim is India's least populous State. The rural population constituting 75% of the total population is heavily dependent on forest and agricultural activities for livelihood generation. Administratively, Sikkim is divided into 4 districts - East District, West District, North District and the South District. The distribution of population across the Districts is shown *Table 9* below.

Table 9: Population in Sikkim[41]

District	Population	Male	Female	Rural	Urban
South	146,850	76,670	70,180	125,651	21,199
East	283,583	151,432	132,151	161,096	122,487
West	136,435	70,238	66,197	131,187	5,248
North	43,709	24,730	18,979	39,065	4,644
TOTAL	610577	323070	287507	456999	153578

Household size

As per Census 2011, the average rural household size in Sikkim is only 4.7 as compared to a national average of 4.9. Largest households are in the West District (4.9) followed by South District (4.8). The smallest ones are in the East and the North districts (4.6 each). *Table 10* documents the average rural household sizes in Sikkim.

Table 10: District-wise average rural household size in Sikkim[41]

District	Average Rural HH Size
North	4.6
East	4.6
South	4.8
West	4.9
Average	4.7
India Average	4.9

Social Classification

Sikkim is a multi-ethnic state. Broadly, the population can be divided into tribal and non-tribal groups. Population of the Scheduled Tribes Lepchas, Bhutias, and Sherpas exceeds 84% in the State. Lepchas are the original inhabitants of the State. The Bhutias comprise Sikkimese Bhutias and the Bhutias from Bhutan as well as Tibet. The Sherpas are a marginal ethnic group in the State. Over 70% of the population is of Nepalese origin and is a dominant ethnic group in the State.

[41] Sikkim Census, 2011.

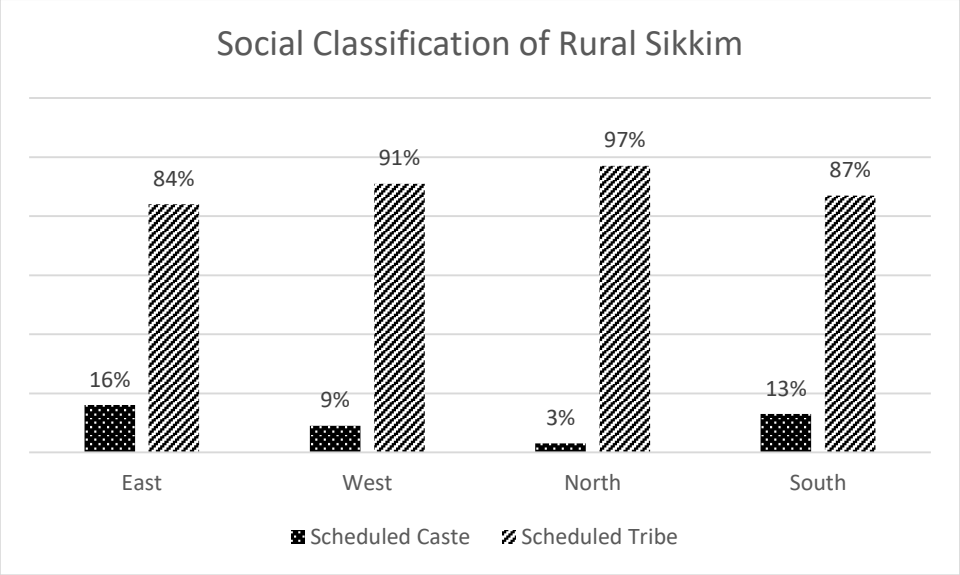


Figure 4: Social classification of the rural population across all the 4 districts in Sikkim

Livestock Holding

Figure 5 shows the district-wise livestock distribution as of 2012. Until the mid-1990s, the increasing demand for dairy products from an expanding local population had resulted in increased pressure on forests for grazing and fodder. As a result, Reserve Forests, especially in the temperate regions of the State, were gradually getting degraded and fragmented. Concerned with the threat to the ecosystem balance, the Government of Sikkim, in 1998, banned grazing in all Reserve Forests, water source areas and plantation areas. The highland pasture lands are now protected areas and are not available for grazing by sheep, hence the decline in their population (47% decline between 1997 and 2007). This major policy decision has resulted restoration of the degraded forest patches as forest grazing has declined. This action affected the average livestock holding amongst general households in Sikkim (Table 11). However, in recent years, people are now seeing rising trends in cattle holding because of the demand from dairies.

Table 11: Livestock population in Sikkim (1997 and 2007)[42]

Livestock	1997 Livestock Census	2007 Livestock Census	Change (%)
Cattle	143,024	140,690	-2
Buffalo	1,970	892	-55
Yak	4,781	6,220	+30
Sheep	5,023	2,684	-47
Goat	82,938	110,870	+34

[42] Livestock Census, 1997 and 2007; www.sikkim.ahvs.gov.in

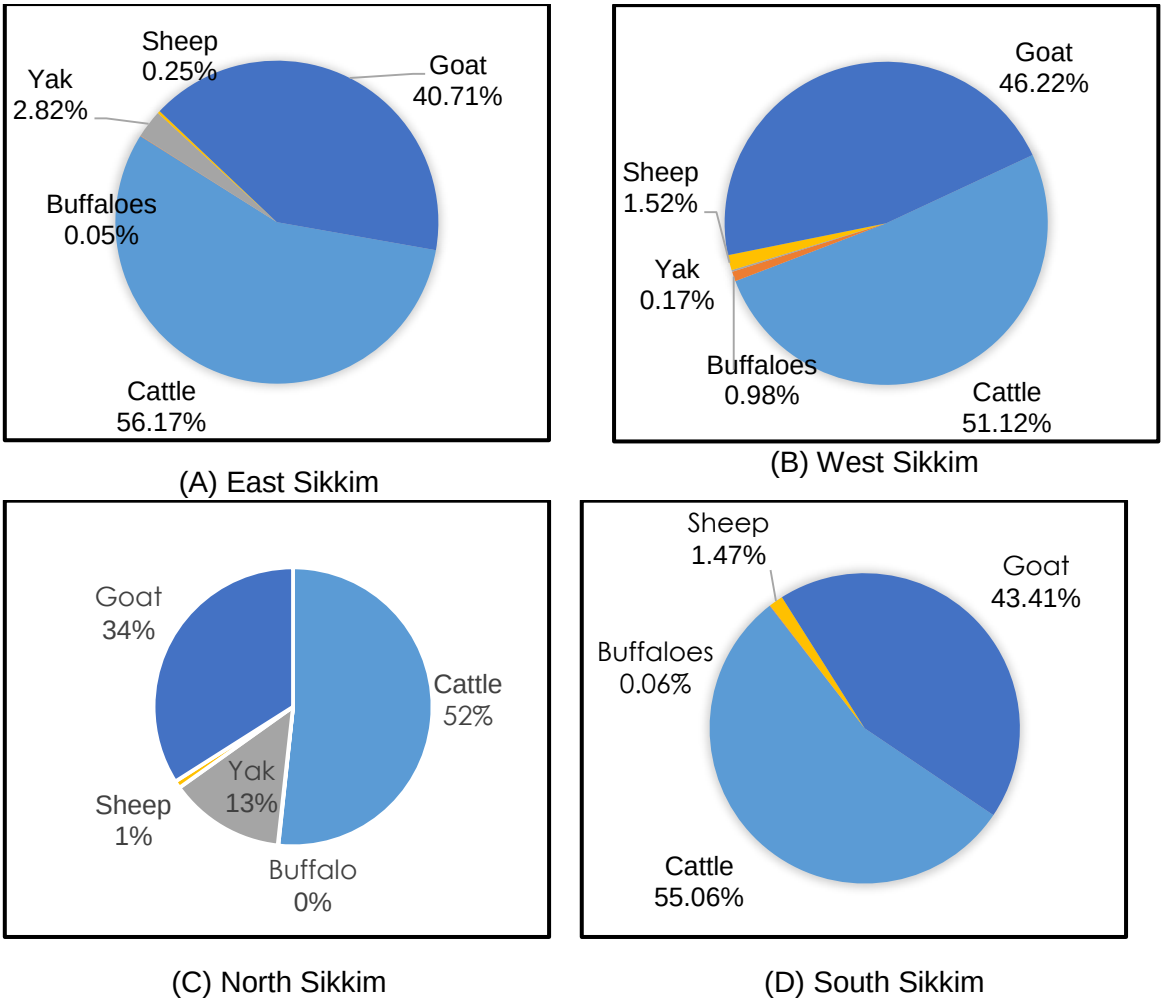


Figure 5: Livestock Holding Pattern (A) East, (B) West, (C) North, (D) South Districts[42]

Land Use

Land use involves the management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods. It also has been defined as "the total of arrangements, activities, and inputs that people undertake in a certain land cover type."[43] Land use classification, in line with the IPCC requirements, based on spatial mapping has been done for 2013. Table 12 gives the LULC classification in the state as has emerged from the spatial mapping performed. Six major LULC classes has been identified namely Forest Land, Crop Land, Grassland, Wetlands, Settlements, and Other Lands. This classification has also been verified by the Government of Sikkim. As per the geospatial analysis, Forest Land is the largest LULC class by area in Sikkim. The least area under forests is in the in North district (29.62% of land area) and the maximum area in the East district (69.40% of land area).

Table 12: Land use classification in 2013 based on spatial mapping

Land use type	North (ha)	West (ha)	South (ha)	East (ha)
Forest	125,188.10 (29.62%)	71,348.78 (61.19%)	51,230.46 (68.31%)	66,206.48 (69.40%)
Cropland	1,165.89 (0.28%)	11,758.67 (10.08%)	12,328.53 (16.44%)	8,272.29 (8.67%)

[43] IPCC Special Report on Land Use, Land-Use Change And Forestry, 2.2.1.1 Land Use

Land use type	North (ha)	West (ha)	South (ha)	East (ha)
Waterbodies	1,124.21 (0.27%)	105.25 (0.09%)	107.26 (0.14%)	11.52 (0.01%)
Grassland	29,241.44 (6.92%)	11,434.55 (9.81%)	5,049.83 (6.73%)	8,600.41 (9.02%)
Otherland	265,820.90 (62.90%)	21,928.56 (18.81%)	5,999.47 (8.00%)	11,828.22 (12.40%)
Settlements	59.48 (0.01%)	24.20 (0.02%)	284.44 (0.38%)	481.26 (0.50%)
TOTAL	**422,600.03**	**116,600.00**	**75,000.00**	**95,400.18**

Note: The figures in the brackets indicate the percentage of the land category of the total in each district, respectively.

For the most part, it is difficult to come across vast areas of flat land in Sikkim. Although Sikkim is mostly an agrarian economy (more than 64% of its population depends directly or indirectly on agricultural activities), the rocky and precipitous slopes make agriculture difficult. Agricultural land in the state is in excess of 109,000 ha, or more than 15% of the State's geographical area[44].

Flora and Fauna:

Sikkim is a part of the Eastern Himalayas, which is a global biodiversity hotspot. The state contains within itself diverse forest types and a range of ecosystems, with immense biodiversity value: it has nearly half of the nation's bird diversity, wild trees, orchid and Rhododendron wealth and a third of the country's flowering plants. 165 plants have been named after Sikkim[45]. There are more than 40 mammal species and 31 bird species which have been classified as rare and endangered in Sikkim[46]. Some high value conservation plant species are found in Sikkim, notably *Swertia chirayta*, a high-value medicinal herb[47].

Of the approximately 1,200 orchid species found in India, 527 are found in Sikkim alone, thus making it one of the richest hotspots for orchid diversity in the Himalayas. The state is also home to 4,458 of the 15,000 flowering plants found in India, and 40% of India's pteridophytes[48]. Some common medicinal plant species of Sikkim are given in Table 13.

Table 13: Common medicinal plant species found in Sikkim.

Scientific Name	Local Name
Nardostachys grandiflora	Jatamasi
Eranthis hyemalis (winter aconites)	Monkshood/Bikhma
Artemisia vulgaris	Titeypaty
Piper longum	Pipla
Picrorhiza kurrooa	Kutki

The State boasts over 700 medicinal plant species, and is home to 38 of the 90 rhododendron species found in the country. Sikkim's diverse fauna includes about 125 species of mammals, about 574 species of birds and about 689 species of butterflies, in addition to many reptiles, amphibians, and insects (Table 14).

[44] *icarzcu3.gov.in/ne/sikkim.htm* (Accessed 29th July, 2017)
[45] Arrawatia, M.L. and Tambe, S. (2011); Biodiversity of Sikkim: Exploring and Conserving a Global Hotspot; Government of Sikkim.
[46] sikenvis.nic.in/writereaddata/sd71.pdf (Accessed 29th July, 2017)
[47] Pradhan, B.K. and Badola, H.K. (2015); *Swertia chirayta*, a Threatened High-Value Medicinal Herb: Microhabitats and Conservation Challenges in Sikkim Himalaya, India; Mountain Research and Development 35(4):374-381.
[48] Sikkim Human Development Report 2014.

Table 14: The biodiversity of Sikkim.

Taxa	Number of species
Flowering plants	4458
Orchids	527
Rhododendrons	38
Conifers	16
Bamboos	11
Ferns and allies	480
Medicinal plants	700
Mammals	125
Birds	574
Reptiles	88
Amphibians	50
Butterflies	689
Fish	48

Some of the *Red Data Book (maintained by IUCN)* mammal species found in Sikkim are red panda (the official State Animal), snow leopard, clouded leopard, musk deer, Tibetan wolf, red fox, Indian wild dog, Tibetan sheep or argali, Tibetan gazelle and Tibetan wild ass (Table 15)[49].

Table 15: Endangered fauna in Sikkim

Fauna	No. of species/sub-species found	Endangered species
Mammals	125	Clouded Leopard, Himalayan Thar, Great Tibetan Sheep, Snow Leopard, Spotted Lingsang, Tibetan Antelope, Tibetan Fox
Birds	574	Black-necked Crane, Blood Pheasant, Tragopan Pheasant, Siberian Crane
Butterflies	689	NA

The diverse landscape and topography of Sikkim leads it to exhibit unusually diverse climatic conditions. A range of ecological conditions can be found in the State, from tropical moist forests to alpine meadows, making it the only biogeographic zone of its kind in India. A variety of microclimates can be found within the mountainous terrains of the state, which support various biophysical and climatic scenarios.

[49] Sikkim: A Statistical Journal (2013).

4. Forest Reference Emissions Levels

4.1 Introduction

According to the UNFCCC, a national forest reference emission level and/or forest reference level or, as an interim measure, subnational forest reference emission levels and/or forest reference levels, is one of the elements to be developed by developing country Parties implementing REDD+ activities (according to paragraph 71 of decision 1/CP.16). The Conference of Parties (COP) recognized the importance and necessity of adequate and predictable financial and technology support for developing such reference levels.

Reference levels are expressed as tonnes of CO_2 equivalent per year for a reference period against which the emissions and removals from a results period will be compared. Thus, reference levels serve as benchmarks for assessing each country's performance in implementing REDD+ activities. Reference levels need to maintain consistency with the country's greenhouse gas inventory estimates.[50]

4.2 LULC Changes over the Historical Reference Period

Detailed RS/GIS analysis and field work was undertaken to identify and classify the changes in land-use patterns in the jurisdiction over the selected historical reference period. Analysis on remote sensing platforms, backed up by field data validation, has been undertaken to accurately classify the LULC types in the State. This has enabled the development of maps for various aspects of analysis – LULC maps, forest strata maps and fractional cover maps, to map the deforestation and forest degradation over the historical reference period.

Methodology

The project area is the jurisdictional boundary of the State of Sikkim. Spatial analysis has been conducted along with corresponding field validation to successfully classify the different forest strata in Sikkim. Satellite imagery of the years 2002, 2009 and 2013 has been analysed to interpret changes in forest cover over time in the 12 years reference time period. An LULC analysis has been conducted and it is observed that the certain vulnerable patches of forestlands in Sikkim will get deforested and/or degraded in a mosaic manner in the absence of the interventions proposed as part of the project activity. LISS-III images for the year 2013 have been used to represent the latest satellite imagery of the region. Similarly, satellite imagery of the year 2009 to represent imagery 4-9 years before the project start date and finally another satellite dataset of the year 2002 have been used for a historical reference period to represent the oldest imagery. Hence, accurate data on past LULC and Forest Cover in Sikkim is available and has been used in the analysis for three points in time.

The selection of data sources is according to Chapter 3A.2.4 of the IPCC GPG LULUCF. The multispectral satellite data of LISS-III has been used for baseline analysis. The satellite data required was obtained from Department of Science and Technology, Sikkim and National Remote Sensing Centre (NRSC)/Indian Space Research Organization (ISRO). Ancillary data on past LULC and forest cover in Sikkim was made available to guide the classification and validation process. The temporal resolution of satellite images for the three points are:

- 0-3 years before the project start date: 2013.
- 4-9 years before the project start date: 2008.
- 10-15 years before the project start date: 2002.

[50] REDD+ Web Platform (http://redd.unfccc.int/fact-sheets/forest-reference-emission-levels.html)

Table 16: Characteristics of the satellite imagery used

Data Source	Main Use of Data	Information about data collected		
Medium resolution of 23.5 m remote sensing data of at least one image for 3-time periods				
Time Frame	Historical analysis of deforestation and forest degradation	0-3 years before project start date	4-9 years before project start date	10-15 years before project start date.
Year of Satellite Imagery		2013 (LISS-III)	2009 (LISS-III)	2002 (LISS-III)
Source		Received from the Department of Science and Technology, Sikkim National Remote Sensing Agency (NRSA), Department of Space, Government of India, Balanagar, Hyderabad – 500037 Telangana, India.		
Type and Resolution (spatial and spectral)		Satellite imagery using visible (Green, Red) and near-infrared bands (NIR, SWIR). LISS-III multi-spectral data with a spatial resolution of 23.5m, operating in the visible, near infra-red bands and 70.5m resolution in the shortwave infra-red band.		
Coordinate system and pre-processing **(If different sources of remote sensing data are used, a formal comparison of the sensors should be added to the monitoring report to ensure consistency)**		WGS 84 – UTM zone 45N Layer Extent: 599872.62 690630.18 3113204.24 2995881.73 IRS ID LISS-III multi-spectral sensor with a spatial resolution of 23.5m, operating in the visible, near infra-red bands and 70.5m resolution in the shortwave infra-red band, with a swath of 141 Km. Resourcesat-1 LISS-III multi-spectral sensor with a spatial resolution of 23.5m, operating in the visible, near infra-red bands and shortwave infra-red band, with a swath of 141 Km.		
Minimum Mapping Unit (ha)	Training of classification procedures Independent verification of the analysis of historical images	≥1 hectare		
Description of method used to produce these data		The LULC maps for historical baseline are classified using supervised approach with Maximum Likelihood Classifier (MLC).		
Descriptions of the LULC classes and/or LULC-change categories		The LULC classes or categories described are as follows: **Moist Mixed Deciduous Forest** **Wet Temperate Forest** **Sub-Tropical Wet Hill Forest** **Conifer Forest** **Sub-Alpine Forest** **Cropland**		

		Waterbodies **Grassland** **Otherland** **Settlements**

The Accuracy Assessment of LULC and forest cover maps reveals an overall accuracy of 93%. A detailed Accuracy Assessment and Confusion Matrix is presented as

Annexure 1: Accuracy Assessment of LULC Classification of this PDD.

Ancillary Data

Ancillary data such as ground-truth information, working plans, forest circle and range boundaries maps, administrative boundary maps, slope maps, elevation maps, agro-ecological zonation maps, etc. have been used.

Pre-processing of remote sensing data

Pre-processing includes radiometric and geometric correction and handling image data loss due to cloud cover. Geometric correction ensures that images in a time series overlay properly to each other and to other GIS maps used in the analysis (i.e. for post-classification stratification). The average location error between two images (RMSE) must be less than or equal to one pixel.

A Forest Benchmark map was generated to show forest cover status in the project area. The final LULC map in the historic series was used as the forest benchmark map, however missing values within the project area due to clouds and cloud shadow was filled with remotely sensed data acquired within three years before the start of the crediting period to be eligible.

Calculation of GHG benefits in the project area after the project start will include only cloud-free imagery. When clouds and cloud shadows are present, calculation of the GHG benefits from these areas will be postponed until cloud-free remote sensing data is available in a subsequent monitoring period. These temporarily halted NERs may be added to the NERs generated in the subsequent monitoring period. This is only allowed on areas for which the forest status was unambiguously demonstrated at the beginning of the crediting period.

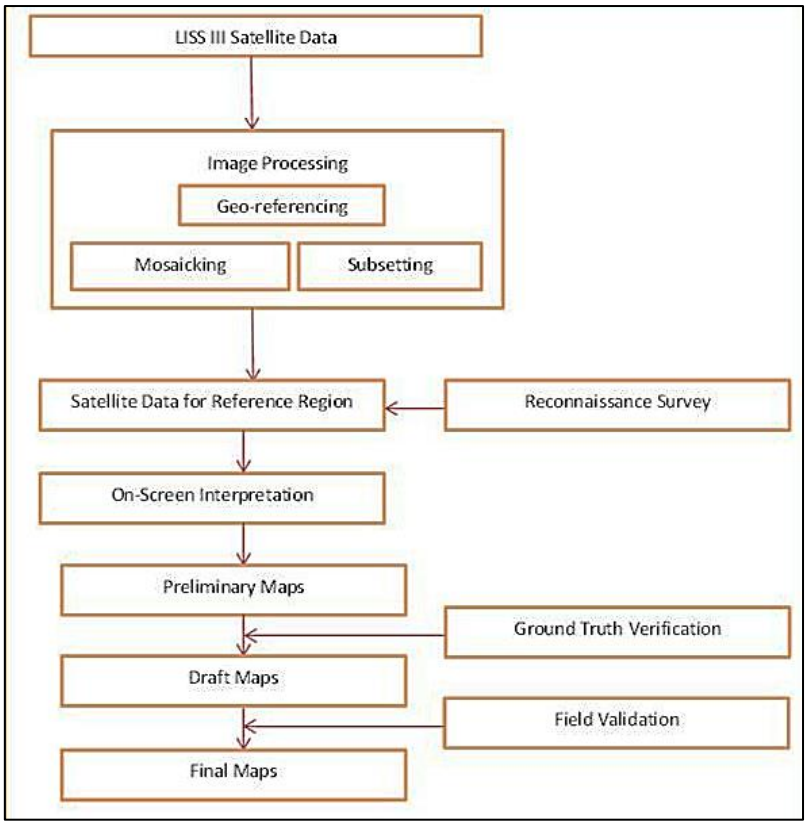


Figure 6: Detailed methodology for analysis of satellite imagery

The satellite imagery was subjected to radiometric and geometric corrections to get a clear image in real world coordinates. The images and layers are maintained in a common system, which are as follows:

Projection Type	UTM
Spheroid Name	WGS 84
Datum Name	WGS 84

Reconnaissance survey was conducted to acquaint with the general patterns of vegetation of the area, main vegetation types and variation and tonal patterns which were observed on existing imageries and maps. The landscape was traversed along roads, major drainages and hilltops for collecting ground truth information. Global Positioning System (GPS) readings were taken representing various land-use classes and forest types. In addition, existing literature like Working Plans and Annual Reports were consulted.

Classification of land cover using remotely sensed data was done by digital classification algorithms, which allows for automated grouping of spectrally similar pixels in order to classify different features of the landscape.

Definition of LULC Classes and Forest Strata

The six IPCC LULC classes, namely Forest Land, Crop Land, Grassland, Wetlands, Settlements, and Other, were distinguished in cognisance to the IPCC's Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003 (IPCC GPG-LULCF 2003).

To achieve the goal of defining classes that are homogeneous in carbon stock density, the forest LULC class was further sub-divided into forest strata. The preliminary LULC Classes along with Forest Strata and their areas for the 3 time periods are as follows:

Table 17: Classification of land and forests in Sikkim over the reference period

LULC Classification	Canopy cover	Area (ha)			
LULC	**(%)**	**Name of strata**	**2002**	**2009**	**2013**
Moist Mixed Deciduous Forest	10-30	MMD 10-30	4806	5169	5154
Moist Mixed Deciduous Forest	30-50	MMD 30-50	7659	8331	8481
Moist Mixed Deciduous Forest	50-70	MMD 50-70	9521	8947	8226
Moist Mixed Deciduous Forest	Above 70	MMD Above 70	5434	4883	4647
Wet Temperate Forest	10-30	WTF 10-30	17637	19761	20688
Wet Temperate Forest	30-50	WTF 30-50	36418	31109	27320
Wet Temperate Forest	50-70	WTF 50-70	41561	41630	42356
Wet Temperate Forest	Above 70	WTF Above 70	52892	55511	57110
Sub-tropical Wet Hill Forest	10-30	SWH 10-30	6551	6115	6159
Sub-tropical Wet Hill Forest	30-50	SWH 30-50	11641	12331	11997
Sub-tropical Wet Hill Forest	50-70	SWH 50-70	19368	18081	17868
Sub-tropical Wet Hill Forest	Above 70	SWH Above 70	28335	29226	29321

Coniferous Forest	10-30	CF 10-30	2612	3058	3111
Coniferous Forest	30-50	CF 30-50	7925	6724	6363
Coniferous Forest	50-70	CF 50-70	6228	6299	6430
Coniferous Forest	Above 70	CF Above 70	3508	3923	3820
Sub-Alpine Forest	10-30	SAF 10-30	17322	16300	14891
Sub-Alpine Forest	30-50	SAF 30-50	36444	33909	33234
Sub-Alpine Forest	50-70	SAF 50-70	22541	27247	28751
Sub-Alpine Forest	Above 70	SAF Above 70	3786	4427	4860
Cropland		CROPLAND	16653	20450	23354
Waterbodies		WATERBODIES	529	793	891
Grassland		GRASSLAND	54463	50955	50888
Otherland		OTHERLAND	295528	293999	293175
Settlement		SETTLEMENT	238	422	505
Total			**709600**	**709600**	**709600**

The forest type and LULC of Sikkim is provided in the above table. There are mainly 5 forest types that have been identified, with reference to the Champion and Seth 1968[51] Classification. The five other LULC types: Otherlands, Croplands, Waterbodies, Settlements and Grasslands, have also been detailed in the map, according to the IPCC. Forest type maps for previous years in the reference period have also been included to account for relevant changes.

Other relevant maps that have been produced during classification has been provided in Annexure II to this PDD. Within each of the 4 Forest Divisions in Sikkim, various Forest Ranges are spread out which are responsible for administering forestry activities at the local levels. Ecological data collection was performed in selected Ranges of the State to estimate the biomass in the selected Carbon Pools, through the laying of sample plots of 0.1 Ha. These sample plots have been mapped and depicted in Figure 8.

[51] Champion, S. H., & Seth, S. K. (1968). A revised survey of the forest types of India. *A revised survey of the forest types of India.*

4.3 Thematic Maps

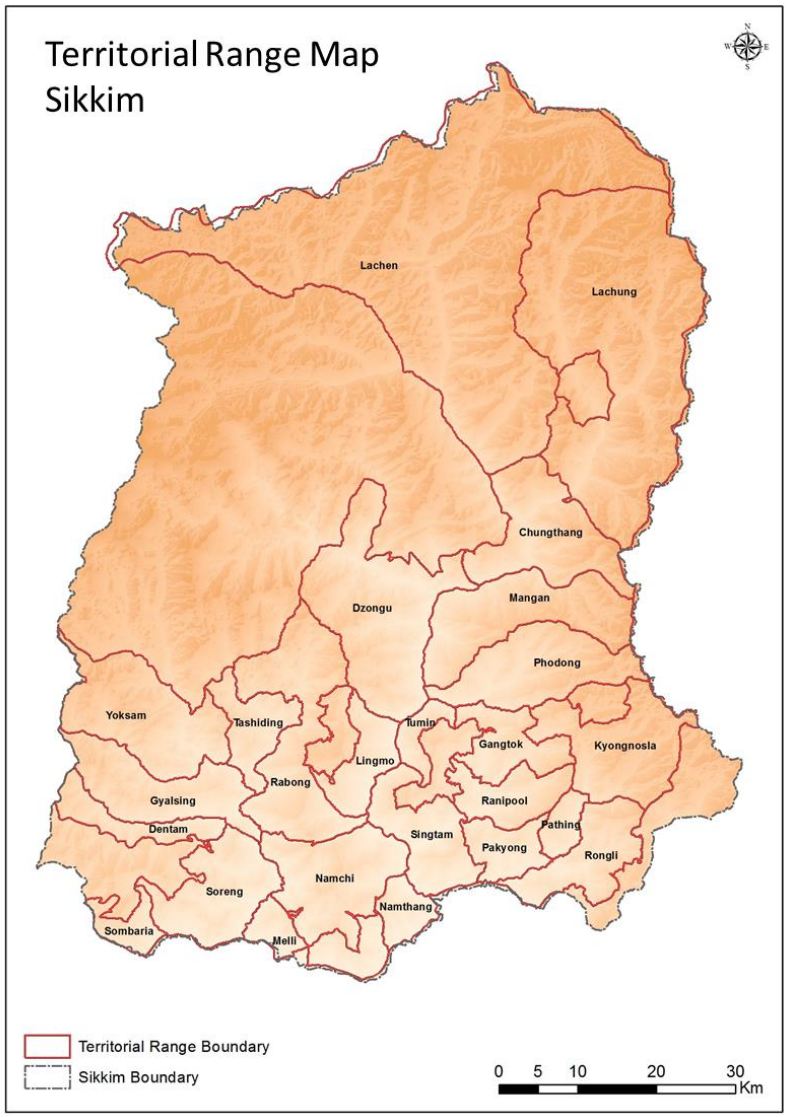


Figure 7: Map of all Forest Ranges in Sikkim

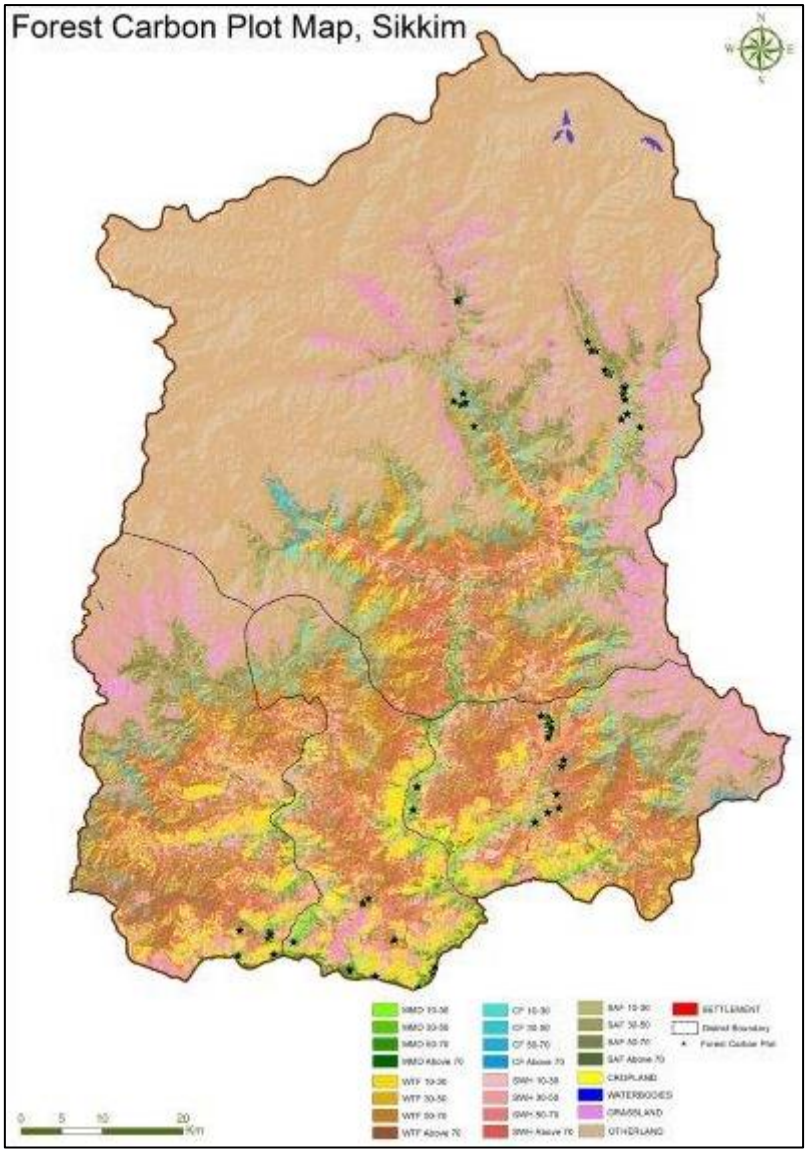


Figure 8: Location of the sample plots laid (star-marked), overlaid on the canopy density classification, for carbon stock assessment in Sikkim.

Classification Code	Forest Type
MMD	Mixed Moist Deciduous
WTF	Wet Temperate Forest
SWH	Sub-tropical Wet Hill
CF	Coniferous Forest
SAF	Sub Alpine Forest

From the ecological data collection from these sample plots, and fractional cover analysis, Forest Strata and Canopy Density Maps have been developed for 3 time points in the reference period, i.e. 2013, 2009 and 2002.

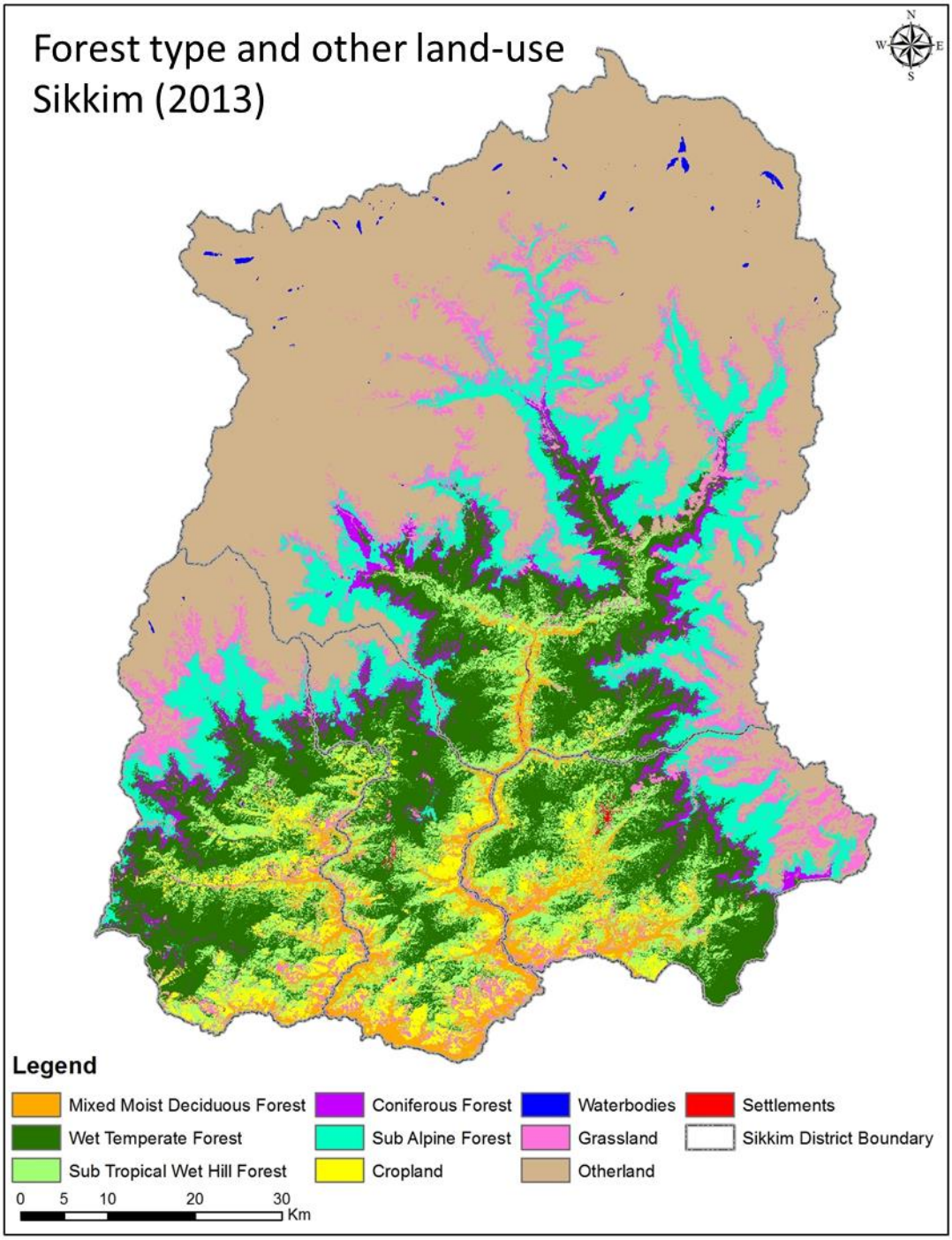


Figure 9: Forest type and other land use map for 2013

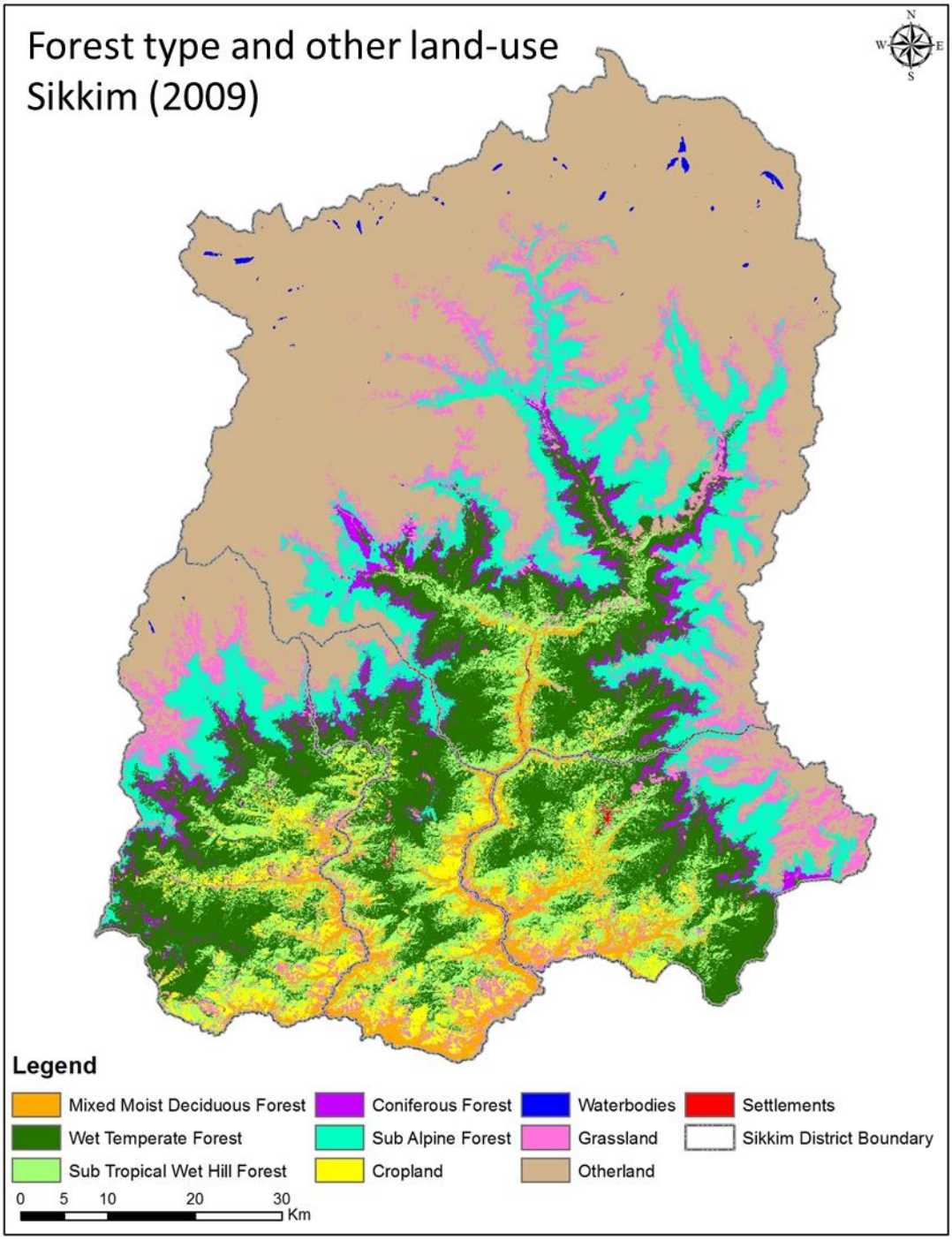


Figure 10: Forest type and other land use map for 2009

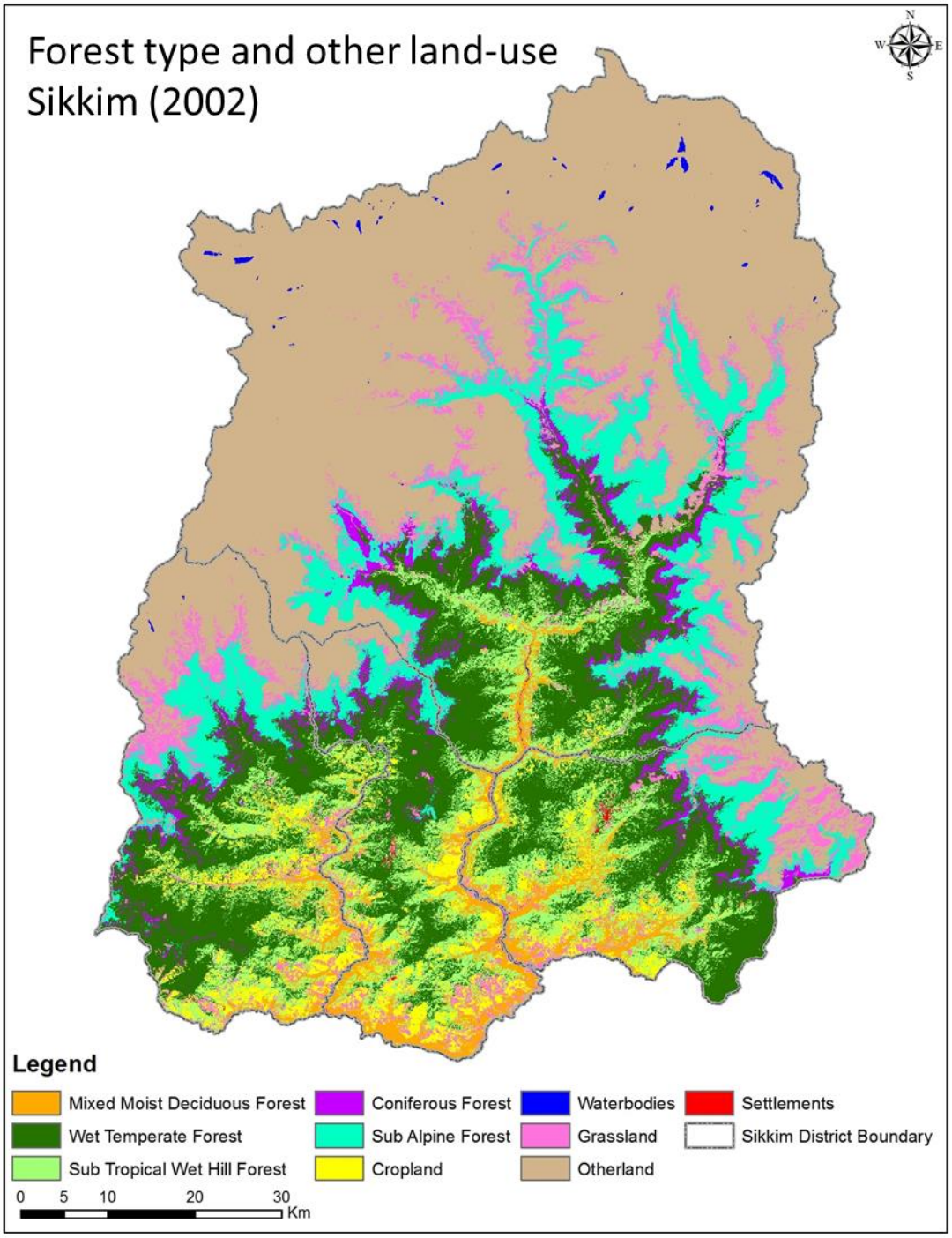


Figure 11: Forest type and other land use map for 2002

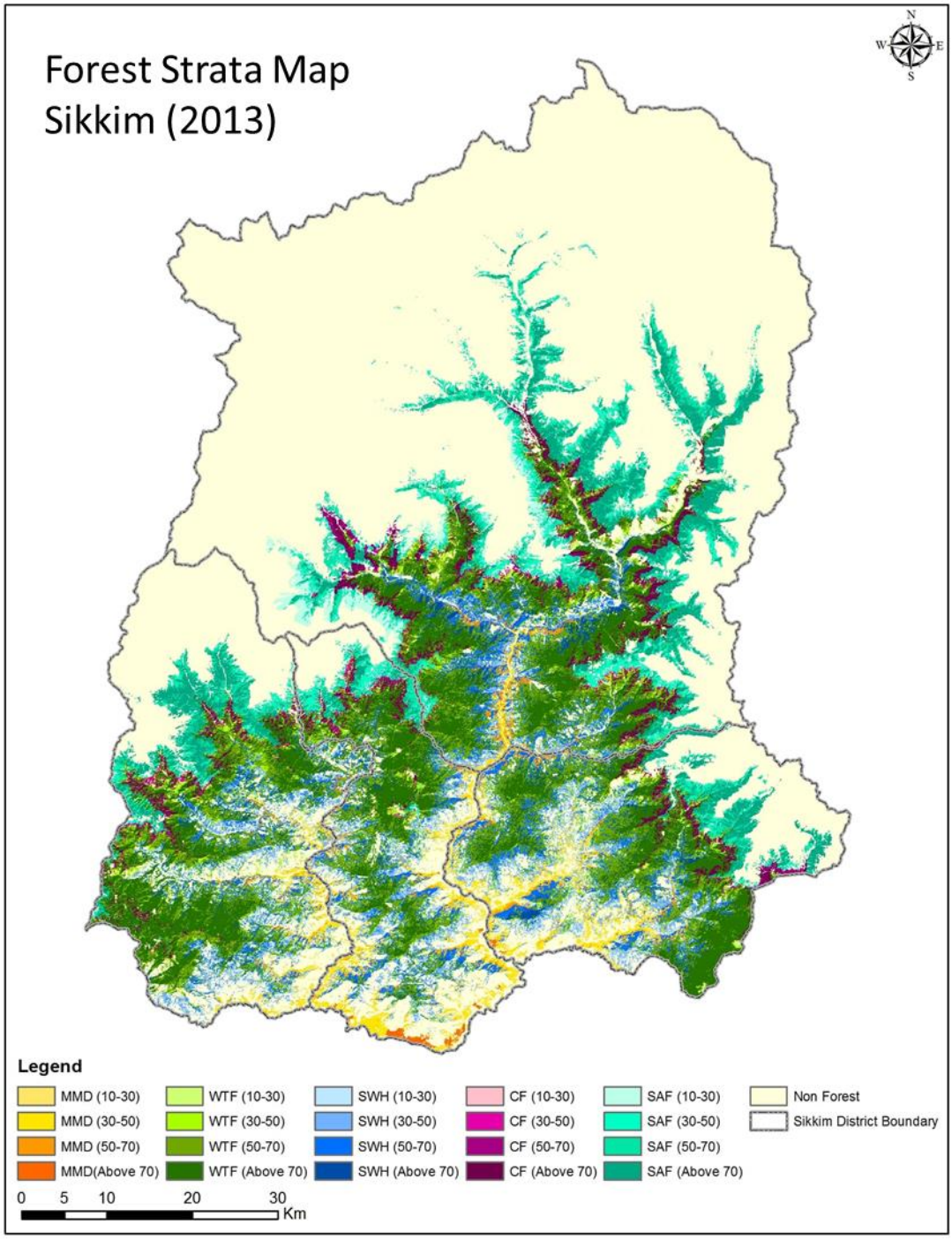


Figure 12: Forest Strata map for 2013

Classification Code	Forest Type
MMD	Mixed Moist Deciduous
WTF	Wet Temperate Forest
SWH	Sub-tropical Wet Hill
CF	Coniferous Forest
SAF	Sub Alpine Forest

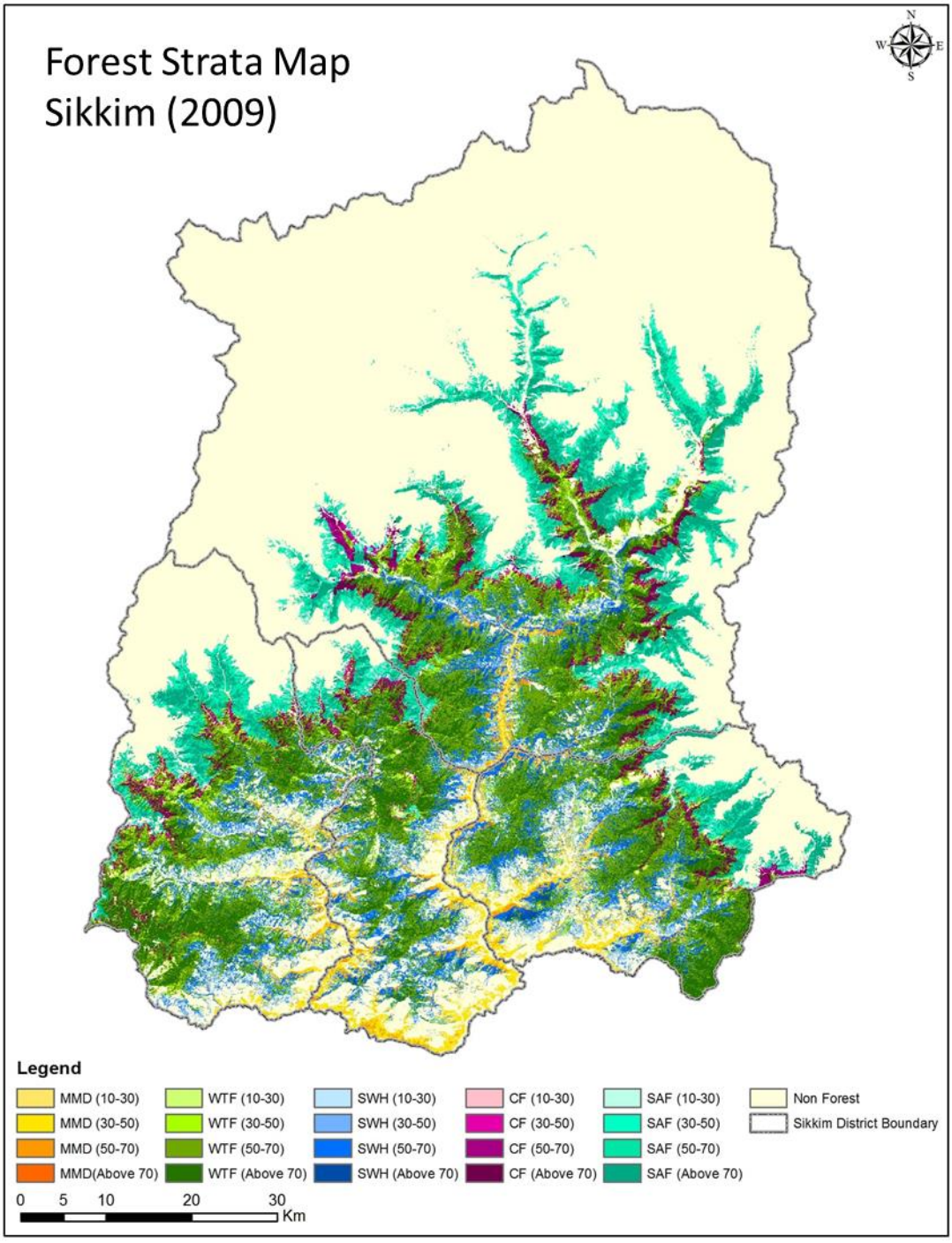


Figure 13: Forest Strata map for 2009

Classification Code	Forest Type
MMD	Mixed Moist Deciduous
WTF	Wet Temperate Forest
SWH	Sub-tropical Wet Hill
CF	Coniferous Forest
SAF	Sub Alpine Forest

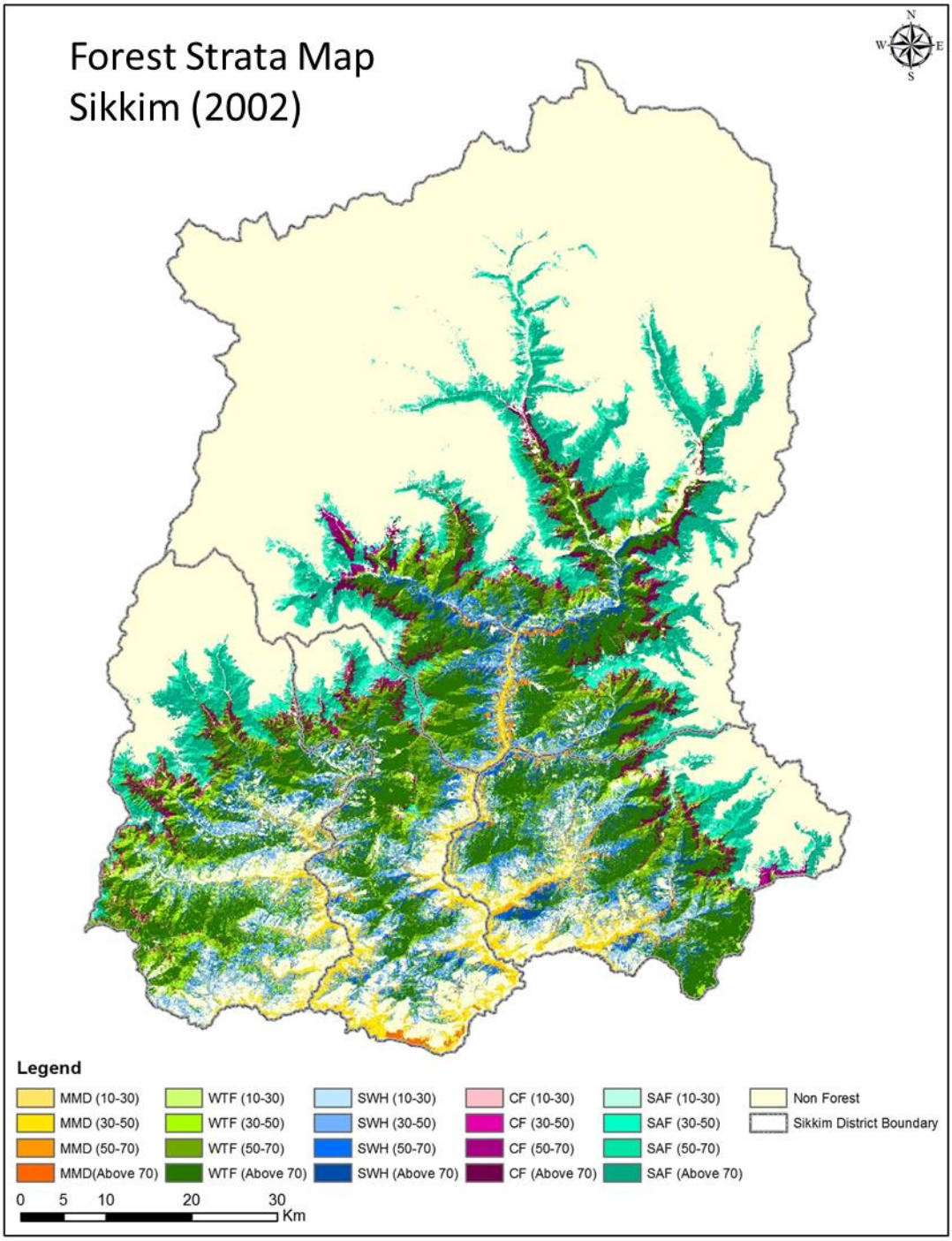


Figure 14: Forest Strata map for 2002

Classification Code	Forest Type
MMD	Mixed Moist Deciduous
WTF	Wet Temperate Forest
SWH	Sub-tropical Wet Hill
CF	Coniferous Forest
SAF	Sub Alpine Forest

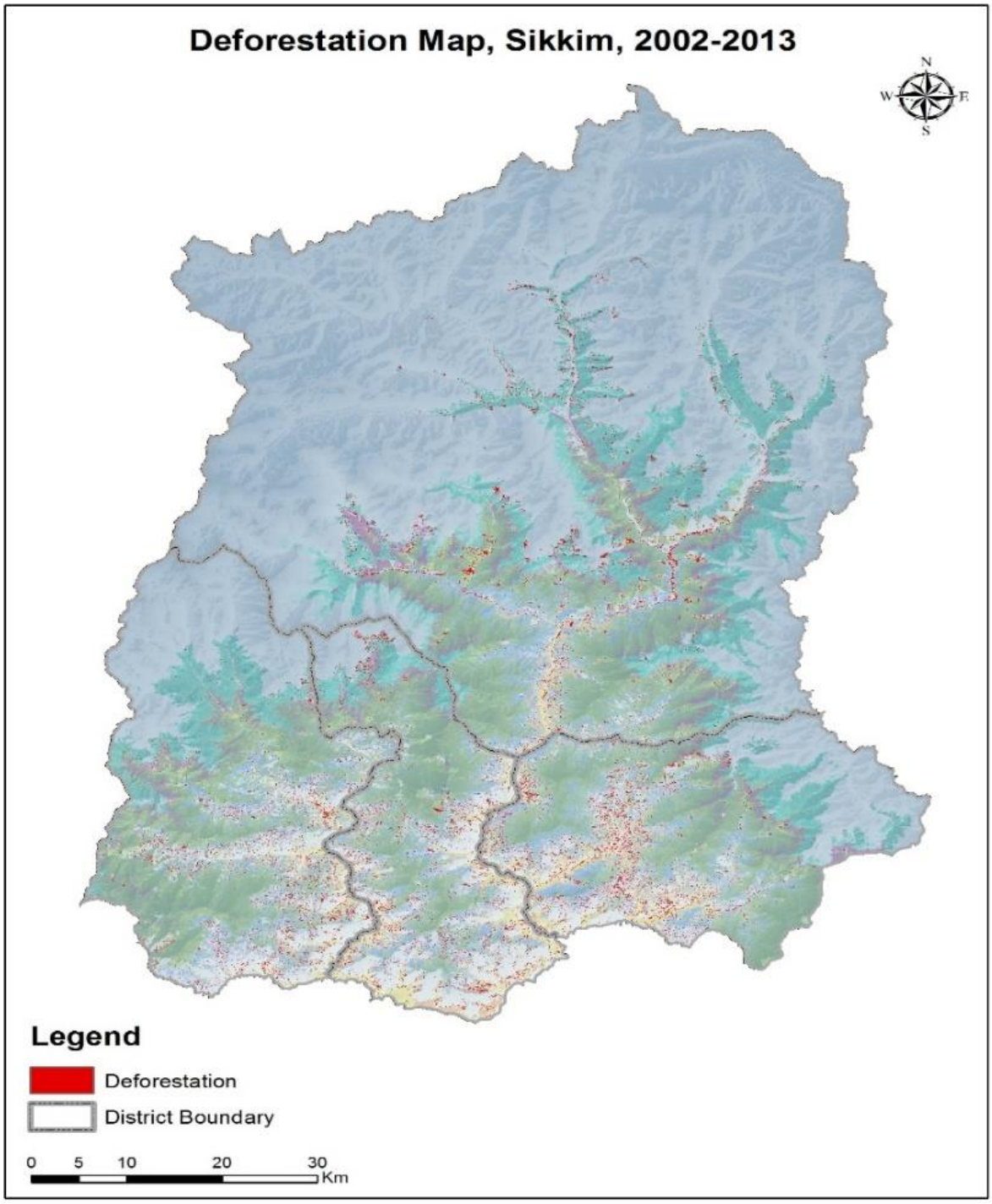


Figure 15: Deforestation in Sikkim (2002-2013)

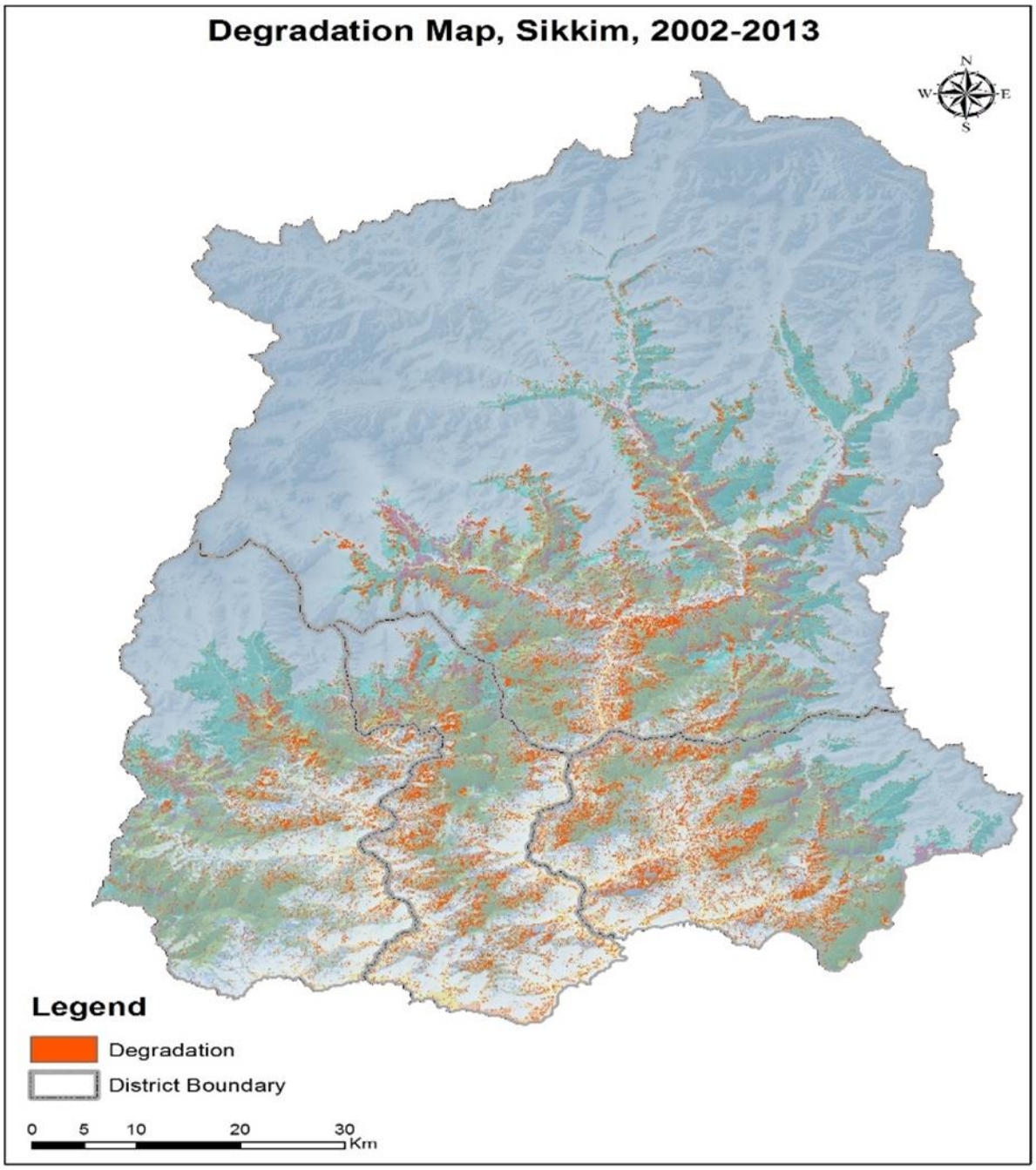
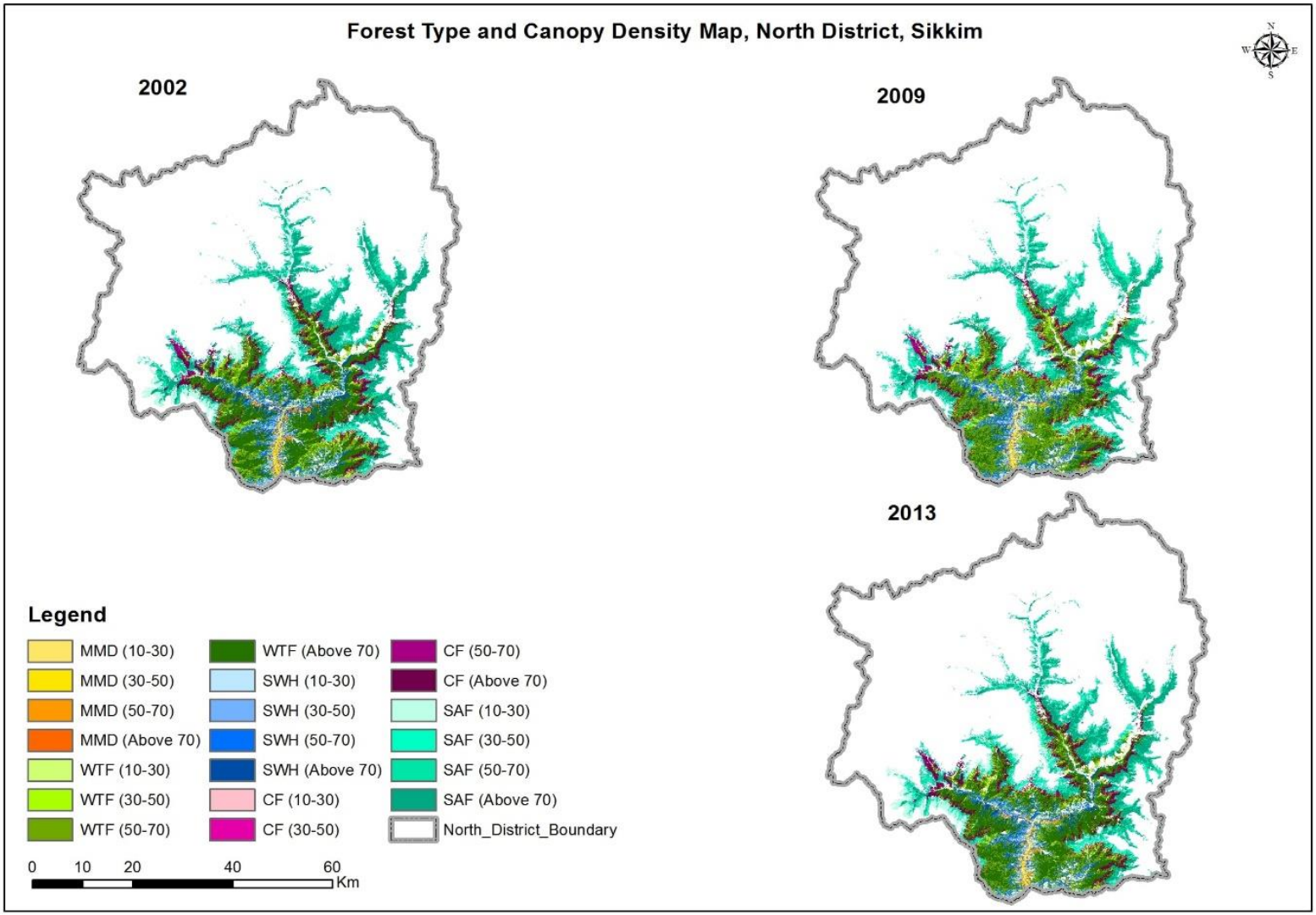
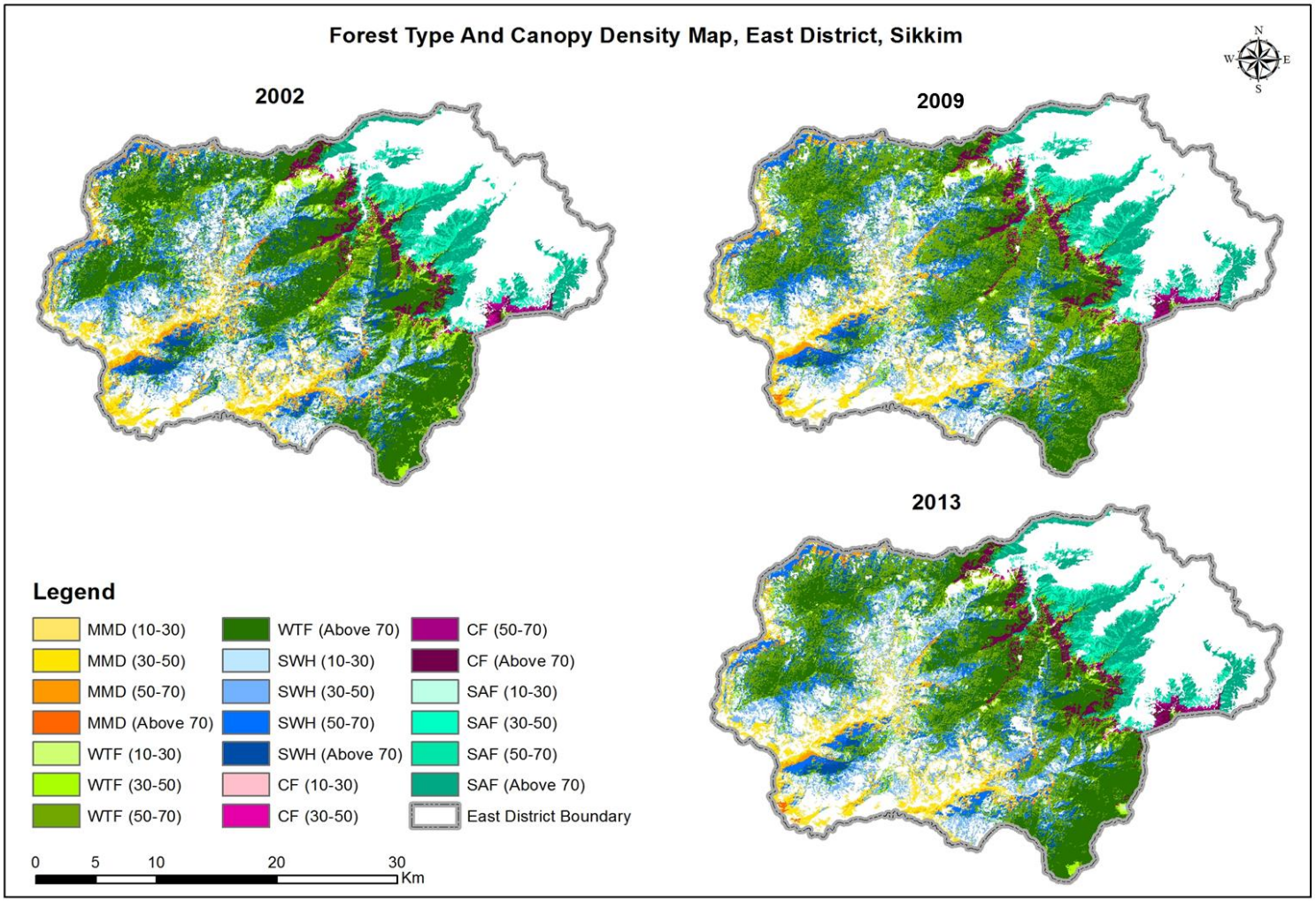


Figure 16: Forest Degradation in Sikkim (2002-2013)



Classification Code	Forest Type
MMD	Mixed Moist Deciduous
WTF	Wet Temperate Forest
SWH	Sub-tropical Wet Hill
CF	Coniferous Forest
SAF	Sub Alpine Forest

Figure 17: Changes in Forest Type and Canopy Density (2002-13), North Sikkim



Classification Code	Forest Type
MMD	Mixed Moist Deciduous
WTF	Wet Temperate Forest
SWH	Sub-tropical Wet Hill
CF	Coniferous Forest
SAF	Sub Alpine Forest

Figure 18: Changes in Forest Type and Canopy Density (2002-13), East Sikkim

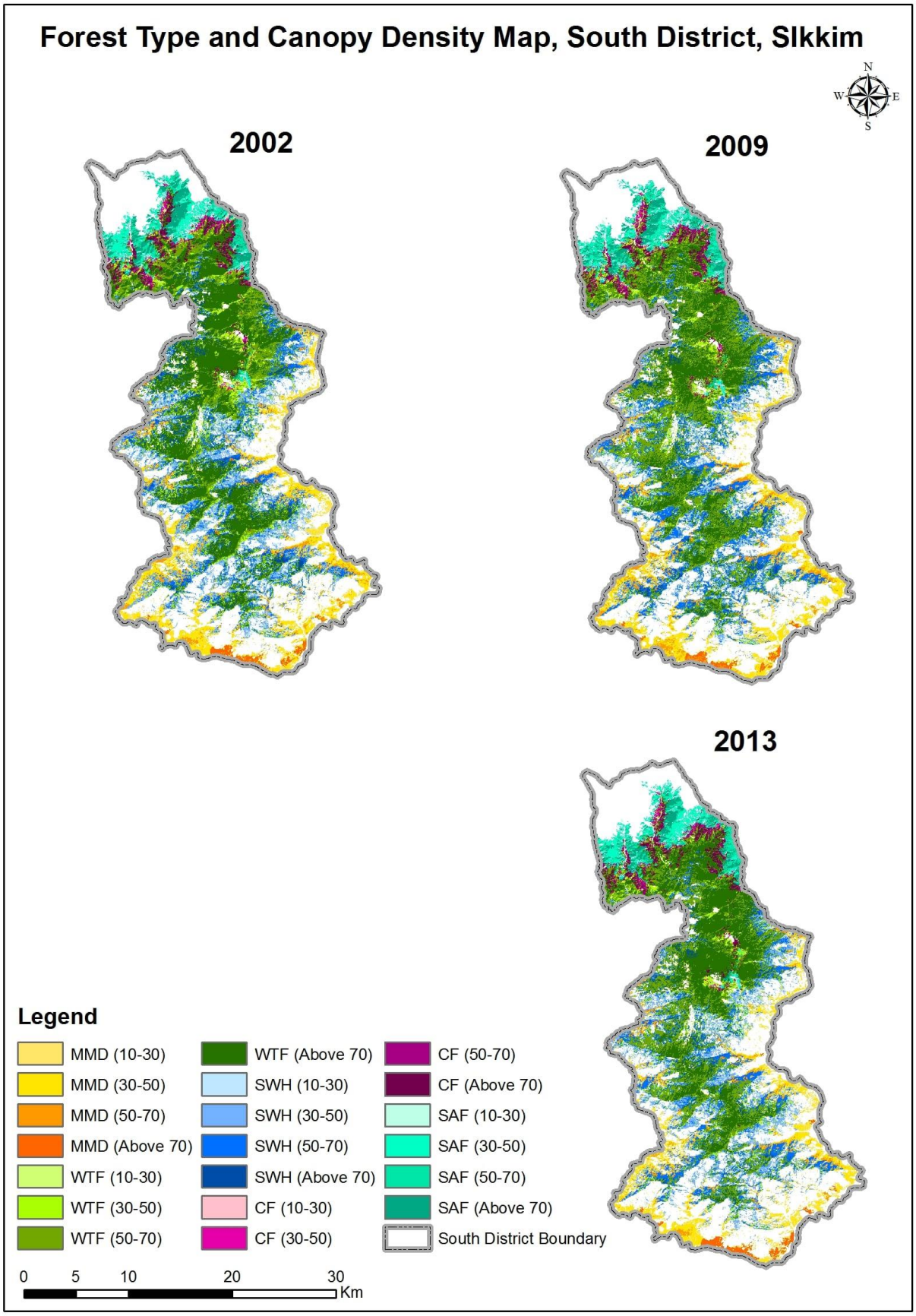


Figure 19: Changes in Forest Type and Canopy Density (2002-13), South Sikkim

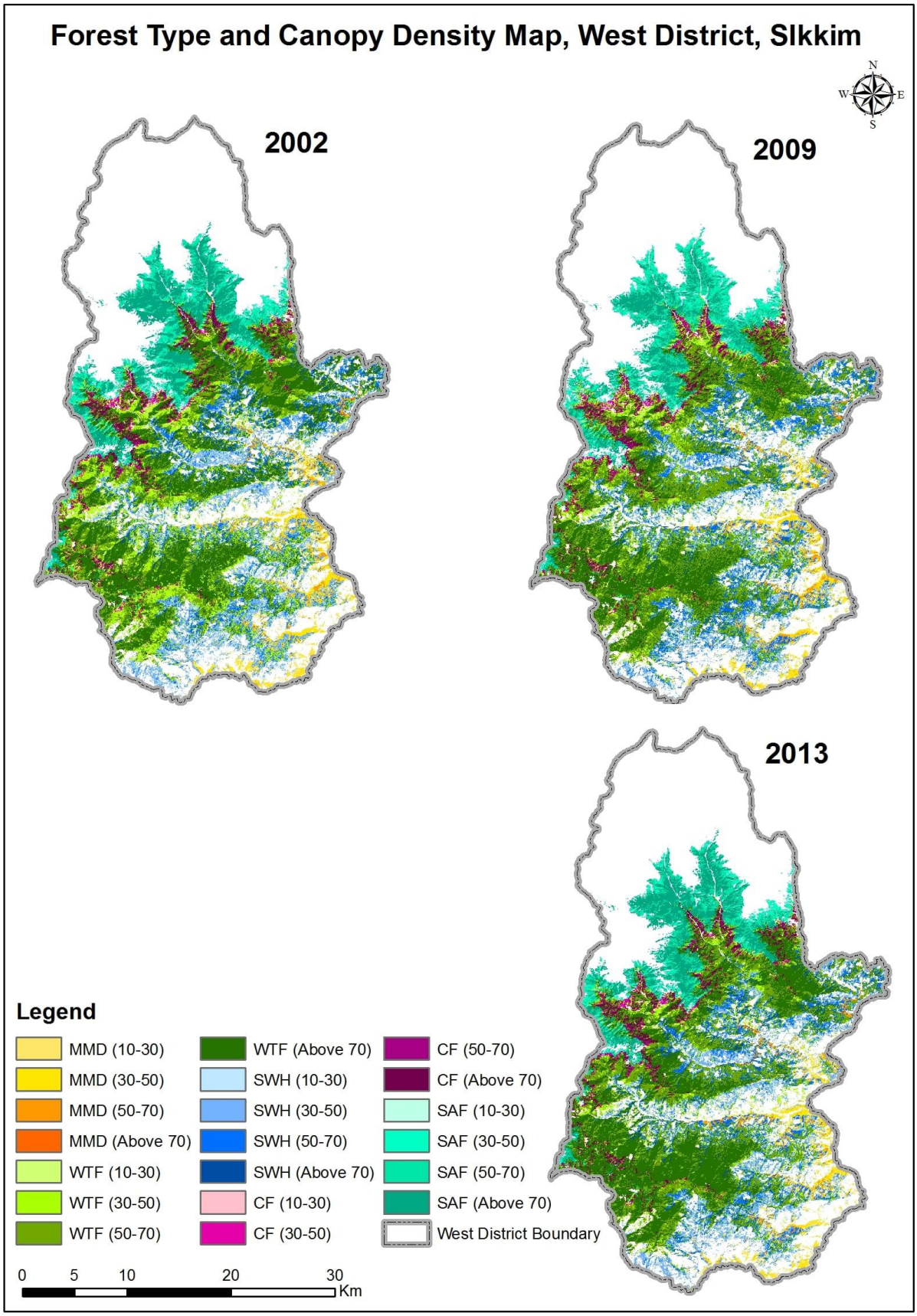


Figure 20: Changes in Forest Type and Canopy Density (2002-13), West Sikkim

Ecological data was collected to develop a forest inventory. Collection of data from sample plots was based on National Working Plan Code 2014 published by the MoEFCC. Scientific tools such as meter tapes, densiometer, altimeter, hypsometer, clinometer, etc. were used to measure various parameters. Soil samples were collected from each plot to be tested in government recognized laboratories for Soil Organic Carbon. Measurement of litter also followed scientific and standard methods. Volume of each tree in the sample plot was calculated based on the volume equations developed by FSI or from other peer reviewed literature. Based on these measured values, the total organic carbon content in four carbon pools was estimated.

Table 18: Organic content in various carbon pools

Class/Stratum	C_{AGL} (tC/ha)	C_{BG} (tC/ha)	C_{Litter} (tC/ha)	C_{SOC} (tC/ha)	C (i) (tC/ha)
Moist Mixed deciduous Forest 10-30	56.8	14.4	**0.6**	**72.6**	**144.4**
Moist Mixed deciduous Forest 30-50	184.7	44.9	**1.4**	**80.3**	**311.4**
Moist Mixed deciduous Forest 50-70	277.8	69.3	**1.4**	**79.2**	**427.6**
Moist Mixed Deciduous Forest Above 70	425.6	114.9	**1.5**	**74.9**	**616.9**
Wet temperate Forest 10-30	31.5	9.0	**1.2**	**94.6**	**136.3**
Wet temperate Forest 30-50	49.2	15.3	**4.0**	**76.4**	**144.9**
Wet temperate Forest 50-70	52.4	15.3	**0.7**	**93.9**	**162.2**
Wet temperate Forest Above 70	114.9	30.0	**1.5**	**89.1**	**235.5**
Subtropical wet hill Forest 10-30	28.0	9.4	**0.6**	**89.1**	**127.0**
Subtropical wet hill Forest 30-50	46.0	15.9	**0.7**	**89.5**	**152.0**
Subtropical wet hill Forest 50-70	123.2	33.5	**2.0**	**60.4**	**219.1**
Subtropical wet hill Forest Above 70	192.5	52.0	**0.9**	**92.7**	**338.1**
Coniferous Forest 10-30	30.8	9.8	**0.6**	**80.0**	**121.2**
Coniferous Forest 30-50	42.3	13.7	**1.3**	**97.8**	**155.1**
Coniferous Forest 50-70	83.2	20.1	**0.8**	**79.1**	**183.2**
Coniferous Forest Above 70	128.6	30.4	**2.5**	**112.9**	**274.4**
Sub-Alpine Forest 10-30	76.6	20.8	**2.0**	**99.8**	**199.2**
Sub-Alpine Forest 30-50	70.5	18.4	**1.9**	**108.9**	**199.7**
Sub-Alpine Forest 50-70	103.3	24.8	**2.1**	**124.7**	**254.9**
Sub-Alpine Forest Above 70	165.8	37.6	**5.0**	**77.6**	**286.0**
Cropland	0.0	0.0	0.0	0.0	**0.0**
Waterbodies	0.0	0.0	0.0	0.0	**0.0**
Grassland	0.0	0.0	0.0	0.0	**0.0**
Otherland	0.0	0.0	0.0	0.0	**0.0**
Settlement	0.0	0.0	0.0	0.0	**0.0**

5. Drivers of Forest Change

5.1 Introduction

The dynamics and causes of deforestation and forest degradation are multifaceted, complex and vary from place to place. They are an interplay of demographic, economic, technological, institutional, and socio-cultural factors (Geist and Lambin, 2002[52]). These factors are known as 'drivers' of deforestation and forest degradation. The factors that cause these drivers are called 'agents'. These agents could be any community, social group, or any other entities involved in deforestation and forest degradation.

5.2 Agents and Drivers of deforestation and forest degradation

The agents and the activities executed by them which lead to deforestation/forest degradation have been identified as a part of this project for Sikkim state. These activities include firewood collection, timber extraction, land clearing for agriculture, unsustainable NTFP collection, etc.

Drivers of deforestation and forest degradation fall in two categories - first, those which are planned and projected in accordance with policies, legal framework and management plans, etc. and second, that are unplanned and spontaneous, beyond government and management control.

Planned and unplanned withdrawals of forest resources from forests affect the forest carbon stock (i.e. deforestation and forest degradation). Thus, it requires proper understanding and management tools including transparent governance, effective enforcement and appropriate mitigation actions to counter these drivers. Both categories of drivers relevant to India are listed below in *Table 19* as identified in India's submission to the UNFCCC's Subsidiary Body of Scientific and Technological Advice (SBSTA) on REDD+.

Table 19: List of planned and unplanned drivers[53]

Planned Drivers	Unplanned Drivers
Infrastructure and other developmental works: - Road construction - Hydro-electric power - Irrigation projects - Industrial development - Expansion of cities and towns - Mining and stone quarry activities	Unauthorized activities, routine local unsustainable practices not covered in official management plans, and natural causes such as: - Encroachment of forest land for agriculture and housing - Unplanned felling - Unsustainable extraction of firewood, small timber and NTFP - Uncontrolled livestock grazing - Unsustainable fodder collection - Unplanned stone quarry operations

In order to minimize the impacts of planned drivers, appropriate interventions need to be implemented. These interventions encompass policy instruments and management options such as effective legal framework and site-specific mitigation measures. Unplanned drivers and activities are mainly a direct outcome of local people's dependence on the adjoining forest areas to meet their livelihood and subsistence needs of firewood, grazing, fodder, and food supplements, etc. To a small extent, illegal mining activities within forest is also an unplanned driver of forest change.

Geist, H.J., Lambin, E.F., 2002. Proximate causes and underlying driving forces of tropical deforestation. Bioscience 52, 143–150

[53] India's Submission to SBSTA. Available at: unfccc.int/files/land_use_and_climate_change/redd/submissions/application/pdf/india_driversdeforestationdegrdn_sbsta.pdf

Weaning the local communities away from such livelihood related practices will require sizable investment in providing alternatives for the forest products that the communities have been deriving from the forests traditionally, but not necessarily in a sustainable manner. Many of these people dependent on forests are poor, with little land and limited options for sustaining livelihood.

5.3 Pre-project Scenario

The Sikkim forest area is divided into two categories namely, Reserved Forest area and Protected Forest area. The reserved forest area constitutes 93.3% of the total forest area of the State. The protected forests are further categorized into *Khasmal and Gorucharan* forests. *Khasmal* forests refer to the forest land set aside for meeting *bonafide* domestic need of timber, firewood and fodder of the adjoining villages, whereas *Gorucharan* forests are forest land area set aside for the purpose of grazing of cattle of the adjoining villages.

Table 20: Recorded Forest Area in Sikkim[54]

Geographic area (sq km)	Reserved Forests (sq km)	Protected Forests (sq km)	Recorded Forests of State's Geographic area (sq km)		% of Total Forest area in India
7096	5452	389	5841	82.31%	0.76%

About 3,392 sq. km (47.80%[54] of the total geographical area of the state) is under forest and tree cover in Sikkim. The per capita forest and tree cover is 0.63 ha - highest in the country. Sikkim has one national park and seven wildlife sanctuaries covering 2,179 sq. km (31 per cent of state geographic area) - the highest in the country in percentage terms. Over 80 per cent forests in Sikkim are very dense and moderately dense forests.

5.4 Methodology

Identification of Stakeholders

As a part of project activity and to ensure successful project delivery, it is of utmost importance to assess roles and responsibilities, dependencies and impacts of each stakeholder of the project. Multiple stakeholders have been identified in the landscape, each having their own unique influence on the project. In view of this, all important stakeholders in the landscape have been mapped in this project[55].

The mapping has been performed after analysis of multiple criteria, enabling a clear understanding of their influence on implementing the project in the state. The stakeholders have been categorized as **Veto** and **Key** stakeholders based on their extent of influence. The categorization is described as under:

Veto stakeholders — Principal stakeholders with decision making powers having a direct impact on the project, with authority to direct the direction of the project.

Key stakeholders — Stakeholders that directly affect demand-supply scenarios of forest resources or have a strong influence on Forestry project activities. They contribute significantly through their direct participation in the project, and are expected to be involved with the project throughout. Their support is crucial in achieving the objectives of the project.

[54] India State of Forests Report 2015, Forest Survey of India.
[55] The methodology that has been used for stakeholder mapping has been adapted from the GIZ Capacity Works tool.

Table 21: Veto stakeholders for the REDD+ project in Sikkim

Name	Affiliation	Agenda	About the Organization	Roles and Responsibilities
Chief Minister's Office and Chief Secretary's Office	Government of Sikkim	Administration	Administrative centre of the Government of Sikkim	To provide administrative backing for project implementation; to approve and finalize new policies/policy reforms to support the project.
Sikkim Forest, Environment and Wildlife Management Department (FEWMD)	Government of Sikkim	Administration	Government department responsible for all matters related to forests, environment and wildlife protection in Sikkim	To act as the Nodal Agency for the project; to mobilize overall resources and manage all aspects of the project; to undertake new initiatives towards improving the output and functioning of the project.
Sikkim REDD+ Steering Committee	Government of Sikkim	Administration	Setup to look after the overall administration of the project and provide guidance for all activities	To provide inter-sectoral coordination among government departments; to monitor the progress of the project and administer benefits accrued from it and to advise the Government of Sikkim on enacting relevant policy interventions.

Table 22: Key stakeholders for the REDD+ project in Sikkim

Name	Affiliation	Agenda	About the Organization	Roles and Responsibilities
Sikkim REDD+ Cell	Sikkim FEWMD	Administration	Setup to work closely with project partners to implement and provide overall monitoring of project activities	To facilitate capacity building towards REDD+ within FEWMD and provide institutional measures towards REDD+ readiness in Sikkim
JFMCs/EDCs	CBOs	Community	Community bodies set up with cooperation from DoEF to sustainable manage and administer forest resources	To play an active role in establishing relationships between project team and local communities to promote project activities; to provide assistance in identification of interventions and beneficiaries, and in developing benefit sharing and safeguards mechanisms.
United States Agency for International Development (USAID)	Bilateral	Technical and Financial	Bilateral agency steering the technical and financial cooperation between India and the US, as part of the Forest-PLUS Program.	Main supporting agency of the project

5.5 Social Survey, Discussions and Consultations

A step-wise approach to assess drivers, agents and the underlying causes for deforestation and degradation using a bottom up approach has been adopted. A study team with knowledge of local language was formed comprising of experts from forestry and social sectors.

The steps involved in driver assessment are depicted below.

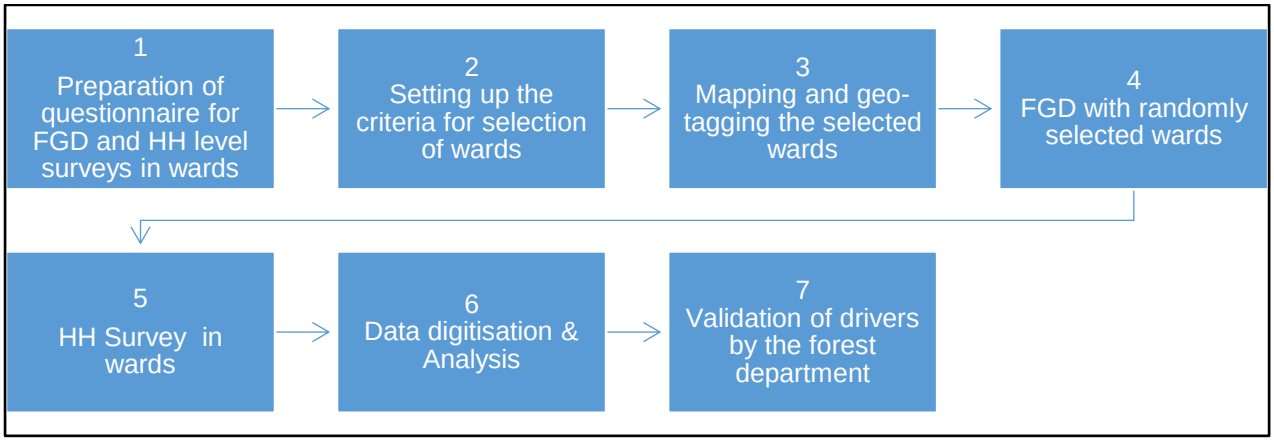


Figure 21: Steps towards Assessment of drivers of deforestation and degradation in Sikkim

Questionnaire preparation

Based on the initial discussions with the State forest officials, two questionnaires were prepared to understand the drivers of degradation and deforestation in the State. These questionnaires were revised based on inputs from the key stakeholders and through field testing. The questionnaire had a multipronged approach to ascertain a single driver through multiple questions.

Criteria of selection of wards and households

The wards which showed 1% or more degradation and deforestation within their 1 km buffer zone were mapped. This criteria actually covers 93% of the total 918 wards in the State ie. a total of 854 wards constituting 92,638 households in all of Sikkim. District wise distribution is shown in *Table 23* below.

Table 23: District wise number of wards and households chosen for the survey

	Number of wards	Number of wards with >1% degradation and deforestation within a 1km buffer	No. of Households that can be potentially surveyed
North	119	106	6906
South	262	257	24510
East	242	236	34333
West	296	255	26889
Total	919	854	92638

Sampling design

Steps undertaken to quantify and assess drivers of deforestation and forest degradation:

- District by district forest change maps were generated to identify spatial distribution of degradation, deforestation, reforestation and enhancement in forest cover that has taken place between 2002 and 2013. LISS-III imageries were used for this purpose.

- Criteria for selection of wards for survey set: choosing wards located around forests showing any amount of change in terms of deforestation and degradation within 1 km of forest buffer zones. A total of 854 wards out of 918 in Sikkim (i.e. 93% of the total) fell under this criteria.

- As per UN guidelines[56], general purpose surveys that focus on several subjects (such as the present one) should have sample sizes large enough to enable reliable measurement. The guidelines suggest that 5–10% of the total population samples need to be covered; the exact percentage can be left to the discretion of the survey manager. Based on this, a ward sample size of 7.5% of the total number of wards falling within the chosen strata was chosen. As a result 64 potential number of wards emerged as the number of wards that could be surveyed across the 4 districts of Sikkim.

- Total number of households to be surveyed that would give meaningful results within the 64 wards across Sikkim. As per literature, number of samples within a population of 100,000 and above (in this case population refers to HHs), survey needs to be done for a maximum of 384 samples, beyond which the samples become saturated and repetition of results occurs[57]. However, for conservative estimates, we doubled the survey HHs to potentially weed out outliers. Therefore, a total of 685 HHs were surveyed.

- Based on the ratio of total rural HHs in each district as compared to the total number of rural HHs in Sikkim, 205, 173, 79 and 182 HHs were surveyed in the West, East, South and North districts, respectively. The HHs were selected randomly within the criteria of detection of sign of degradation and deforestation within 1 km buffer of forests.

- Random selection of shortlisted wards was done within each district to avoid bias; surveys carried out in a total of 62 wards. Additional Focus Group Discussions (FGDs) were carried out in 31 wards randomly to assess the socio-economics and overall behaviour of forest dependency of the villages.

- Focus Group Discussions (FGDs) were carried out at randomly selected wards in each district. The FGDs were carried out to validate the hypothesis about the drivers of deforestation and degradation in general broadly specific to each of the districts.

Field records

The socio-economic survey was carried out from late August to early September 2016. In total 685 households surveys were carried out which spread across 62 villages.

Quality Assurance/Quality Control

The stringent QA/QC procedures were followed to gather good quality data through field measurements. The household level questionnaire was designed and field tested before administering the actual questionnaire survey. The survey team was first given an orientation and was explained the objective of study.

Data Digitization and Analysis

The responses in the questionnaires were digitized for further analysis. Statistical analysis was carried out to decipher the dominant driver in each of the wards which were then added

[56] UN, 2005. Designing Household Survey Samples: Practical Guidelines. Department of Economic and Social Affairs, Statistics Division, Studies in Methods, Series F No.98. Available at: http://unstats.un.org/unsd/demographic/sources/surveys/Handbook23June05.pdf

[57] Krejcie, R.V. and Morgan, D.W. 1970; Determining Sample Size for Research Activities; Educational and Psychological Measurement (30).

up to assess the dominant driver in each of the districts and then in the entire State. The results of the same are presented hereafter.

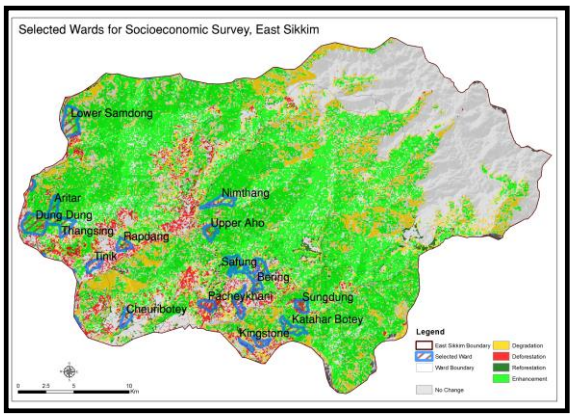
Details of Study Area

Details of the households and wards covered during the socio-economic survey in the four districts of Sikkim is given in the *Table 24*.

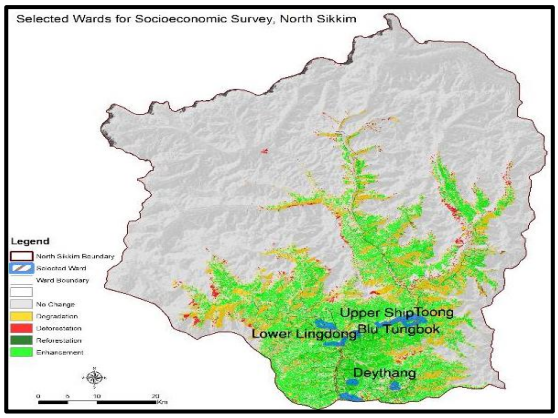
Table 24: Details of district wise household survey

District	Ward	HHs covered	Total
East Sikkim	Kingstone	12	173
	Rhenock	7	
	Sungdung	12	
	Katarbortey	12	
	Pacheykhani	8	
	Dung –Dung	13	
	Takchang	10	
	Nimthang	10	
	Upper Aho	10	
	Lower Samdung	9	
	Chewrobhotey	9	
	Safung	9	
	Rapdang	10	
	Upper Biring	10	
	Aritar	11	
	Ganchung Tokchi	11	
	Thangsing	10	
South Sikkim	Upper Mickhola	10	182
	Shyampani	10	
	Upper Omchu	12	
	Lower Karek	10	
	Bul	10	
	Deythang	10	
	Lower Tingrithang	10	
	Rameng	10	
	Upper Ramabong	10	
	Manghim	6	
	Upper Manghim	4	
	Upper Tarku	10	
	Rashyap	10	
	Rolak	10	
	Namprick	10	
	Tinik	10	
	Subok	10	
	Gairi Goan	10	
	Broom	10	
	Lower Lingdong	10	126

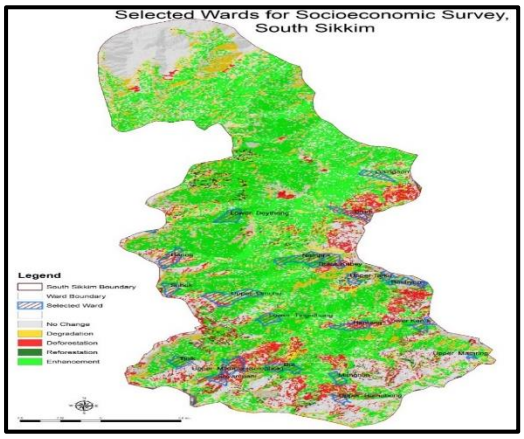
North Sikkim	Lachen	20	
	Lachung	27	
	Bhutungbuk	8	
	Toong	10	
	Gyenzel	10	
	Ramthang	12	
	Deythang	10	
	Upp. Gyer	8	
	Upper ship	11	
West Sikkim	Tenzerbong	12	205
	Upper Ribdi	10	
	Mangbir	12	
	Bermiok Daragoan	11	
	Ratomatey	13	
	Upper Mukrung	10	
	Fambong Mathilotar	12	
	Darap	10	
	Sombaria	11	
	Lower Yangtey	12	
	Singling Ogeng	12	
	Daragoan Teendhuray	12	
	Thingle	10	
	Kongri Naku	10	
	Lower Begha	12	
	Mansabong	12	
	Srinagi	12	
	Lingchom Middle	12	
Total			685



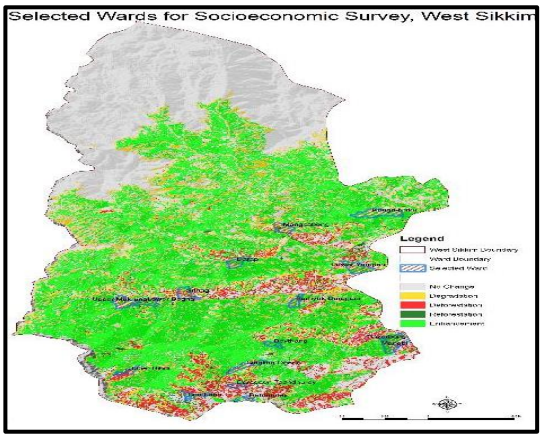
East Sikkim



North Sikkim



South Sikkim



West Sikkim

Figure 22: Forest change map with location of surveyed wards in Sikkim

5.6 Mapping Active Drivers

Livelihood Pattern

In order to identify the active drivers of forest change, the livelihood pattern of the population in the project area must be identified in detail. The survey results indicate that although the most preferred livelihood is government jobs, farming remains the dominant livelihood in Sikkim. Maximum number of households (84%) in North district are dependent on farming as compared to South district where 71% households are engaged in farming as compared to around 50% of households in East and West districts. Only 9-24% of the population is engaged in government jobs across the 4 districts. The East district has the highest dependency on government jobs (22%) compared to the other districts (3%, 7% and 8% in North, East, and South, respectively). This is because the State capital (Gangtok) lies in East Sikkim. As regards business and private jobs, West district has maximum number of households dependent on private jobs (16%) and on businesses (13%).

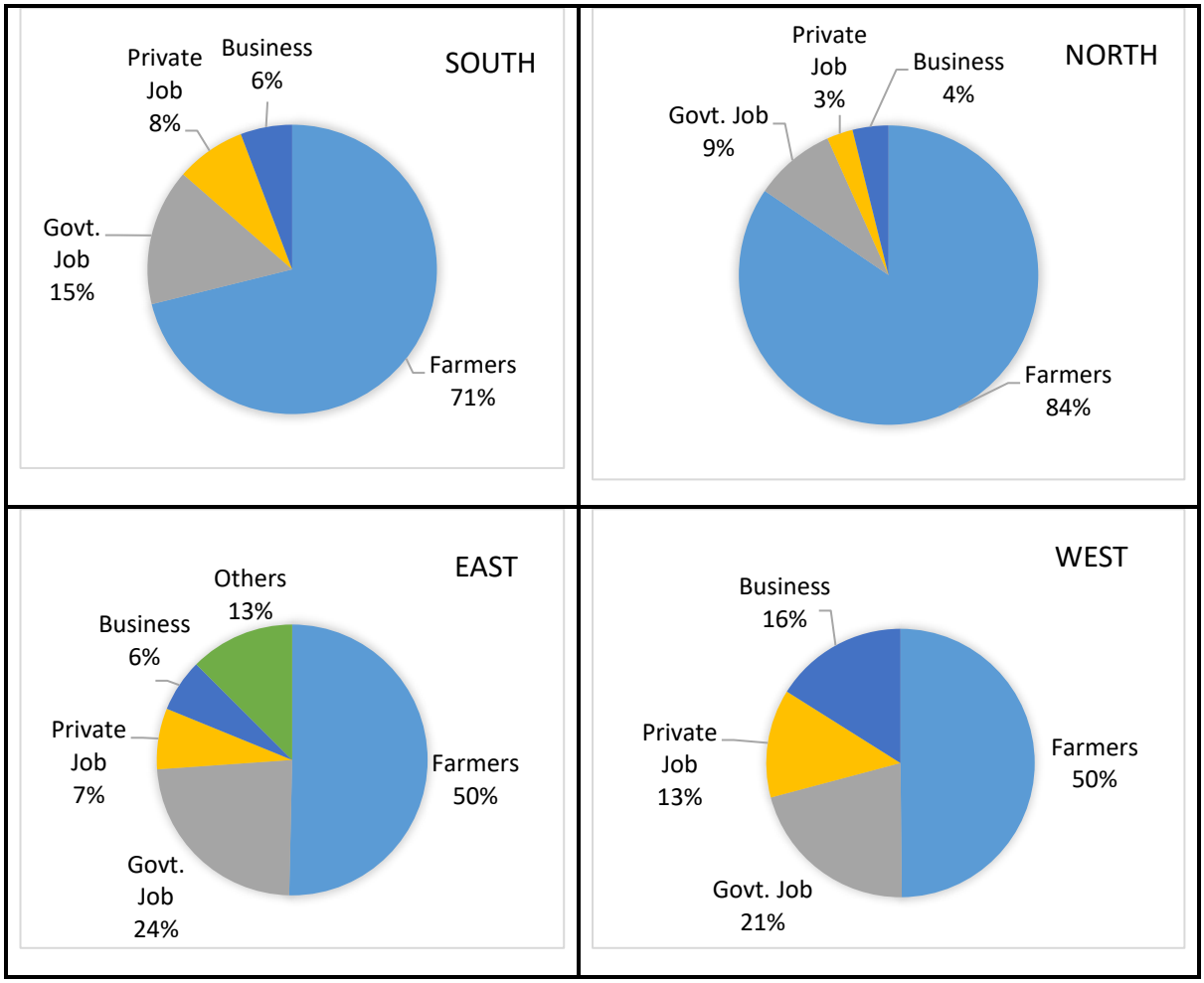


Figure 23: Livelihood pattern in each district as emerged from survey

A very small percent earns its living from business and other livelihoods. North district has the highest dependency on agriculture i.e. 84% followed by South (71%).

Produce Collected from Forests

Although extraction of forest produce has been banned by the Government of Sikkim, some extraction is still taking place as has emerged from the survey. The respondents indicate that they source material from forests to meet their energy demands, constructing houses and sheds for cattle, for medicinal plants, for green manuring, amongst other uses. The table below lists the types of produce collected from forests and their utilisation. The table also notes the different species used for these purposes as noted in our survey.

Table 25: Types of forest produce collected by households for various purposes

Need	Type of Forest Produce collected	Species (Vernacular Names)
Meeting energy demand	Firewood	Chilauni, Jamuna, Kafal, Bakal patey, Utish, byapari, Dhupi. Chilauni being predominant
Fodder and feed for Cattle	Fodder	Napier, Salimmey, Banmara, Jamun, Kafal, Katush, Furkey, Kharuki, Kamley, Syalphsrey, nebara, Batt, Nevara, Kabro, Syaphurse, Gaglato, Dudilo, Maney, Bamboo

Need	Type of Forest Produce collected	Species (Vernacular Names)
Medicinal requirements	Medicinal plants	Sisnu, Niguro, Fern, Mushroom, Utis, Tite patti, Saur, Kane Jhar, Kalo Hardi, Chimphing, Bakaino
Fencing, Housing, cattle shed	Small timber	Chilauni, Cherry, Phamphul, Gagul, Paiyou, Chilauni
Roofing, Fencing, cattle shed, agriculture equipment's, Baskets, prayer flags etc.	Bamboo	Kanta Baans, Bhalu Baans, Latthi Baans, Dhugre Baans, Tokre Baans
Cattle bed, Mulching, Green manure	Forest litter	Chilauni, Banmara, Uttish,Titepati
Construction of houses, doors & Furniture	Large timber	Utish, Chilauni, Mauwa, Chappi

Firewood Demand (Extraction by Source)

As per the survey, agroforestry has emerged as the largest source of firewood (62%) (See *Table 26*). This is mainly because of the banning of green felling in Sikkim forests since 1995. However, forests still remain a significant source of firewood.

The forests from where firewood is extracted are the protected forests including *Khasmal and Gorucharan* areas that are next to the villages. On an average these forests supply 22% of all firewood requirement of households. At a district level it is seen that the East District extracts the maximum amount of firewood from forests (36%), followed by West district (28%), South (22%) and North (5%). Though the forest depots do not keep firewood, waste wood that is not sold is bought over by people and is used as firewood.

The districts have a large number of private forests. They are also a substantial source of firewood amongst other produces. Permission for felling trees for any purpose on any type of forests even if it is a private forest has to be taken from the Forest Department in Sikkim. Clearly, crop lands are a large source of fuelwood in Sikkim as more than 50% of the firewood is coming from firewood trees planted in cropland.

Further, people lease firewood trees in other people's lands, if they do not have sufficient sources. These leased firewood trees are considered as purchased in this study.

Table 26: Fuel wood extraction by source

Districts	Reserved Forests (%)	Crop Land (%)	Private Forests (%)	Purchased (%)	Forest depot (%)
South	22	53	18	7	NR
North	5	66	15	2	12
East	36	56	7	NR	1
West	28	72	NR	NR	NR

Note: NR: Not Reported

Fuelwood Utilisation Pattern

Fuelwood in rural households is used for cooking, water heating, space heating, festivals, and occasionally for marriages and death. Here household cooking includes cooking for people in the house and cooking feed for the cattle. Around 48-50% of the total fuelwood goes for

cooking in rural households, across all districts. Water heating takes up 8-14% of the total fuelwood collected by the households. Events like weddings and death, each use 8-11% of the total fuelwood collected by households annually. Festivals that happen year round, consume 8-20% of the total fuelwood consumption of the rural households across the four districts.

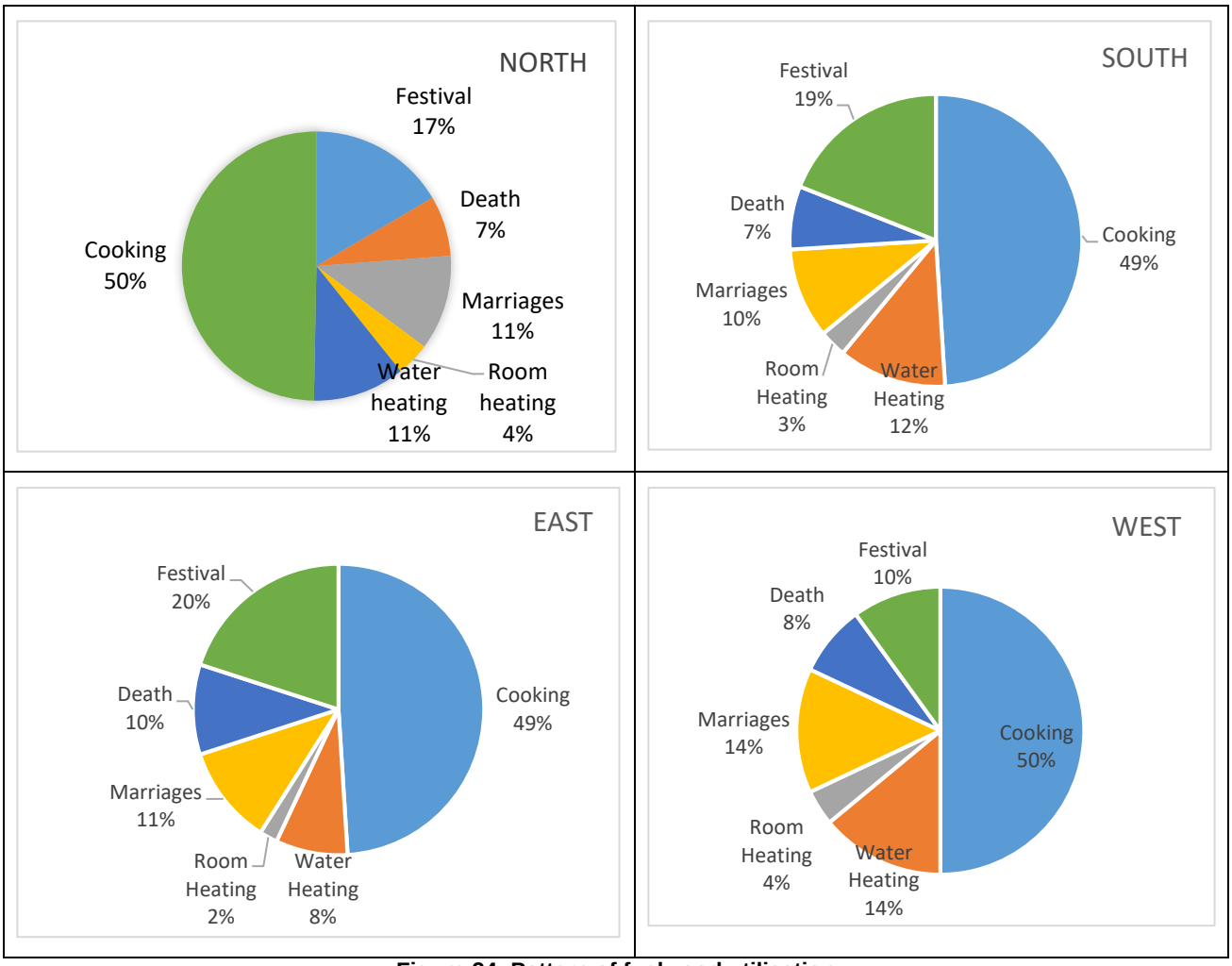


Figure 24: Pattern of fuelwood utilisation

Cooking devices in use

The types of devices available for cooking with the households were also taken into consideration. It appears that due to government's efforts, LPG has reached in most of the households in Sikkim including the ones living in forest fringe areas. Maximum reach of LPG has been in North district where 73% of the respondent rural households have indicated that they have LPG connection. The West district has about 61% of the respondent households with LPG connection. However comparatively lesser number of households in South district (48%) and East district (44%) are in possession of LPG connection. The survey indicates that households still possess and use traditional cook stoves using fuelwood. In East and the South districts traditional cook stoves are still used by about 45-51% of the rural households whereas 23% households in the North and 34% in the West district use traditional cook stoves. Improved cook-stoves have not made much inroads due to the fact that technology best suited to cultural practices of cooking, is not available. However electricity run induction plates are being increasingly used for easy and small cooking needs.

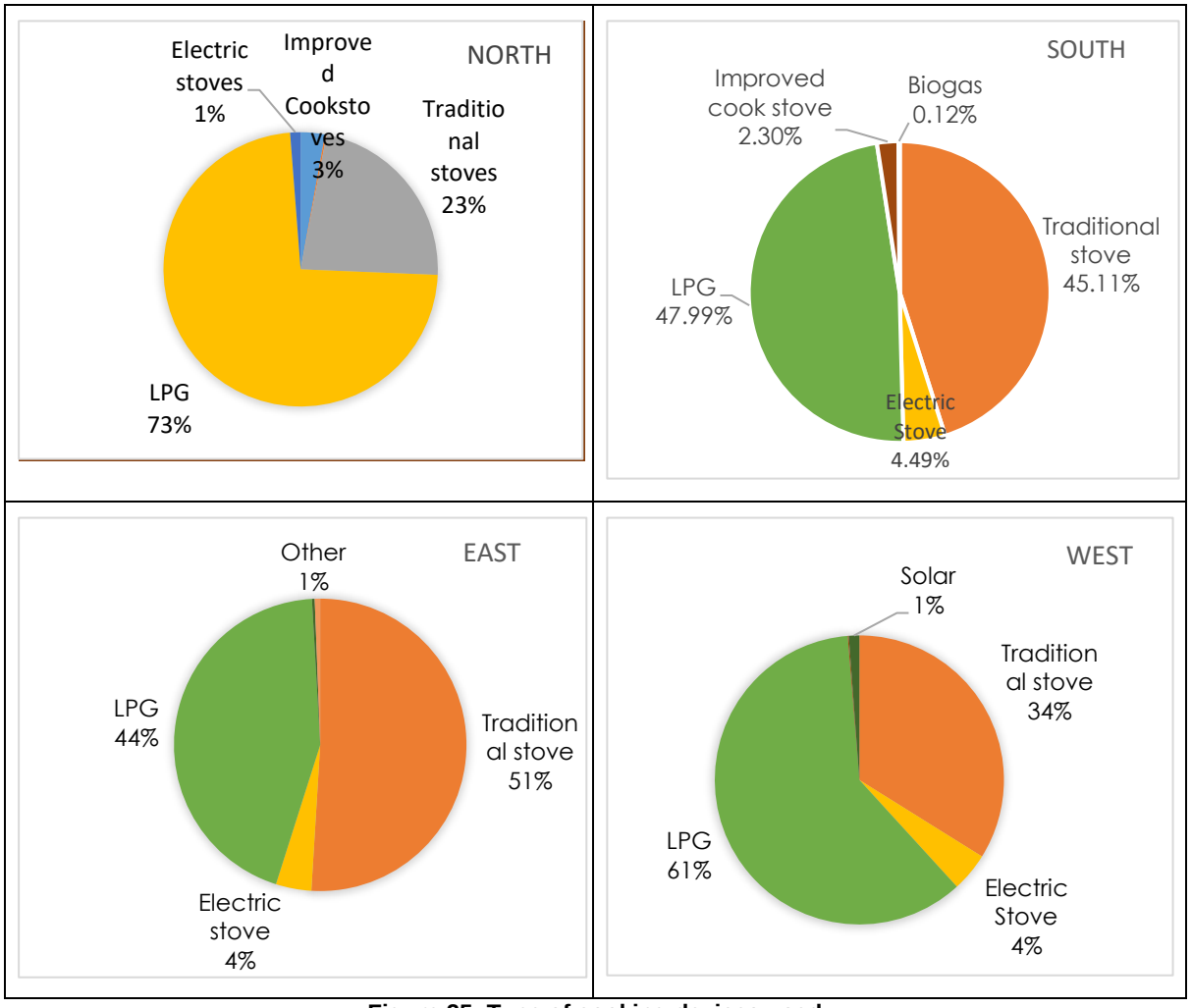


Figure 25: Type of cooking devices used

Fuel Used for Cooking

It has been found through the survey that though LPG connections are available with majority of the households, fuelwood dominates when it comes to type of energy preferred for cooking (see figure below). The percent of households using fuelwood ranges from 35% in West district to 57% in the North district.

Other than fuelwood and LPG the households also use a mix of other fuels, namely, electricity, biogas, charcoal, coal, kerosene, broom grass, and crop residue. The maximum utilisation of fuelwood seems to be in the Northern district (57%), followed by East and South (44% each), and least utilisation seems to be in the West District (35%).

Crop residue is another fuel used extensively, but its percentage use is lesser than fuelwood and LPG. Its usage is highest in the North (15%) and South districts (16%) followed by the East and the West districts (8% and 11%, respectively). Kerosene utilization also prevails and ranges from 14% in the West to 7% in North and the households using biogas is found to be the highest in West district (15%), quite low in East (5%) and South (2%), and negligible in the North district (below 1%).

Usage of Broom grass sticks is low in comparison to other fuels mentioned earlier - East district (2%) and North district (3%), and similarly in the South and the West districts (5% and 7% respectively).

Electricity is used in cooking appliances like electric stoves. Usage of induction plates in the State is gaining popularity, but their number is still very limited. Electric stoves utilized are below 1% in South, 3% in North, 1% in West, and 2% in the East district. The East district also uses charcoal (2%) unlike the North, South and the West districts. Coal is also used for cooking the East and South districts of Sikkim (1% each).

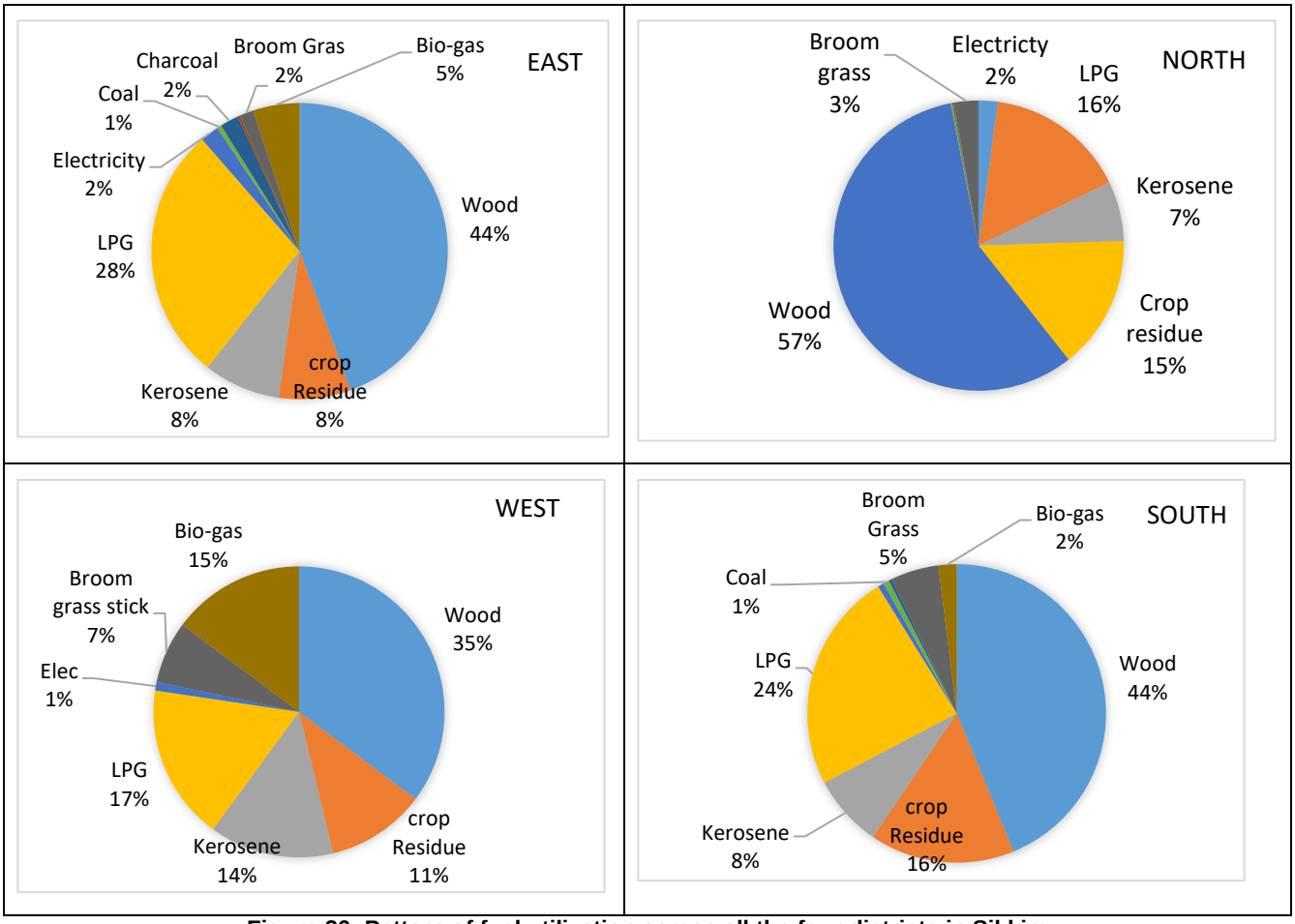


Figure 26: Pattern of fuel utilization across all the four districts in Sikkim

Quantification of Fuelwood Consumption

Survey results indicate that in the North, households use least amount of fuelwood (~15.93 kg/per day/household) for various purposes. In comparison, fuelwood combustion in all other districts is higher and ranges from 22.8 kg/day/household to 29.6 kg/day/household. On average, households surveyed across Sikkim use 23.2 kg fuelwood/household/day.

These numbers are a bit lower than what is reported in some of the earlier studies. For example, Chetri and Sharma (2006) mention that households in the North district on an average combust 25 kg fuelwood per day. Similarly, the Sikkim Human Development Report (2014) quotes that a rural household on an average, requires about 20 kg of fuelwood per day for cooking, space heating and other miscellaneous purposes, based on a JICA study carried out in 2009. Lower fuelwood consumption can be attributed to increase in LPG penetration in the rural fuel use mix.

In order to quantify the total amount of fuelwood used across the rural households in each of the districts, these numbers are extrapolated to the total households that fall within the wards with >1% forest degradation and deforestation within a 1 km buffer zone around them. Thus,

a total amount of 829 million tons of fuelwood is being used in 93% of the wards in entire Sikkim. It is estimated that the rural households covered under this classification together consume around 0.83 million tons of fuelwood annually.

There was a separate survey conducted for the villages of Lachen and Lachung as demanded by the forest officials during the first phase of validation. The officials perceived this region to have different consumption pattern than the rest of the district (North). The additional survey results projected a minimal deviation from the rest of the district, which is incorporated in the table below.

Table 27: Quantification of Fuelwood extracted from forests

District	Fuelwood per HH	Number of Rural HH	Total annual Fuelwood consumption
	(kg/day)		(000" tons)
North	15.93	6906	40.2
East	23.3	34333	292.0
West	29.6	26889	290.5
South	22.8	24510	204.0
Average	22.9		

Fodder

Fodder Source

Fodder is collected from various sources and is of various species[58]. In absence of sufficient rangeland the forest tree species play an important role in solving the fodder shortage. The principal fodder plants are *Napier, Salimmey, Banmara, Jamun, Kafal, Katush, Furkey, Kharuki, Kamley, Syalphsrey, nebara, Batt, Nevara, Kabro, Syaphurse, Gaglato, dudilo, maney* etc.

Table 30 gives an assessment of the share of source of fodder collected for cattle in the various districts of Sikkim based on the survey. As visible, forests are not the dominant source of fodder, but croplands are. This is because of the combined effect of the ban on grazing in forests and the policies of the AH&VS Department, which distributes free fodder seeds to farmers for growing on their cropland. The Department is providing seeds for plants such as oats, barseem, etc., which have high nutritive value, under the National Livestock Mission.

In East Sikkim however, the survey indicates that only 0.5% of the total fodder comes from forests, and majority of the fodder is bought by respondents from markets. The validation exercise indicated that majority of the fodder bought for livestock rearing has become a common livelihood source in East District since dairy development in the State has picked up. The fodder is sourced from Siliguri in the State West Bengal. It is bought from formal markets unlike in other districts where excess fodder requirements are purchased from neighbourhood croplands.

People also purchase fodder from other people's lands. This has also gone under the purchased category for analysis purpose in this study.

Table 28: Source of Fodder Collection in the surveyed rural households

[58] Singh, P., and Dash, S. S. (2002); "Database on trees of Sikkim Himalaya."; *Journal Of Economic And Taxonomic Botany* 26.2: 285-310.

District	Reserved Forest (%)	Cropland (%)	Purchased (%)
South	17	66	17
North	15.02	84.98	NR
East	7	32.5	60
West	8	71	21

Quantification of Fodder consumption

According to the Sikkim Human Development Report (HDR) 2014, fodder collection is mainly done once in the dry season and then stored for use round the year. Our survey also indicates the same pattern across all the districts. The estimated average fodder collected per household is 15 kg per day or 5,475 kg per year which may widely range from 340 kg in Lachen in North Sikkim to 1,290 kg in Uttaray in West Sikkim.

Assessments based on the survey carried out indicate that the maximum fodder is collected by households in the East Sikkim district (~89 kg/HH/day). Households in the other districts collect around 65.5 to 66.5 kg of fodder per day. Applying the same logic as before, fodder consumption data was extrapolated across all households that are spread across wards that have greater than >1% forest degradation and deforestation within a 1 km buffer zone. On this basis it is estimated that about 2.5 million tons of fodder is collected by these households annually.

Table 29: Amount of fodder extracted from forests in various districts of Sikkim

	Fodder collected per HH	Number of HH's	Fodder consumed annually
District	(kg/day)		('000 tons)
North	66.5	6906	167.63
East	89	34333	1115.31
West	63	26889	618.31
South	65.5	24510	585.97
TOTAL	284	92638	2487.22

Grazing

Grazing Pattern

In the 1990s, Sikkim forests witnessed rampant and large scale grazing in the mountainous region. The increase in the cattle population resulted in increased pressure on the fragile mountain ecosystem. In 1998, the Government of Sikkim imposed ban on grazing in reserved forest areas, plantation areas and water source areas with a view to encourage regeneration of forest resources, augment rural water supplies and develop degraded lands. There is a mixed practice of stall feeding and grazing. The cattle is left out for it to graze on its own. The grazing sources are documented in the table below, as per the villagers' perceptions.

Table 30: Grazing sources and pattern

District	Forest (%)	Cropland (%)	Private Forests (%)
North	10.05	89.93	0
South	19.1	13.8	67
East	0.47	39.5	60

West	65.7	32.8	1.49

Grazing is high in the West Sikkim district due to the presence of a large number of ponies accompanying tourists travelling to the Khangchendzonga Biosphere Reserve (KBR), through West Sikkim. While travelling the ponies graze within the forests.

Small Timber

Extraction pattern

Small Timber are species with diameter 20-30 cm and these serve purposes like furnishings, house repair and maintenance and fencing. Also, these are used in making agriculture equipment and tools. Mainly the small timber is being extracted from crop land. The next preferred source of course remains the forests. In the East district however, the largest source of small timber is the plantations.

Table 31: Small Timber Extraction and Sources

District	Forests (%)	Private forests (%)	Cropland (%)	Purchased (%)
South	13	2	77	8
North	18	4	78	NR
East	18	45	32	5
West	23	21	50	6

Quantification of small timber consumption

Small timber collection has been indicated in terms of pieces per day the sizes of which are around 1 m in length and around 20-30 cm in diameter. The table below documents the volume (in cubic metres) of small timber collected by the households and provides the estimate of collection of this product. It is estimated that about 677.90 thousand tons of such small wood is collected annually.

Table 32: Amount of small timber collected

District	Small timber collected (Kg/day)	No. of HH	Total collection ('000 tons)
North	8.42	6906	21.22
East	17.01	34333	213.16
West	26.75	26889	262.54
South	20.23	24510	180.98
Total	71.07	92638	677.90

Large Timber

Extraction pattern

Some of the important timber yielding tree species in the State are – Abies densa (*Gobra Salla*) Albizia chinensis (*Siris*), Alnus nepalensis (*Utis*), Betula alnoides (*Saur*), Boehmeria rugulosa (*Daar*), Castanopsis indica (*Dalne Katus*) C. tribuloides (*Patle Katus*), Cryptomeria japonica (*Duphi*), Juglans regia (*Okhar*), Michelia cathcartii (*Teatey champ*), Michelia doltsola (*Champ*), Shorea robusta (*Sakhna*), Tectona grandis (*Sagoon*), Toona ciliata (*Tooni*) and Terminalia myriocarpa (*Pani-Saj*).[59] The large timber is used for flooring, doors, windows, and furniture.

Timber in Sikkim is generally procured from the FEWMD. They dispose of those trees that are fallen and not felled, trees that have been usurped due to road construction or due to construction of institutional buildings. Additionally, timber is also sourced from private forests, again with the permission of the FEWMD. Therefore the respondents procure from reserved forests as the ones given by the FEWMD. They are sourcing timber largely from private forests. Felling of timber in private forests also requires permission of the FEWMD.

Table 33: Large Timber Extraction and Sources

District	Reserved Forest (%)	Private Forests (%)	Cropland (%)	Purchase (%)	Forest Depot (%)
South	26	74	NR	NR	NR
North	20.81	71.53	3.5	1.8	2.36
East	26	74	NR	NR	NR
West	70	30	NR	NR	NR

According to the study, the West district procures maximum timber from forests. The rest of them procure only 7-9% of the total timber consumed from forests. The main source is plantations. But the households in the West district indicate that they procure 62% of their timber from trees outside the forests (TOF).

Quantification of large timber consumption

Estimates indicate that about 17.94 kg/day/hh of timber is consumed annually in households that fall within wards that have deforestation and forest degradation if >1% within their 1 km buffer zone. The West district is consuming about 57.5% of the large timber used annually in Sikkim.

[59] Singh, P., And S. S. Dash. "Database On Trees Of Sikkim Himalaya." *Journal Of Economic And Taxonomic Botany* 26.2 (2002)

Table 34: Timber consumed by households

District	Timber consumed (kg/day)	Households	Timber used annually ('000 tons)
North	6.38	6906	16.08
East	0.46	34333	5.76
West	7.48	26889	73.41
South	3.62	24510	32.39
Total	17.94	92638	127.64

Green Manure, Mulching and Cattle Beds (Collection pattern)

Green manure is a fertilizer that consists of growing plants that are ploughed back into the soil, most of which is sourced from agricultural lands. Forest floor litter is extensively collected for use in livestock bedding, mulching, composting and for creating shade for select crops. The estimated annual household use of forest floor litter is 2,920 kg per household.[60]

The survey reveals that the South and the West districts consume a high quantity of green manure. South district also consumes high quantity of mulching material, second only to the East district by a few thousand tonnes. However, consumption of green produce for cattle bed is low in South district and high in East and the West district.

Table 35: Green Manure: Sources and Quantification

District	Forest (%)	Cropland (%)
South	41	59
North	22	78
East	58	42
West	20	80

Table 36: Mulching Material: Sources and Quantification

District	Forest (%)	Private Forests (%)
South	38	62
North	29	71
East	54	46
West	46	54

[60] Sikkim Human Development Report 2014.

Table 37: Cattle bed Material: Sources and Quantification

District	Forest (%)	Private forest (%)
South	20	80
North	19	81
East	54	46
West	41	59

Quantification of Mulch, Cattle-bed and Manure consumed

Mulching material is maximum from forests in the West district. Overall, the extraction of mulching material from various sources ranges from 0.92 kg/day in the North district to about 10.9 kg/day in the West district. The total amount of mulching material collected annually in the State is 134.71 million tons annually.

Table 38: Mulching material collected annually

District	Mulch material collected per HH (kg/day)	Households	Mulching material collected annually ('000 tonnes)
North	0.92	6906	2.32
East	1.1	34333	13.78
West	10.9	26889	106.98
South	1.3	24510	11.63
Total			134.71

Table 39: Estimate of amount of green manure collected annually

District	Material for Cattle bed collected per HH (kg/day)	Households	Annual collection of green manure ('000 tonnes)
North	11.79	6906	29.72
East	0.4	34333	5.01
West	12	26889	117.77
South	0.3	24510	2.68
	24.49	92638	155.19

Table 40: Estimate of amount of cattle bed material collected annually

District	Material for Cattle bed collected per HH (kg/day)	Households	Cattle bed material collected annually (million tonnes)
North	6.85	6906	17.27
East	12.1	34333	151.63
West	11.6	26889	113.85
South	1.3	24510	11.63
Total			294.38

5.7 Validation of Results

The results of the survey were presented for validation to Forest Range Officers in all the 4 districts, who have on-ground experience of movement of forest produce. The overarching goal of this activity was to design possible interventions for addressing deforestation and forest degradation in the State.

Feedback was taken on the driver-source allocation and the potential interventions that can be propagated to address deforestation and degradation through discussions and in writing from each participant.

In general, the allocation by source and quantification of all the drivers were agreed upon by the stakeholders who participated in the meetings. The key points that emerged during the discussions were as follows:

- Respondents in general agreed with the unplanned drivers identified through the survey
- Forests produce in in Sikkim are sourced from:
    - *Khasmal* forests
    - *Gorucharan* forests
    - Private forests
- The plantations mentioned in the survey questionnaire refer to the Private forests.
- The trees outside forests (ToFs) considered in the questionnaire are actually trees along the roads which are again part of the forests and therefore need to be merged within the forest category.
- The penetration of Compressed Natural Gas (CNG) is high in Sikkim wards, but fuelwood continues to be used for cooking HH food and for cooking feed for cattle as well. The cattle feed is entirely cooked using fuelwood.
- In South Sikkim, the high amount of purchased fodder is attributed to rapid rise in dairy as a livelihood alternative. Households are buying fodder from markets in Siliguri (in the neighbouring state of West Bengal) to meet the demand.
- If needed, people buy fodder from neighbouring fields also. Therefore, markets may be replaced with a generic term “Purchased”.
- Fodder collection during the peak winter and summer months increase as schools in the State are shut.
- In West Sikkim, the high amount of grazing (60%) reported from forests is during the tourist season when ponies graze in the forests while they travel with tourists to the

Khangchendzonga Biosphere Reserve (KBR). In other seasons grazing from forests is around 25-30%.

- In future demand for fodder and feed is likely to go up manifold as dairying is becoming a viable lucrative livelihood option in rural areas
- Small timber is not purchased from the market in general in any district. So this source category should be deleted and instead this allocation should be attributed to forests. Mainly people use bamboo in place of small timber. Again, bamboo is sourced from private land but with permission of the FEWMD.
- Grazing is done in forests, private forests and in fallow cropland. There is no “other land” from which grazing is done. All the other land indicated should be merged with cropland and private forests.
- Large timber is mainly sourced from private sources, and from *Gorucharan* and *Khasmal* areas but felling is done with permission of the FEWMD. Additionally the FEWMD collects all timber that is felled during construction/expansion of roads and also when trees fall in forests due to various natural reasons. These are also given away or auctioned.
- Mulching and cattle bed material is sourced from forests (*Khasmal* and *Gorucharan*), and from private forests. TOFs here need to be included within the Forest category itself. Monasteries in West Sikkim collect 50% of the revenue generated through forest produce sales as equal proportion of forest land is under their control. FEWMD Depots are stocking firewood and timber but there are no direct buyers. They are giving away wood to timber agents. A value chain for that may be worked out.
- Mixed cropping in private lands may be planned systematically as it will increasingly become the source of fuelwood fodder, large timber, small timber, mulching material, cattle bed material and in some cases green manure as well. In the North District, it is important to carry out surveys in largely inaccessible areas like Lachen and Lachung as well, though changes in forests in these areas are mainly driven by natural causes such as landslides. Stakeholders are of the opinion that the people in these areas are more dependent on forests. In the East district, between Fambongloh Wild Life Sanctuary (FWLS) and Gangtok, Singtam, Ranipool, significant deforestation and forest degradation has been observed. Further during the discussions it emerged that the largest planned drivers in Sikkim such as construction of roads and hydropower have all been sanctioned. No further sanctions will be made in the future. However, the scope of expansion of cities and cropland in the future can be a matter that can be looked into to.

6. Driver-Intervention Matrix

6.1 Introduction

Based on primary and secondary studies as well as consultations held with the stakeholders in the State, a number of potential interventions were identified as a part of this project. The interventions have been categorized into 3 main groups:

1) Forest Management (FM)
2) Energy Management (ENE)
3) Agriculture and Land Management (ALM)

Implementation of the interventions under the category Forest Management (FM) will be directly managed by the FEWMD. These activities include fire management, Assisted Natural Regeneration (ANR), Afforestation/Reforestation (AR), oak regeneration and plantation, pasture and grassland management etc. The interventions in the Energy Management (ENE) category focus on decreasing the consumption of non-renewable biomass from forests for energy. Agriculture and Land Management (ALM) attempts to substitute extraction of resources from forests by growing them in alternative sources such as community land, private land etc. Some activities which are supportive in nature and attempt strengthening communities and local institutions, are also suggested. All the activities can be interlinked with the schemes of the State Government. This will ensure all the departments are involved in combating climate change through initiatives and active participation in implementing interventions in the State.

In the following tables all the intervention activities have been detailed out describing the problems, solutions, and their implementation plans, among others.

6.2 Interventions to Decrease Emissions from Forests

Each intervention activity to address deforestation and degradation has specific objectives to serve. The objectives could be better forest management, capacity building, governance, clean energy solutions like solar, improved cook stoves (ICS), etc. All the intervention activities have been classified into different categories and details of the same are given below.

Table 41: List of interventions planned for Sikkim under the REDD+ project

S. No.	Code	Name of Intervention	Drivers Addressed
1	FM-ANR-FEWMD	1. Assisted Natural Regeneration in forests to stop degradation 2. Afforestation/Reforestation in non-forest lands	Unsustainable extraction of fuelwood
2	FM-OAK-SILV	Oak regeneration and plantation	
3	FM-GAU-KHSM	Silvi-pastoral and Horti-pastoral practices in Khasmal and Gorucharan lands	Overgrazing in forest lands
4	FM-FIRE-FL	Creation and maintenance of firelines in forests	Forest fires
5	FM-FIRE-COMM	Community-based firefighting	
6	FM-FIRE-TOW	Permanent fire-camps and fire watchtowers	
7	FM-MAP-KG	Identification and creation of a registry of Khasmal and Gorucharan forestlands in Sikkim	Overgrazing in forest lands
8	FM-FRAS-GAU	Grassland restoration in Gorucharan and Khasmal lands	

9	FM-BRDR-PLANT	Bio-fencing to reduce encroachment, illegal felling and man-animal conflicts	Encroachment, unsustainable fuelwood and NTFP extraction, man-animal conflicts
10	FM-PTRL-FEWMD	Procurement and recruitment for better patrolling	Encroachment, unplanned felling
11	ENE-FW-MON	Sustainable fuelwood management in religious institutes such as monasteries	Fuelwood extraction from forests for events like weddings and death
12	ENE-ICS-HH	Alternate energy technologies for cooking in Households	Unsustainable fuelwood extraction from forests for cooking and heating purposes
13	ENE-ICS-COMM	Improved Cook Stoves for community cooking	
14	ENE-DRY-CARD	Fuelwood efficient driers for cardamom processing	
15	ENE-ICS-FODD	Improved Cook Stoves for fodder preparation	
16	ENE-BRQ-FW	Smokeless Biomass briquettes as a fuelwood substitute	
17	ENE-ICS-SCH	Improved Cook Stoves, LPG and solar cookers in schools as part of the Mid-Day Meal Scheme	
18	ALM-FW-PVT	Fuelwood plantations and fodder plantations in private forests	Unsustainable Fuelwood extraction from forests and overgrazing in forest lands
19	ALM-FODD-HYDP	Development of hydroponics and azolla for fodder	Overgrazing in forest lands
20	ALM-AGR-CARD	Multi-storey agro-forestry model in Cardamom plantations	Unsustainable fuelwood extraction from forests for heating purposes

Details of the Interventions

1) Afforestation/Reforestation and ANR activities

Name of the intervention:	Plantation activities: 1. Afforestation and Reforestation in non-forest lands for tree cover. 2. Assisted Natural Regeneration in forests to stop degradation.
Code:	FM-ANR-FEWMD
Description of the problem	Through LULC change mapping, it is observed that there are pockets of forest degradation and deforestation in Sikkim, which leads to emissions.
Description of the solution	Plantation activities in identified degraded pockets through Assisted Natural Regeneration (ANR) and gap plantation and identified non-forest pockets which are prone to deforestation (Afforestation and Reforestation) will help in enhancement of forest stock and increase forest and tree cover.
Detailed description of the technology	Afforestation and reforestation both refer to establishment of trees on lands not currently having trees. Reforestation refers to establishment of forest on land that had recent tree cover, whereas afforestation refers to land that has been without forest for much longer[61]. For such activities, it is stipulated that the identified land at the time of commencement of plantation is not a forest, and woody vegetation on the land is below the forest threshold as decided for the national GHG inventory; which is a crown cover of 10%.

[61] www.ipcc.ch/ipccreports/sres/land_use/index.php?idp=47

<table>
<tr><td></td><td>ANR is a method for enhancing the establishment of secondary forest from degraded grassland and shrub vegetation by protecting and nurturing the mother trees and their wildlings inherently present in the area[62]. ANR activities are focused on lands currently classified as forests (and which meet the minimum eligibility criteria for forests mentioned above), but which may not remain one in the future due to anthropogenic pressures from the drivers of forest change identified in the socio-economic surveys conducted in the landscape. Depending on the existing condition and canopy cover of the identified area, appropriate techniques and methods for plantations and development of the degraded landscape will be employed towards regenerating forest cover through selection of appropriate tree species, forest management, protection and monitoring.</td></tr>
<tr><td>Institutional partners</td><td>JFMCs/EDCs</td></tr>
<tr><td>Identified barriers</td><td>1. Non-availability of degraded areas on a suitable scale.
2. Lack of sufficient funds to undertake plantation activities across Sikkim.
3. Lack of technology-driven cost effective monitoring of these plantations.</td></tr>
<tr><td>How will these be overcome through REDD+ project?</td><td>1. Training of FEWMD personnel and JFMCs on undertaking best land regeneration practices through trainings planned under REDD+.
2. Undertaking communication campaigns focusing on the benefits of forest conservation and enhancement.
3. Distribution of native tree species' seeds and saplings for plantation to JFMCs and EDCs under an appropriate scheme.
4. Convergence of funds and schemes for better regeneration of degraded forest and non-forest land.
5. Use the tools and techniques developed under the Forest-PLUS program for better monitoring of the forests where plantation activities have taken place.</td></tr>
<tr><td>Implementation plan</td><td>1. Identification and demarcation of degraded forest and non-forest land, its extent of degradation and suitability for A/R and ANR activities. This has been done and is detailed in the nested tables below.

Potential sites identified for ANR totalling 837 ha to stop degradation completely:
<table>
<tr><th>Canopy density</th><th>10-30 & 30-50</th><th>10-30 & 50-70</th><th>10-30 & 70 abv</th><th>30-50 & 50-70</th><th>30-50 & 70 abv</th><th>50-70 & 70 abv</th><th>Total (ha)</th><th>Area selected for ANR (ha)</th></tr>
<tr><td>MMD</td><td>105</td><td>7</td><td>2</td><td>124</td><td>31</td><td>26</td><td>294</td><td>294</td></tr>
<tr><td>WTF</td><td>290</td><td>-75</td><td>-48</td><td>-104</td><td>-116</td><td>-183</td><td>-236</td><td>290</td></tr>
<tr><td>SWH</td><td>87</td><td>-59</td><td>-29</td><td>80</td><td>1</td><td>-57</td><td>23</td><td>191</td></tr>
<tr><td>CF</td><td>53</td><td>-18</td><td>-3</td><td>-21</td><td>9</td><td>-31</td><td>-11</td><td>63</td></tr>
<tr><td>SAF</td><td>-33</td><td>-188</td><td>0</td><td>-290</td><td>-15</td><td>-109</td><td>-636</td><td>0</td></tr>
<tr><td>Total</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>837</td></tr>
</table>
Other potential sites to enhance the forest cover:
<table>
<tr><th>Table 2.1</th><th>MMD (total)</th><th>10-30</th><th>30-50</th><th>50-70</th><th>70 and above</th></tr>
</table></td></tr>
</table>

[62] www.fao.org/forestry/anr/en/

Total area in 2013	25,767	5,276	7,888	8,009	4,594
Enhancement per year (ha/year)	219	79.56	88	51	0
Degradation per year (ha/year)	512	0	162	227	123
Net degradation (ha/year)	294	-80	74	176	123

Table 2.2	**WTF (total)**	**10-30**	**30-50**	**50-70**	**70 and above**
Total area in 2013	1,47,465	20,857	27,329	42,341	56,938
Enhancement per year (ha/year)	1,417	440.87	614	363	0
Degradation per year (ha/year)	1,181	0	581	392	208
Net degradation (ha/year)	-236	-441	-32	29	208

Table 2.3	**SWH (total)**	**10-30**	**30-50**	**50-70**	**70 and above**
Total area in 2013	64,148	5,859	11,688	17,481	29,120
Enhancement per year (ha/year)	653	208.11	205	240	0
Degradation per year (ha/year)	676	0	195	269	213
Net degradation (ha/year)	23	-208	-11	29	213

Table 2.4	**CF (total)**	**10-30**	**30-50**	**50-70**	**70 and above**
Total area in 2013	19,553	3,069	6,251	6,419	3,814
Enhancement per year (ha/year)	326	62.09	178	86	0
Degradation per year (ha/year)	315	0	92	151	72
Net degradation (ha/year)	-11	-62	-86	65	72

Table 2.5	**SAF (total)**	**10-30**	**30-50**	**50-70**	**70 and above**
Total area in 2013	79,581	14,150	32,929	27,772	4,730
Enhancement per year (ha/year)	1387	706.60	507	174	0
Degradation per year (ha/year)	751	0	441	232	79
Net degradation (ha/year)	-636	-707	-65	57	79

Table below shows the area where plantation to stop deforestation will be targeted totalling 765 ha:

Forest type	MMD	WTF	SWH	CF	SAF
Deforestation per year (ha/yr)	264	165	201	65	70

Mapping and plantation activities in this 1,602 ha (837 ha ANR + 765 ha reforestation) will be taken up by Year 2 of the REDD+ activity.

2. Selection of suitable native species to be used for regeneration of forest through consultations within FEWMD.
3. Convergence of schemes and funds for implementing the plantation activities on the degraded lands. For example; under the SBFP, 3,600 Ha of afforestation and regeneration activities have been planned (2010-2020)[63], which will supplement the activities under this intervention.
4. Expert consultations to identify, and attempt to overcome, expected challenges (environmental, ecological, and financial) for carrying out the regeneration of the degraded land.
5. Development of an Action Plan for administration and monitoring of the intervention with JFMCs and FEWMD.
6. Year 3 onwards, further ANR to increase the forest stocks. This will be done in a phased manner as explained in the table below.

Culturable waste land in Sikkim has been identified to be around 3,000 ha (ISFR 2015). Of these, 1,800 ha shall be brought under forest cover in 20 years in a phased manner by targeting 100 ha plantation each year, and maintenance for 3 years for each of the 100 ha. This area is identified under 'area to be brought under afforestation'.

Land currently under agriculture (especially spices such as cardamom which needs shade) is planned to be brought under agro-forestry.
ANR involves enhancement of existing forests through gap plantation and other activities in the forest land.

Oak regeneration (also detailed under another intervention in another table below) is planned to be taken up in 1,800 ha over 20 years.

Plantation activities	Year 1	Year 2	Year 3	Year 4	Year 5
Area to be brought under afforestation (ha)	0	0	100	100	100
Area to be brought under agro-forestry (ha)	0	0	200	200	500
Area to be brought under ANR (ha)	0	0	200	200	500
Oak regeneration (ha)	0	0	100	100	100
Total	0	0	600	600	1,200

Plantation activities	Year 6	Year 7	Year 8	Year 9	Year 10

[63] JICA-assisted Sikkim Biodiversity Conservation and Forest Management Project; Forests, Environment and Wildlife Management Department.

	Area to be brought under afforestation (ha)	100	100	100	100	100
	Area to be brought under agro-forestry (ha)	500	500	500	500	500
	Area to be brought under ANR (ha)	500	500	500	500	500
	Oak regeneration (ha)	100	100	100	100	100
	Total	1,200	1,200	1,200	1,200	1,200

Plantation activities	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**
Area to be brought under afforestation (ha)	100	100	100	100	100
Area to be brought under agro-forestry (ha)	500	500	500	500	500
Area to be brought under ANR (ha)	500	500	500	500	500
Oak regeneration (ha)	100	100	100	100	100
Total	1,200	1,200	1,200	1,200	1,200

Plantation activities	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Total**
Area to be brought under afforestation (ha)	100	100	100	100	100	**1,800**
Area to be brought under agro-forestry (ha)	500	500	500	500	500	**8,400**
Area to be brought under ANR (ha)	500	500	500	500	500	**8,400**
Oak regeneration (ha)	100	100	100	100	100	**1,800**
Total	1,200	1,200	1,200	1,200	1,200	**20,400**

Co-benefits	Access to timber, fuelwood and fodder, increase the forest cover and health, provision of labour to people in plantation and site preparation activities, decrease in incidents of landslides.
Potential schemes	All existing schemes and programs on afforestation, reforestation in the sites • National Afforestation Policy (NAP), NAEB (MoEFCC) [State Implementing Agency: SFEWMD] • State Compensatory Afforestation Fund Management and Planning Authority (CAMPA) • Forestry and Environment Mission, Sikkim • State Green Mission • Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) [State Implementing Agency: RMDD]

2) Oak Regeneration

Name of the intervention:	Oak regeneration and plantation
Code:	FM-OAK-SILV
Description of the problem	Oak is a native species of Sikkim. Oak forests in the State have declined over the past centuries owing to various reasons.
Description of the solution	Oak is a native tree of the state – a total of 11 varieties of oak are found in Sikkim. Oak trees are known to be keystone species and are intimately linked with a large number of organisms, thus playing an important role in maintaining ecosystem stability. The planting of oak trees would augment natural regeneration in the landscape, as well as providing benefits like supporting higher species diversity, stratification, litter production and soil fertility[64]. Regeneration of oak, even in those areas with *c. japonica* will help in improving the forest health.
Description of technology	Patches of forest where the invasive species[65] are commonly found to be identified and strategies advanced for felling the invasive species under special provisions of the FEWMD. Oak can be planted in their place through the Direct Seed Sowing (DSS) technique. DSS has been field-tested in hilly environments and found to be extremely successful in reducing seedling mortality and ensuring healthy growth of individuals.
Institutional Partners	JFMCs/EDCs
Identified barriers	Financial and technical barriers in mapping sites to take up oak plantation.
How will these be overcome through REDD+ project?	1. Training and capacity building of Range-level FEWMD personnel towards managing oak plantations 2. Encouraging associations such as the Central Himalayan Environment Association (CHEA) and other organizations to provide new techniques for oak plantation and management
Implementation plan	1. Identification of patches of forest where *invasive species* dominate, and to evolve strategies to clear them as per the existing policies and map those areas. 2. Identify other areas where oak plantation can be taken up. 3. Provision of oak seedlings under earmarked funds under central and state schemes, as well as exploring associations with environmental organizations.
Co-benefits	Potentially decrease incidents of landslides, increase biodiversity
Potential schemes	Existing afforestation programs and schemes under FEWMD. • National Afforestation Policy (NAP), NAEB (MoEFCC) [State Implementing Agency: SFEWMD] • State Compensatory Afforestation Fund Management and Planning Authority (CAMPA) • Forestry and Environment Mission, Sikkim • State Green Mission • Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) [State Implementing Agency: RMDD]

[64] Report of the Exposure Visit to learn the Techniques of Direct Seed Sowing (DSS) of Acorns; FEWMD and Forest-PLUS.
[65] Sekar, KC., *"Invasive Alien Plants of Indian Himalayan Region- Diversity and Implication",* American Journal of Plant Sciences (2012), 3, 177-184

3) Silvi-pastoral and Horti-pastoral Models in Khasmal and Gorucharan lands

Name of the intervention:	Silvi-pastoral and Horti-pastoral practices in Khasmal and Gorucharan lands
Code:	FM-GAU-KHASM
Description of the problem	Households in Sikkim typically own several animals – cows, buffaloes, yaks, sheep and goats – due to which Sikkim has a sizeable livestock and poultry population. It is estimated that there are 291,626 livestock in the State, which require a constant supply of fodder and pasture lands[66]. There are 92,638 rural households in Sikkim, with average of 3 livestock per household. This leads to pressure on existing lands to provide fodder and pastures. From the socio-economic survey conducted in the landscape, it is estimated that about 2.5 million tonnes of fodder is consumed annually in Sikkim.
Description of the solution	Development of silvi-pastoral models on Khasmal and Gorucharan lands to meet the pasture demands of local livestock and to provide for the cultivation of trees for fuelwood purposes.
Detailed description of the technology	Silvi-pastoral systems advocate the cultivation of trees simultaneously with the cultivation of grasses and forage. In this system, the space between individual tree specimens in silvi-pastoral and horti-pastoral systems will be utilized for cultivation of grasses and forage for livestock. In-situ grazing will be provided for livestock throughout the year (in silvi-pastoral systems) and for a period of 3-4 months during fruiting season (in horti-pastoral systems). In addition, foliage is to be made available for livestock consumption.
Partner institutions	1. Rural Management and Development Department (RMDD) 2. JFMCs/EDCs/SHGs and Gram Panchayats
Identified barriers	1. Lack of awareness and knowledge of silvi-pastoral and horti-pastoral practices and their benefits 2. Lack of resources and capacity of local communities towards the development and monitoring of silvi-pastoral landscapes. 3. Lack of coordination among institutions for the deployment of this intervention, along with other financial and technical towards adoption of these modern techniques
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns on benefit of forest conservation, importance of silvipastoral and hortipastoral practices 2. Training and capacity building on silvipastoral and hortipastoral practices 3. Distribution of ecologically adaptive and agro-climatically suitable tree species seeds and saplings for silvi-pastoral and horti-pastoral plantations 4. Financial, technical and institutional support to overcome the barriers of silvipastoral and hortipastoral practices
Implementation plan	1. Identification and selection of Khasmal and Gorucharan forests in each district for adoption of silvi-pastoral activities 2. Designing of silvi-pastoral and horti-pastoral activities in consultation with experts and institutions and agencies like local NGOs, SHGs and others. 3. Training, capacity-building and promotion of silvi-pastoral and horti-pastoral activities 4. Facilitating distribution of seeds of ecologically adaptive and agro-climatically suitable species

[66] 19th Livestock Census Report 2012; Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture.

	5. Convergence of public funds and schemes for promoting and implementing silvi-pastoral and horti-pastoral practices 6. Development of an Action Plan for administration and monitoring of the intervention with Gram Panchayats, RMDD and FEWMD.
Co-benefits	Availability of fodder and shade for livestock, better demarcated boundaries will help in better management of resources, will also help in watershed management.
Potential schemes	Existing fodder and livestock management schemes in Sikkim • Forestry and Environment Mission • Sikkim Green Mission • Accelerated Fodder Development Programme, Ministry of Agriculture (Government of India)

4) Development of Fire lines

Name of the intervention:	Creation and maintenance of fire lines in forests with help of GIS techniques
Code:	FM-FIRE-FL
Description of the problem	Fire has long been integral part of the forest environment and has played an important role in shaping the flora and fauna. Forest fires are a common occurrence in the summer months in Sikkim, especially in the Moist Mixed Deciduous Forests found in the lower elevations. Every year forest fire causes great loss to the forest ecosystem, diversity of flora and fauna and economic wealth and is one of the major disasters in the state. Incidences of forest fire have increased over the years, where a major attribution is on lack of moisture due to quicker evapotranspiration. These fires, set mainly in the slopes of the sub-Himalayan region, produce clouds of smoke thereby releasing tons of CO_2 into the atmosphere, hence contributing to the phenomenon of climate change. There are many indigenous and endangered species which are adversely affected due to forest fires. In general, surface fires are observed which affect ground vegetation, bushes as well as leaf and woody litter. In 2014, there were 62 total forest fire cases in Sikkim, while in 2013, 38 such cases were observed[67]. Fires occur at remote places of the forests which are very difficult to identify with normal sight. Traditional fire lines will disappear after rainy season and winter. It is very difficult to identify them. Regular maintenance of these fire lines are essential. At present geo tagging is not done for all fire lines.
Description of the solution	Development of 'fire lines' before the onset of the summer season to check the advance the forest fires. A 'fire line', also called 'fire-break', is the traditional practice of burning a strip of vegetation and clearing the land so that if there is a fire, the flames don't spread. Geo-tagging of each fire line will be done to monitor forest fires using advanced GIS mechanisms. This will help in mapping the existing lines and also establish new ones if required fire lines.
Detailed description of the technology	Fire lines are demarcated around a swathe of forest land covering a given area, usually a Beat or less, and the vegetation is normally burnt during the onset of winter as the moisture, including early morning mist, helps in controlled burning[68]. All the fire lines are geo-tagged with advanced GIS protocols. These geo-tagged fire lines are mapped and monitored using satellites. Whenever forest fires occur, satellite will

[67] www.sikkimforest.gov.in/Forest-Fires-Sikkim.asp
[68] www.thehindu.com/news/national/karnataka/Forest-officials-bracing-up-for-fire-lines-ahead-of-schedule/article16079227.ece

	trigger a warning message to the forest fire line control centre, to take further action on real time basis.
Partner institutions	1. Local JFMCs/EDCs 2. Rural Management and Development Department (RMDD) 3. Sikkim State Disaster Management Authority (SSDMA) 4. ISRO
Identified barriers	1. Lack of training and capacity of local community members to carry out controlled burning, maintain fire lines and knowledge about GIS mechanisms.
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns to sensitize local communities on the ill-effects of forest fires, the common do's and don'ts and the relevant precautions to be taken in forests 2. Supporting the capacity building of local FEWMD personnel and local communities towards forest fire management 3. Dissemination of best practices of fire management and preventing fire outbreaks
Implementation plan	1. Identification of forest areas vulnerable to fires in each district. 2. Training and capacity building of FEWMD personnel and JFMC/EDC members to carry out controlled burning at selected sites in RFs. 3. Establishment of fire lines: Take up fire lines across 1,000 km in Sikkim and geo-tag them individually with clear identification of vulnerable and fire prone areas using latest GIS technology and ground reconnaissance. 4. Development of SOP for maintaining the fire lines. 5. Create JFMC groups to help in creation and maintenance of the fire lines.
Co-benefits	Less casualties and loss of property due to fire incidents, employment generation, capacity building.
Potential schemes	To be built under the Working Plan prescriptions.

5) Community-based Firefighting

Name of the intervention:	Community-based firefighting
Code:	FM-FIRE-COMM
Description of the problem	The problem of forest fire has been explained in the intervention given above.
Description of the solution	Apart from creation of fire lines, fire management activities undertaken in coordination with local JFMCs/EDCs to reduce the instances of fires in forestlands across the state are found to be very effective in controlling fire.
Detailed description of the technology	Community involvement in forest fire management techniques and methods undertaken by the FEWMD. This would include coordination in maintenance of fire lines and regulating access to forests among a suite of activities as per a jointly-developed Action Plan. Under the JICA-assisted Sikkim Biodiversity Conservation and Forest Management Project (SBFP), 90 new JFMCs/EDCs have been formed across Sikkim. These newly-created JFMCs and EDCs, along with

	already-present ones, will be strengthened through capacity building to assist the FEWMD in carrying out its fire management activities[69].
Partner institutions	1. JFMCs/EDCs 2. RMDD 3. Sikkim State Disaster Management Authority (SSDMA)
Identified barriers	1. Lack of interest among local communities to participate in fire management 2. Irregular monitoring of vulnerable forest areas, making it susceptible to further fire attacks
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns to sensitize local communities on the ill-effects of forest fires, the common do's and don'ts and the need to take certain precautions when in forestlands. 2. Supporting the capacity building of local FEWMD personnel and local personnel towards forest fire management. 3. Training the department staff and communities with advanced GIS mechanisms on forest fire management
Implementation plan	1. Identification of forest areas vulnerable to fires in each district. 2. Identification of active JFMCs and EDCs in identified areas. 3. Training and capacity building of FEWMD personnel and JFMC/EDC members to carry out specified forest fire management activities. 4. Development of an Action Plan for constant monitoring of identified sites to ensure continued restriction of fire outbreaks, in coordination with FEWMD, RMDD and SSDMA, and overseen by the REDD+ Cell.
Co-benefits	Less casualties and loss of property due to fire incidents, employment generation, capacity building.
Potential schemes	Part of JFMC/EDC; village development schemes

6) Fire-camps and Fire Watchtowers

Name of the intervention:	Establishment of fire-camps and fire watchtowers
Code:	FM-FIRE-TOW
Description of the problem	The problem of forest fires is explained in the description of the intervention above.
Description of the solution	Establishing permanent fire camps and fire watchtowers in vulnerable forest areas in Sikkim for constant monitoring to avoid the initiation and spread of forest fires.
Detailed description of the technology	Fire camps are campsites for firefighters and support personnel setup to monitor fires in areas which require large manpower, logistics and organization. Permanent fire camps setup in the identified vulnerable forest patches help in round-the-clock monitoring of the landscape to avoid the development of forest fires. Similarly, fire watchtowers ensure regular monitoring of forest fires in vulnerable areas by providing a panoramic view of the forestlands.
Partner institutions	1. RMDD 2. Sikkim SDMA 3. Local JFMCs/EDCs
Identified barriers	Lack of funding for construction of fire camps and watchtowers.

[69] JICA-assisted Sikkim Biodiversity Conservation and Forest Management Project; Forests, Environment and Wildlife Management Department.

How will these be overcome through REDD+ project?	1. Making available sustainable sources of funding for the development and maintenance of fire camps and watchtowers 2. Supporting the capacity building of local FEWMD personnel and local personnel towards forest fire management
Implementation plan	1. Identification of forest patches vulnerable to fires in each district. 2. Construction of fire camps and fire watchtowers from fire management funds earmarked under the annual budget of the FEWMD in selected sites. 3. Training and capacity building of FEWMD personnel to carry out specified forest fire management activities. 4. Development of an Action Plan for constant monitoring of sites to ensure no fire outbreak occurs.
Co-benefits	Less casualties and loss of property due to fire incidents, employment generation, capacity building.
Potential schemes	Can be made a part of existing working plan/management plan prescriptions.

7) Identification and Demarcation of Khasmal and Gorucharan forests

Name of the intervention:	Identification and Registry of Khasmal and Gorucharan forestlands in Sikkim through GIS techniques
Code:	FM-MAP-KG
Description of the problem	Khasmal and Gorucharan forestlands are protected forest under the jurisdiction of the FEWMD. Sustainable extraction is allowed for local communities for bona-fide use from these forests. Classified under Protected Forests, these forests make up a total of 389 km^2 in Sikkim[70]. However, exact demarcation of boundaries of these lands is required for better management of these lands. At present there is no geo-referenced map of these lands.
Description of the solution	Identification and creation of a registry of Khasmal and Gorucharan forests through spatial analysis and field surveying is required. This will help in better management of these forests by the FEWMD. These measures will streamline the interventions proposed under this project, including increasing fuelwood and fodder plantations and management of these forests in coordination with JFMCs and EDCs. This is also in line with the resolutions of the FEWMD[71].
Description of technology	Survey, mapping and spatial analysis in each range will help in the demarcation of the extent of Khasmal and Gorucharan forests in Sikkim. At the range level, the forest guards and beat officers shall be tasked with surveying, after adequate training and capacity building. Officers from the GIS Cell will be deployed to every division to facilitate the easy coordination of these activities across the division. The surveying and mapping part also involves extensive stakeholder consultations so as to ensure any disputes are settled in an amicable manner.
Institutional Partners	Revenue Department, Agriculture Department
Identified barriers	1. Lack of surveying capacity (in terms of people, hardware and software) 2. Lack of political support to undertake mapping and surveying of these lands.

[70] India State of Forest Report, 2015.
[71] Resolution of the FEWMD, Government of Sikkim.

How will these be overcome through REDD+ project?	1. Training and capacity building of FEWMD personnel. 2. Procurement of hardware and software required for mapping, including survey equipment and GIS software. 3. Making this a part of the overall stakeholder consultations and engagement under REDD+ to enhance livelihood, which will ensure support to this activity from all stakeholders. This will also ensure sustainability of other interventions on Khasmal and Gorucharan lands.
Implementation plan	1. Undertaking training programs in mapping and surveying techniques for FEWMD officials nominated by each Range. 2. Detailed study of land records, other available government records and secondary literature on the lay of these lands. 3. Consultation with key informants on steps to be taken on the ground. 4. Prepare ground survey plan, consultations with revenue department and agriculture department to finalise the plan. 5. Conduct stakeholder consultations and survey of land. 6. Geo-spatial mapping. 7. Round-2 of inter-departmental consultations to demarcate the areas. 8. Round-2 stakeholder consultations. 9. Setting up mechanisms for redressal; creation of the registry of these forests.
Co-benefits	Better land demarcation empowers people, decrease in incidents of encroachment, community-led management of conservation of grazing lands.
Potential schemes	Under FEWMD

8) Restoration of Grass in Gorucharan forests

Name of the intervention:	Grass restoration in Gorucharan lands
Code:	FM-FRAS-GAU
Description of the problem	Households in Sikkim typically own several animals – cows, buffaloes, yaks, sheep and goats – due to which Sikkim has a sizeable livestock and poultry population. It is estimated that there are 291,626 livestock and 451,966 poultry numbers in the state[72]. Fodder requirements to support this population is causing loss of natural capital in Sikkim. Some forestland in each region is set aside as Gorucharan lands, where livestock grazing is permitted. These lands have undergone degradation due to mismanagement of land and overgrazing over the years, which has reduced the quality and quantity of forage available in the vicinity of the villages.
Description of the solution	Development of strategies focused towards grass restoration in Gorucharan forests[73] for better quality and quantity of forage to bring down the fuelwood and fodder demand from the Reserve Forests.
Detailed description of the technology	Gorucharan forests have traditionally catered to meet the grazing requirements of the livestock in the State. Development of appropriate strategies towards grass restoration in these landscapes would help

[72] 19th Livestock Census Report 2012; Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture.
[73] Khasmal Forests – government owned forests land set aside to meet the need of timber, firewood and fodder of the adjoining villages
Gorucharan Forests – government owned forests land set aside for the purpose of grazing of cattle of the adjoining villages

	check degradation of these lands and continue to meet the livestock requirements sustainably.
Institutional partners	JFMCs/EDCs
Identified barriers	1. Lack of awareness on better management practices of Gorucharan and Khasmal lands for grazing. 2. Financial and technical barriers towards restoration of lands
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns on benefits of conservation, protection, and development of grazing lands in the vicinity. Community based maintenance of such grazing lands will be especially focussed in these trainings. 2. Training and capacity building of local JFMCs on sustainable forest management practices. 3. Distribution of ecologically adaptive and agro-climatically suitable grass species seeds and saplings. 4. Convergence of government, public and private funds and schemes for better management of Gorucharan forests. 5. Financial and technical support.
Implementation plan	1. Training of FEWMD personnel and community on best practices related to grass rotation and regulation. 2. Identification of pilot lands where grassland restoration activity are to be taken up in a phased manner. 3. Community handholding in developing grazing lands and maintaining them sustainably. 4. Monitor the implementation of the project through community based monitoring tools, including the ones developed under the Forest-PLUS Program.
Co-benefits	Source of fodder and decrease soil erosion.
Potential schemes	• Existing fodder management schemes • Accelerated Fodder Development Programme, Department of Agriculture (Government of India)

9) Bio-fencing to counter encroachment

Name of the intervention:	Bio-fencing to reduce encroachment, illegal felling and man-animal conflicts
Code:	FM-BRDR-PLANT
Description of the problem	Encroachment and illegal felling are some of the many causes of deforestation and forest degradation, especially in areas close to the Sikkim border. Further, in areas where agricultural fields are situated adjacent to forestlands, there are frequent man-animal conflicts due to animals like wild boars, porcupines and barking deer that approach crops for foraging[74].
Description of the solution	Development of biological barriers such as agave plantation can stop the felling and transport of local timber out of Sikkim, while also acting as a barricade against animal incursion. These natural barriers would supplement existing efforts undertaken by the FEWMD, like surveillance through watchtowers and procurement of night-vision glasses, to check these illegal activities. In addition, such vegetative barriers restrict animals from foraging on agricultural produce and causing crop

[74] Sikkim State Action Plan on Climate Change.

	damages. A pilot project for developing agave plantations as natural barriers in Sikkim is already underway under the SBFP.
Description of technology	Agave plantations have been used across various states in India for live fencing due to its low maintenance requirements, growth of marginal lands and its soil binding properties. Agave leaves are thick and fleshy, and its tips are full of spines[75]. Rows of agave plantations would help check illegal encroachment, felling and transport of timber, as well as man-animal conflicts, by acting as a natural barrier. Other types of vegetation can also be explored to act as bio-fencing towards restricting these activities.
Identified barriers	1. Lack of protection and maintenance of these bio-fencing techniques 2. Lack of capacity and training of local FEWMD personnel and communities towards bio fencing 3. Destruction of such fences by encroachers
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns on the benefits of natural barriers to restrict these activities. 2. Training and capacity building of JFMCs and local communities, in addition to convergence of central and state funds and schemes, on the plantation and maintenance of these bio-fences 3. Distribution of saplings (e.g. agave or other thorny species) of plants which can be used for live fences
Implementation plan	1. Training of FEWMD personnel, JFMCs and local communities on the construction and maintenance of live fences 2. Identification of areas which are priority plantations to take up agave plantation, geo-tagging them. 3. Ground reconnaissance, raising agave, planting them in the prescribed manner. 4. Development of strategies to converge the objectives of this intervention with other FEWMD initiatives to check illegal felling and transport. 5. Convergence with the JICA-supported pilot project on agave plantations to cover more areas across the district.

[75] biogov.in/article/agave-a-multipurose-dryland-plant/

	 Figure 27: Agave plantation
Co-benefits	Decrease man-animal conflict, encroachment, smuggling.
Potential schemes	Existing FEWMD schemes

10) Procurement of equipment and recruitment of personnel

Name of the intervention:	Procurement and recruitment for better patrolling
Code:	FM-PTRL-FEWMD
Description of the problem	The FEWMD is responsible for the management of forests in the State of Sikkim. Lack of considerable human resource in the forest department causes problems in enforcing policies and assigning staff for patrolling activities.
Description of the solution	Streamlining the recruitment of FEWMD personnel at regular intervals through rigorous selection and assessment will help develop a cadre of dedicated staff at the state level equipped with the resources to ensure the management of forests in Sikkim. Procurement of vehicles and equipment like night vision goggles under state government funds allotted to the FEWMD will help the personnel discharge their duties effectively and promptly. State-of-the-art equipment to monitor the forests and personnel for patrolling can help in stopping forest degradation.
Detailed description of the technology	A multi-pronged approach on better equipped forest monitoring and patrolling is planned. 1. Procurement of one motorcycle in each range office for watchers to quickly move to areas within the forests. 2. Procurement of night vision goggles in each range.

	3. Procurement of smart phones equipped with hi-resolution camera and GPS receiver in each range. 4. Procurement of mini-weather stations for each of the range offices. 5. Recruitment of watchers and guards, as possible.
Partner institutes	NA
Identified barriers	Lack of funds available for recruitment and procurement.
How will these be overcome through REDD+ project?	1. Facilitating the utilization of funds for recruitment and procurement 2. Coordinating funding assistance from the FEWMD to the Government of Sikkim, through the REDD+ Steering Committee and REDD+ Cell. 3. Strengthening existing monitoring structure and overall project management.
Implementation plan	1. Assessment of current manpower deficiencies among frontline FEWMD staff and costs involved for additional recruitment. 2. Assessment of resources available to each Range for patrolling and administration, and costs involved for additional procurement. 3. Facilitation of additional recruitment of FEWMD personnel and procurement of resources (vehicles, night vision goggles, etc.), overseen by REDD+ Cell. 4. Training in using the equipment provided.

Energy Management Interventions

11) Sustainable Fuelwood Management for Religious Establishments

Name of the intervention:	Sustainable fuelwood management in religious institutes such as monasteries
Code:	ENE-FW-MON
Description of the problem	Fuelwood is used by monasteries across Sikkim to meet their energy requirements towards residential uses, religious events, and wood used for cremations. This fuelwood is sourced largely from forests, usually managed by the monasteries. A constant alternate supply of fuelwood is essential to ease the pressure on forests to supply fuelwood to these monasteries.
Description of the solution	Development of a multi-pronged sustainable fuelwood management strategy to meet fuelwood requirements of religious establishments like monasteries and temples. This would include: 1. Institutional framework for access to fuelwood depots for residual wood utilization for religious events (deaths, events) and construction of fuelwood depots in monasteries for storage of fuelwood 2. Clean technologies: LPG, induction cookers and ICS for cooking. Efficient fuelwood burning systems for Hindu and Buddhist cremations. 3. Afforestation: Fuelwood plantations 4. Communication through monasteries for the general public.

	5. Solar and biomass based hybrid energy systems. Alternative sources of fuelwood also can be a good model to reach out to people and create awareness among the public on various energy efficient systems. The monasteries also will be key in communicating the impact of climate change and the role forests play in fighting climate change to the general public.
Detailed description of the technology	1. Development of institutional framework: Coordination between FEWMD and individual monasteries through identified channels to access the fuelwood depots and meet their requirements from the sale of fuelwood from these depots. Concurrently, the construction of fuelwood depots in religious establishments to ensure the storage of fuelwood irrespective of climatic conditions and the regulation of fuelwood demand and supply in these establishments and cut down time taken for fuelwood extraction. 2. Clean technology deployment: Provision of a mix of LPG cylinders, large ICS and induction cook plates to religious establishments for cooking and heating water in monasteries for preparation of meals to bring down fuelwood demand. Concurrently, efficient burning systems identified and introduced at religious and community spaces in selected areas within Sikkim on a pilot basis to bring down fuelwood demand. These systems may include, but would not be limited to, electric crematoriums. These technologies to be provided on a pilot basis in some monasteries in each district. Analysis of the effects of these measures to inform subsequent scaling up of the intervention. 3. Plantation of fuelwood species and species specially utilized for events: The plantation of tree species commonly used in religious rituals and practices on these lands will help decrease the demand from forestlands and help regulate forest loss in Sikkim. Under the SBFP, 700 Ha of afforestation and regeneration activities have been planned (2010-2020)[76], which will supplement the plantations activities planned under this intervention.
Institutional partners	1. Ecclesiastical Department 2. Selected monasteries
Identified barriers	1. Lack of capacity towards raising and maintaining plantations. 2. Cultural barriers towards take-up of new cooking systems. 3. Prohibitive costs of large ICS. 4. Lack of interest and incentives among monasteries to administer plantation activities. 5. Lack of capacity towards raising and maintaining plantations. 6. Cultural and social barriers towards take-up of these systems for performing last rites. 7. Prohibitive costs of setting up and maintaining electric crematoriums.
How will these be overcome through REDD+ project?	1. Collaboration/convergence program between FEWMD and other institutions to support plantation activities. 2. Development of effective communication campaigns that are culturally sensitive to promote resource efficient extraction from forests.
Implementation plan	1. Identification of monasteries and available lands in each district.

[76] JICA-assisted Sikkim Biodiversity Conservation and Forest Management Project; Forests, Environment and Wildlife Management Department.

	2. Undertaking communication campaigns in monasteries on the benefit of plantations and its importance in forest conservation and enhancement. 3. Training and capacity building of monks and FEWMD personnel on sustainable forest management practices 4. Distribution of ecologically adaptive and agro-climatically suitable fuelwood species seeds and saplings 5. Convergence of funds and schemes to carry out plantation in monasteries lands. 6. Undertaking communication campaigns and building on existing campaigns under the project, like Monks for Climate, to sensitize local communities on the ill-effects of fuelwood combustion. 7. Installing pilot solar powered kitchens at least in 5 monasteries in each district. 8. Assisting in delivery mechanisms for uptake of these large ICS through convergence with the Ecclesiastical Affairs Department for installation of ICS in 108 monasteries. 9. Monitoring of pilot schemes in select monasteries with coordination from respective monasteries. 10. Assisting the monasteries in installing culturally sensitive crematoriums with better thermal efficiency.
Co-benefits	Decrease indoor pollution, better health of cooks, financial savings owing to not purchasing fuelwood, propagate clean energy to masses
Potential convergence	• Pradhan Mantri Ujjwala Yojana, Unnat Chulha Abhiyan, schemes under the Ecclesiastical Dept. • School Nursery Yojana (MoEFCC) in monastic schools, [State Implementing Agency: Education Department, DFO (Territorial)]

12) Alternate energy technologies for cooking in Households

Name of the intervention:	Alternate energy technologies for cooking in Households
Code	ENE-ICS-HH
Description of the problem	It has been found from the socio-economic surveys conducted in the landscape that households in Sikkim extensively use fuelwood for cooking purposes on conventional cook stoves. Inefficient combustion of fuelwood results in thermal energy loss in conventional cook stoves. Percentage of households using conventional cook stoves in each district of Sikkim is given below: North 21% South 45.1% East 51% West 34% Results from the socio-economic survey indicate that rural households surveyed in Sikkim use about 23 kg of fuelwood per day. Of the fuelwood used, it has been found that 22% is soured directly from forests on average. Such extraction over time has led to the depletion of forest carbon stocks in Sikkim. In addition, some associated issues have also been observed:

	- Deteriorating health of women and children (especially towards pulmonary diseases) as a result of high particulate matter levels in kitchens owing to conventional cook stoves[77]. - Productive person days are utilized for collection of fuelwood from forests.
Description of the solution	Deployment of a mix of alternative energy solutions for rural households to regulate fuelwood requirements and ease pressures on forests for fuelwood. This mix would involve provision of ICS, LPG connections and induction cook plates tailored towards specific requirements of each district. These measures are backed up by government commitments towards clean energy deployment in rural households across India. Under the Union Budget 2016-17, there are plans to extend LPG connections to 5 crore families in India over the next 3 years, with further plans to development induction cook stoves as well into this basket to enable cleaner cooking. Electric cook plates can also make use of solar power in remote rural areas of Sikkim, where LPG penetration may be low and solar energy be easier to provide[78]. Validation studies conducted in Sikkim have revealed support for provision of induction cook plates due to the reliable electricity connections existing across the state. Induction cook plates are being increasingly used for small cooking needs. Under the REDD+ project it is proposed to distribute ICS to 75% of households and LPG to 25% of households. Details are given below.
Detailed description of the technology	The Ministry of New and Renewable Energy (MNRE) has approved some improved biomass cook stoves for widespread use across the country, as part of the Central Government-sponsored Unnat Chulha Abhiyan. Some of these are[79]: the improved cook stove model will be decided after consulting the communities in the region. In addition, provision of LPG connections and electric cookplates under relevant schemes and programs of the central and state governments in selected households in every district will be explored.
Institutional partners	1. RMDD 2. Gram Panchayats and local SHGs
Identified barriers	1. Lack of awareness about deleterious effects of fuelwood combustion 2. Lack of awareness about alternate efficient sources of cooking 3. Lack of a delivery network for installing/refuelling LPG cylinders 4. Supply chain of LPG cylinders. 5. Cultural barriers to accepting new cooking systems
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns to sensitize communities towards alternative cooking systems and the ill-effects of fuelwood combustion 2. Assisting in delivery mechanisms for uptake of LPG by convergence under government schemes 3. Creation of an enabling environment to facilitate distribution of induction cook plates

[77] Report of the Steering Committee on Air Pollution and Health-Related Issues; Ministry of Health and Family Welfare, Government of India, August 2015.
[78] Panagariya, A., and Jain, A.K. (2016); Electricity and Clean Cooking Strategy for India; NITI Aayog, Government of India.
[79] Approved Models of Portable Improved Biomass Cookstoves, Ministry of New and Renewable Energy.

	4. Monitoring and evaluation of the identified interventions in all districts, overseen by the REDD+ Cell.
Implementation plan	1. Using a scientific and objective decision support system to identify locations of maximum benefit for rollout of these activities. 2. Target beneficiaries will be 75% of the total district population in the case of household ICS, and 20% of the total district population in the case of LPG distribution. 3. Roll-out in a phased manner starting with BPL families and forest fringes with ICS, induction plates and LPG along with appropriate communication. 4. 20% of the identified beneficiaries will be brought under the intervention every year for 5 years. 5. Facilitating distribution, monitoring and management of ICS and induction plates and LPG where the JFMC/EDCs are also involved in installation, maintenance and communication. 6. Implementation has to be through various systems since this will be at a high scale where each household is being targeted directly.
Co-benefits	Better health of women and children, decrease in indoor pollution, contribution to SDGs, decrease drudgery in collection of fuelwood, economical benefit as more time will be available for any income generation activity, skill development, better education as children will be freed from collection of fuelwood, improved standard of living
Potential convergence	Pradhan Mantri Ujjwala Yojana, Unnat Chulha Abhiyan

13) Improved Cook Stoves for Community Events

Name of the intervention:	Improved Cook Stoves for community cooking
Code	ENE-ICS-COMM
Description of the problem	Community events like festivals and marriages involve gatherings of a large number of people. Cooking for these events requires large amounts of fuelwood, which is largely sourced from forests. Inefficient combustion of fuelwood results in thermal energy loss in conventional cook stoves. Large Improved Cook Stoves used for these events would help significantly bring down fuelwood requirements and help maintain forest carbon stocks in Sikkim.
Description of the solution	Large Improved Cook Stoves to be introduced for cooking in community events like festivals and marriages to bring down fuelwood demand. These Cook Stoves will be provided on a pilot basis in some villages in each district. Analysis of the take-up of these measures to inform subsequent scaling up of the intervention.
Detailed description of the technology	The Ministry of New and Renewable Energy (MNRE) has approved some large improved biomass cookstoves for widespread use across the country, as part of the Central Government-sponsored Unnat Chulha Abhiyan. Some of these are[80]:

Model	**Manufacturer**	**Power output (kW)**	**Thermal efficiency (%)**

[80] Approved Models of Portable Improved Biomass Cookstoves, Ministry of New and Renewable Energy.

	<table><tr><td>XXXL Plus Stove</td><td>Alpha Renewable Energy Pvt Ltd, Anand (Gujarat)</td><td>3.78</td><td>35.52</td></tr><tr><td>Ojas-M06</td><td>Sacks Right Energy Innovations, Bengaluru (Karnataka)</td><td>5.43</td><td>35.11</td></tr><tr><td>Vikram Jumbo Bio Super</td><td>Vikram Stoves and Fabricators, Osmanabad (Maharashtra)</td><td>3.64</td><td>28.1</td></tr><tr><td>Digvijay Community Chulha</td><td>Digvijay Sales and Engineering, Beed (Maharashtra)</td><td>4.2</td><td>30.28</td></tr></table> Appropriate large ICS will be chosen for identified villages to regulate fuelwood demand in village-level events.
Institutional partners	JFMCs/EDCs RMDD
Identified barriers	1. Lack of awareness about deleterious effects of fuelwood combustion 2. Cultural barriers about take-up of new cooking systems
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns to sensitize communities towards alternative cooking systems and the ill-effects of fuelwood combustion. 2. Assisting in delivery mechanisms for uptake of these ICS through convergence with the Rural Management and Development Department. 3. Monitoring of pilot schemes in select villages to explore opportunities for scaling up.
Implementation plan	1. Selection of pilot villages based on objective criteria 2. Facilitating distribution of large ICS with Gram Panchayats/JFMC/EDCs. 3. Calculation of benefits (in CO_2 eq.) and costs (in INR), and presentation to the FEWMD and Government of Sikkim. 4. Development of an Action Plan for the administration and monitoring of these interventions in coordination with Gram Panchayats/JFMCs/EDCs and overseen by the REDD+ Cell.
Co-benefits	Better health of women and children, decrease in indoor pollution, contribution to SDGs, decrease drudgery in collection of fuelwood, economical benefit as more time will be available for any income generation activity, skill development, better education as children will be freed from collection of fuelwood, improved standard of living
Potential convergence	Pradhan Mantri Ujjwala Yojana, Unnat Chulha Abhiyan

14) Improved Driers for Cardamom processing

Name of the intervention:	Fuelwood efficient driers for cardamom processing
Code	ENE-DRY-CARD
Description of the problem	India is one of the largest producers of large cardamom and more than 88% of its production comes from the state of Sikkim. Thus, cardamom is an important spice crop in Sikkim, with an annual production of over

	4,500 MT from a cultivation area of about 23,500 Ha[81]. Cardamom-based agro-forestry systems is a source of revenue to the state. Conventional driers used for cardamom processing, result in a large amount of thermal energy loss, leading to increased fuelwood requirements from all sources, primarily forests. This places pressure on local forests and leads towards deforestation and forest degradation – fuelwood efficient driers would bring down the pressure on forests for drying of cardamom and help maintain the forest carbon stocks in Sikkim.
Description of the solution	Fuelwood efficient/electric driers for cardamom to bring down fuelwood demand and provide environmental and social benefits to cardamom cultivators.
Detailed description of the technology	Fuelwood-efficient driers utilize significantly less fuelwood, reduce the curing period and associated pollution, thereby improving the quality of the cardamom. Research and action undertaken by the Spices Board of India[82] and the CSIR-IMMT[83] has focused on post-harvest technologies for increasing productivity of the crop. The CSIR-IMMT Wood Combustor for Cardamom Drier is one of the driers currently commercialized in Sikkim. It burns in a smokeless environment and provides clean gas to cardamom capsules for drying in a temperature range of 50°C to 100°C, reducing 75% of wood consumption on an average. It is portable and detachable and can be used with traditional cardamom *bhattis*. There is high acceptability among cultivators for this technology as it utilizes traditional processes[84].
Partner Institutes	1. Indian Cardamom Research Institute – Regional Research Station (Gangtok) 2. Local Gram Panchayats/SHGs/small enterprise 3. Department of Science and Technology
Identified barriers	1. Lack of awareness about new techniques of cardamom drying 2. Insufficient supply chains and delivery mechanisms of new drying technologies. 3. Lack of production capacity to meet demand. 4. Cultural barriers towards take-up of new technologies 5. High costs of efficient driers
How will these be overcome through REDD+ project?	Through well-coordinated technology and community interface to act as the bridge between research and laboratories and the field where the technology is to be deployed.
Implementation plan	1. Undertaking communication campaigns to sensitize cultivators towards the ill-effects of fuelwood combustion and the benefits of adopting efficient driers for their crop. 2. Selection of beneficiaries in each district. 3. Facilitating distribution and sale of efficient driers in coordination with the JFMC/EDCs and research institutes. 4. Installation and monitoring of efficient driers with selected beneficiaries through convergence with RMDD and Food

[81] Pathak, A. (2008); Cultivation of Large Cardamom in Sikkim, Facets of the North-East.
[82] indianspices.com/major-projects-0
[83] Council for Scientific and Industrial Research: Institute of Minerals and Materials Technology (A Government of India Research Institute).
[84] immt.res.in/WoodCombustOrdryingLargeCardamom.aspx

	Security and Agriculture Department, and with coordination from Gram Panchayats/JFMCs/EDCs. 5. Mobilization of adequate funding for the procurement, demonstration and deployment of these driers. 6. Facilitating the training and demonstration on the use of these driers by scientists/resource persons.
Co-benefits	Better price for good quality cardamom, economical benefit as less amount of fuelwood used.
Potential convergence	• Schemes under horticulture and agriculture departments to promote energy efficient driers. • Science for Equity Empowerment and Development (SEED), Department of Science and Technology (Government of India)

15) ICS for Fodder Preparation

Name of the intervention:	Improved Cook Stoves for preparation of food for cattle
Code	ENE-ICS-FODD
Description of the problem	Households in Sikkim typically own several animals – cows, buffaloes, yaks, sheep and goats – due to which Sikkim has a sizeable livestock and poultry population. It is estimated that there are 291,626 livestock and 451,966 poultry numbers in the State[85]. For preparation of animal feed, fuelwood is utilized for preparation on conventional stoves. These activities result in a sustained fuelwood demand and significant amounts of thermal energy loss. Results from the socio-economic survey indicate that each rural household in Sikkim utilizes about 23 kg of fuelwood per day, part of which is used for cattle food preparation.
Description of the solution	Improved Cook Stoves distributed to identified beneficiaries for preparation of animal feed in households and community establishments. The provision and use of these ICS would significantly bring down the pressure on forests for fuelwood provision and help maintain forest carbon stocks in Sikkim. Analysis of the effects of these measures to inform subsequent scaling up of the intervention.
Detailed description of the technology	The Ministry of New and Renewable Energy (MNRE) has approved some large improved biomass cookstoves for widespread use across the country, as part of the Central Government-sponsored Unnat Chulha Abhiyan. These ICS can also be utilized for fodder preparation at the individual/community levels. Some of these are[86]:

Model	**Manufacturer**	**Power output (kW)**	**Thermal efficiency (%)**
XXXL Plus Stove	Alpha Renewable Energy Pvt Ltd, Anand (Gujarat)	3.78	35.52
Ojas-M06	Sacks Right Energy Innovations, Bengaluru (Karnataka)	5.43	35.11
Vikram Jumbo Bio Super	Vikram Stoves and Fabricators, Osmanabad (Maharashtra)	3.64	28.1

[85] 19th Livestock Census Report 2012; Department of Animal Husbandry, Dairying and Fisheries, Ministry of Agriculture.
[86] Approved Models of Portable Improved Biomass Cookstoves, Ministry of New and Renewable Energy.

	<table><tr><td>Digvijay Community Chulha</td><td>Digvijay Sales and Engineering, Beed (Maharashtra)</td><td>4.2</td><td>30.28</td></tr></table> Appropriate large ICS will be chosen for identified villages to regulate fuelwood demand towards cattle food preparation.
Institutional partners	1. RMDD 2. AH&VS Department 3. Gram Panchayats and local JFMCs/EDCs
Identified barriers	1. Lack of awareness about deleterious effects of fuelwood combustion 2. Lack of awareness about alternate efficient sources. 3. Cultural barriers towards take-up of new technologies
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns to sensitize livestock and poultry owners about the ill-effects of fuelwood combustion. 2. Assisting in delivery mechanisms for uptake of these ICS through convergence with the RMDD and AHVS Department 3. Monitoring of distributed ICS with coordination from Gram Panchayats and local AH&VS Department personnel.
Implementation plan	Each village in Sikkim is being provided one community cook stove each under the project. This community cook stove will demonstrate the efficiency of large cook stoves for preparation of food for livestock. An active communication will describe the advantages of such an improved cook stove. Interested people can then purchase them from the market. 100% of the cost of the devise is through co-financing and not from the project.
Co-benefits	Better health of women and children, decrease in indoor pollution, contribution to SDGs, decrease drudgery in collection of fuelwood, economical benefit as more time will be available for any income generation activity, skill development, better education as children will be freed from collection of fuelwood, improved standard of living.
Potential convergence	Pradhan Mantri Ujjwala Yojana, Unnat Chulha Abhiyan

16) Smokeless Biomass briquettes as a fuelwood substitute

Name of the intervention:	Smokeless Biomass briquettes as a fuelwood substitute
Code	ENE-BRQ-FW
Description of the problem	Unsustainable fuelwood extraction from forests (for household use, for fodder preparation and for use in small enterprises) to support rural communities is a major cause of deforestation and forest degradation in Sikkim. Fuelwood collection from forests in each district (per year) is given below: <table><tr><td>North</td><td>3%</td></tr><tr><td>South</td><td>22%</td></tr><tr><td>East</td><td>36%</td></tr><tr><td>West</td><td>28%</td></tr></table>

	Results from the socio-economic survey indicate that rural households surveyed in Sikkim use about 23 kg of fuelwood per day. Of the fuelwood used, it has been found that 22% is soured directly from forests on average. For fuelwood collection, productive person days are utilized for collection of fuelwood from forests, which can instead be diverted for productive purposes. Household Air Pollution (HAP) from fuelwood burning leads to more than a million premature deaths per year[87].
Description of the solution	Introduction of smokeless bio-briquettes using waste biomass and invasive species will help reduce fuelwood consumption, leading to the conservation and enhancement of Sikkim's forest carbon stocks. In addition, they will lead to the following benefits: - Check the breakout of invasive species causing deterioration of forest health - Provide an outlet for disposal of agricultural and animal feed wastes - Make available organic fertilizer and opportunities for non-farm based livelihoods - Reduce health hazards from smoke and high emissions from burning fuelwood and biomass
Detailed description of the technology	About 400-500 gm of biodegradable waste is utilized for the production of 1 bio-briquette – 40-50 bio-briquettes can be manufactured per day. The processes involved in making bio-briquettes: - Collection and drying of bio-degradable waste and burning in a pit to make active charcoal. - Production of biochar by leaving the charcoal overnight and airtight upto 12 hours. - Mixing biochar with fine mud in 3:1 ratio, and adding water to make a paste - Putting biochar-mud mixture in the briquette moulding frame and drying.
Identified barriers	1. Lack of awareness about deleterious effects of fuelwood combustion 2. Lack of awareness about alternate efficient sources of cooking 3. Lack of established bio-briquettes manufacturing and delivery systems 4. Lack of rural infrastructure to support bio-briquettes manufacturing 5. Lack of data on availability of invasive species as well as agricultural and animal feed wastes 6. Cultural barriers for take-up of alternative systems
How will these be overcome through REDD+ project?	1. Building on existing communication campaigns to popularize the use of bio-briquettes across the state 2. Assisting in procuring equipment, providing training and setting up of small enterprises focused on manufacturing and use of bio-briquettes 3. Building on linkages and convergence with the government, public sector (NABARD) and private sector

[87] Report of the Steering Committee on Air Pollution and Health-Related Issues; Ministry of Health and Family Welfare, Government of India, August 2015.

Implementation plan	1. Training and awareness campaigns on bio-briquettes shall be organised in all the districts in such a way that at least 4 representatives from each village attend the training program. 2. One mould will be given to each village, the SHGs/JFMCs in each village can procure more moulds from wherever they prefer. 3. A market chain will be established to market the bio-briquettes.
Co-benefits	• Better health of women and children, decrease in indoor pollution, contribution to SDGs, decrease drudgery in collection of fuelwood, economical benefit as more time will be available for any income generation activity, skill development, better education as children will be freed from collection of fuelwood, improved standard of living • There is employment generation as well where SHGs can form a group together and market bio briquettes.
Potential convergence	Pradhan Mantri Ujjwala Yojana, Unnat Chulha Abhiyan

17) Improved Cook Stoves, LPG and solar cookers in schools as part of the Mid-Day Meal Scheme

Name of the intervention:	Improved Cook Stoves, LPG and solar cookers in schools as part of the Mid-Day Meal Scheme
Code	ENE-ICS-SCH
Description of the problem	Cooked mid-day meals is distributed to students in all government schools in Sikkim from October 2002, as per the orders of the Supreme Court, dated 28 November 2001. This scheme is administered by the Human Resource Development Department. According to the Sikkim Household Survey 2007, there are 1,10,081 children in the age range of 6-14 years, indicating a significant demand for cooking fuels on a daily basis in 10 months of the year[88]. While preparation of these meals has largely been done on conventional cook stoves, lately there has been a shift towards using gas bhattis and cylinders [89]. Fuelwood is still one of the major fuels, which is largely sourced from forests. Inefficient combustion of fuelwood results in thermal energy loss in conventional cook stoves – large Improved Cook Stoves used for cooking in schools would further significantly bring down fuelwood requirements and help maintain forest carbon stocks in Sikkim.
Description of the solution	In 2006-07, LPG connections were provided to 447 government schools as cooking fuels under the State Trading Corporation of Sikkim (STCS)[90]. The existing status of these connections will be evaluated along with an assessment of the capacity to shift towards cleaner fuels for all existing government schools. Where fuelwood is expected to remain the main cooking fuel (due to geography, accessibility, terrain), large Improved Cook Stoves would be introduced for preparation of mid-day meals to bring down fuelwood demand. These would be provided on a pilot basis in some schools in each district. Analysis of the effects of these measures to inform subsequent scaling up of the intervention.

[88] National Program of the Mid-Day Meal Scheme: Sikkim, Annual Workplan and Budget 2014-15.
[89] www.sikkim-hrdd.gov.in/mid_day_meal.htm#kitchen
[90] National Program of the Mid-Day Meal Scheme: Sikkim, Annual Workplan and Budget 2014-15.

<table>
<tr><td></td><td>In addition, in areas with reliable electricity connections, the feasibility of provision of induction cook plates will be explored.</td></tr>
<tr><td>Detailed description of the technology</td><td>Schools run under the Sikkim government will be targeted in this intervention activity. Out of the schools in the state, 447 schools already have LPG cooking systems. Rest of the 424 schools will need LPG cooking systems. All the schools will be provided with big ICS for community cooking. Solar based cooking will be taken as a pilot in 20 schools in the state. As per the government notification, each school is allowed for 12 subsidised LPG cylinders each year. If LPG cylinders are required above this, they have to be purchased at market rate. Under the project provision for 28 LPG cylinders also has been made. The no. of schools per district, managed by HRDD[91], and all establishments where MDM Scheme is active:

<table>
<tr><th>District</th><th>Total</th></tr>
<tr><td>North</td><td>84</td></tr>
<tr><td>South</td><td>232</td></tr>
<tr><td>East</td><td>236</td></tr>
<tr><td>West</td><td>226</td></tr>
<tr><td>Total schools</td><td>778</td></tr>
<tr><td>Monasteries[92]</td><td>81</td></tr>
<tr><td>Sanskrit Paathshaalas[93]</td><td>12</td></tr>
<tr><td>Total establishments with MDM</td><td>871</td></tr>
</table>

In addition, in schools where fuelwood remains the predominant cooking fuel, large Improved Cook Stoves will be advanced to regulate fuelwood consumption on a daily basis in these schools. Some large ICS approved by the MNRE are[94]:

<table>
<tr><th>Model</th><th>Manufacturer</th><th>Power output (kW)</th><th>Thermal efficiency (%)</th></tr>
<tr><td>XXXL Plus Stove</td><td>Alpha Renewable Energy Pvt Ltd, Anand (Gujarat)</td><td>3.78</td><td>35.52</td></tr>
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<tr><td>Digvijay Community Chulha</td><td>Digvijay Sales and Engineering, Beed (Maharashtra)</td><td>4.2</td><td>30.28</td></tr>
</table>
</td></tr>
<tr><td>Institutional Partners</td><td>1. HRDD
2. Ministry of Human Resource Development, Government of India
3. State Mid-Day Meal Cell</td></tr>
</table>

[91] HRDD Schools List, Government of Sikkim
[92] National Program of the Mid-Day Meal Scheme: Sikkim, Annual Workplan and Budget 2014-15.
[93] National Program of the Mid-Day Meal Scheme: Sikkim, Annual Workplan and Budget 2014-15.
[94] Approved Models of Portable Improved Biomass Cookstoves, Ministry of New and Renewable Energy.

Identified barriers	1. LPG demand-supply scenario. 2. Proper maintenance and use of ICS in schools.
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns to sensitize school administrators and communities on the ill-effects of fuelwood combustion. 2. Assisting in delivery mechanisms for LPG refill cylinders and uptake of large ICS through convergence with the HRD Department.
Implementation plan	1. Selection of pilot schools in each district based on objective criteria 2. Facilitating distribution of LPG and large ICS with HRD Department in all the government schools. 3. Calculation of benefits (in CO_2 eq.) and costs (in INR), and presentation to the FEWMD and Government of Sikkim with the help of school children. 4. Development of an Action Plan for administration and monitoring these interventions, in coordination with the Directorate of School Education and Administration, Sikkim, overseen by the REDD+ Nodal Officers and REDD+ Cell.
Co-benefits	Cleaner energy for cooking in schools can result in less indoor pollution in schools.
Potential convergence	Through existing mid-day meal schemes in Sikkim and Pradhan Mantri Ujjwala Yojana

18) Plantations in Private Lands

Name of the intervention:	Fuelwood plantations and fodder plantations in private forests
Code:	ALM-FW-PVT
Description of the problem	Due to its extensive availability across the State, a large population across Sikkim depends on forests for fuelwood and fodder. Of the fuelwood used in Sikkim, it has been found that 22% is sourced directly from forests on average (with district-wise variabilities), causing pressure on the state's forests. Such extraction over time has led to the depletion of forest carbon stocks in Sikkim. Results from the socio-economic survey indicate that each rural household in Sikkim utilizes about 23 kg of fuelwood per day, part of which is used for fodder preparation. Also, it has been estimated that about 2.5 million tonnes of fodder is collected per year in Sikkim. Out of this, a majority is purchased from markets while 10% is collected from forestlands on average.
Description of the solution	Plantation of tree species in private forest and wasteland which can be used to meet the fuelwood and fodder demand of local communities for their bona-fide use. Successful plantation activities in private lands will help mitigate the pressure on forests, prevent encroachment of forests and help in reducing deforestation and forest degradation. Policies issued by the Government of Sikkim over the years has stressed the need to involve local communities in management of forests and the need to launch afforestation programs with emphasis on production of fuel wood and fodder on degraded and denuded lands both forest and non-forest[95].

[95] neportal.org/northeastfiles/Sikkim/Planning/02_03/chapVI.asp

Detailed description of technology	Plantations carried out on the Social Forestry model on private lands will help meet fuelwood and fodder demands of local communities. Identification of suitable lands will be carried out in consultation with the FEWMD, RMDD and Gram Panchayats. Institutional mechanisms will be developed to enable the Social Forestry Wing to provide the saplings of suitable fuelwood species and the AH&VS Department to provide saplings for suitable fodder species. The exact configuration between fuelwood and fodder species will be further explored through local consultations. Under the National Livestock Mission, the AH&VS Department is propagating different fodder and grass species based on climatic zones[96]: **Sub-Alpine Region** - Red/White Clover, Rye Grass, Timothy Grass, **Temperate Region** - Salyx, Oats, Rye Grass, Red/White Clover **Sub-Tropical Region** - Nappier Spp., Guinea Grass, Para Grass, Cow Pea, Maize, Oats, Centrosema, Desmodium, Nevara, Barr, Gogun, Dudhilo, Rai Khoneu, Barhar, Kabra, Kharri, Khasre, Amliso, Azolla, **Tropical** - Nappier Spp., Guinea Grass, Para Grass, Cow Pea, Maize, Oats, Centrosema, Desmodium, Muringa (Drumstick), Subabul, Azolla
Institutional partners	1. Social Forestry Wing, FEWMD 2. AH&VS Department 3. Local JFMCs and EDCs
Identified barriers	1. Lack of awareness about the ill-effects of fuelwood combustion. 2. Lack of incentives for private landowners to take up the plantation activities. 3. Restricted access to plantations for some vulnerable groups. 4. Lack of inter-departmental coordination to provide saplings and raw materials for plantation.
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns on benefits of forest protection and enhancement. 2. Distribution of tree seeds and saplings for plantation to private land holders, where the land holders have to pay a subsidised amount for each sapling. 3. Providing technical assistance to private landholders through the TTMs developed under the Forest-PLUS Program. 4. Convergence of the programs and schemes to support private plantation.
Implementation plan	1. Demarcation of private lands available to take up the plantation activity. 2. Assessment of the inclination and incentives available for plantation in private lands. 3. Preparation of plantation plans – selection of species, provision of inputs etc. 4. Designing communication campaign for awareness of plantation and conserving forests in Sikkim 5. Calculation of benefits (in CO_2 eq.) and costs (in INR), and presentation to the FEWMD and Government of Sikkim

[96] Personal communication with Dr T.N. Bhutia, AH&VS Department, Government of Sikkim.

	6. Development of an Action Plan for administration and monitoring of the intervention with Gram Panchayats, RMDD and FEWMD, overseen by the REDD+ Cell Identified fodder species suitable for each District, as advised by the AH&VS Department[97]: ***East District*** **Fodder Spp:** Nappier Spp., Guinea Grass, Para Grass, Cow Pea, Maize, Oats, Centrosema, Desmodium, *Nevara, Barr, Gogun, Dudhilo, Rai Khoneu, Barhar, Kabra, Kharri, Khasre, Amliso*, Azolla. ***West District*** **Fodder Spp**: Nappier Spp., Guinea Grass, Para Grass, Cow Pea, Maize, Oats, Centrosema, Desmodium, *Nevara, Barr, Gogun, Dudhilo, Rai Khoneu, Barhar, Kabra, Kharri, Khasre, Amliso*, Azolla, ***South District*** **Fodder Spp**: Nappier Spp., Guinea Grass, Para Grass, Cow Pea, Maize, Oats, Centrosema, Desmodium, *Nevara, Barr, Gogun, Dudhilo, Rai Khoneu, Barhar, Kabra, Kharri, Khasre, Amliso*, Azolla, *Muringa* (Drumstick), *Subabul* ***North District*** **Fodder Spp:** Red/White Clover, Rye Grass, Timothy Grass, Salyx, Oats, Rye Grass, Red/White Clover, Nappier Spp., Guinea Grass, Para Grass, Cow Pea, Maize, Oats, Centrosema, Desmodium, *Nevara, Barr, Gogun, Dudhilo, Rai Khoneu, Barhar, Kabra, Kharri, Khasre, Amliso*, Azolla.
Co-benefits	Extra source of income for people, source of NTFP, fuelwood, timber etc.
Potential schemes	Agro-forestry promotion schemes in Sikkim • Accelerated Fodder Development Programme, Department of Agriculture (Government of India) • Sub-Mission on Agroforestry (SMAF), National Mission for Sustainable Agriculture (NMSA), Govt. of India • MGNREGA [RMDD]

19) Hydroponics and azolla cultivation

Name of the intervention:	Development of hydroponics and azolla initiatives as solution to fodder.
Code:	ALM-FODD-HYDP
Description of the problem	India, having only 2.4% of the world's geographical area sustains 11% of the world's livestock population; this is reflected in Sikkim as well. To meet the fodder requirements of livestock, fodder is often collected from forests due to the absence of sufficient rangelands. From the socio-economic survey conducted in the landscape, it has been estimated that about 2.5 million tonnes of fodder is collected per year in Sikkim. Out of this, a majority is purchased from markets while 10% is collected from forestlands on average. The development of the dairy industry in Sikkim has further increased the demand for fodder. This extraction over time to meet livestock demand has put enormous pressure on forest carbon resources in the state.

[97] Personal communication with Dr T.N. Bhutia, AH&VS Department, Government of Sikkim.

Description of the solution	Hydroponics is the technique of growing plants without soil or solid growing medium, but using water or nutrient-rich solution only, for a short duration. Hydroponics development at individual/community levels in Sikkim can lead to positive outcomes in the provision of feed and fodder, which has a direct impact on the yield of products. Production of fodder through hydroponics techniques ensure meeting of the daily fodder demand with high quality of forage. This will benefit the communities who are dependent on animal rearing and reduce grazing pressure on forests. The development of Azolla cultivation as a cost-effective measure to meet fodder demand in the state and provide income generating opportunities for local communities. It has been seen that Azolla, till now used mainly as a green manure in paddy has tremendous potential to meet the growing fodder demand. Dry Azolla flakes can be used as poultry feed and green Azolla can be utilized as fish feed. Azolla, hitherto used mainly as a green manure in paddy has tremendous potential to meet the growing demand for fodder among the small farmers taking up animal husbandry. Azolla can supplement the traditional fodder provided to livestock throughout the year, thus significantly bringing down fodder demand and pressure on forests.
Detailed description of the technology	Hydroponics does not require much land for cultivation, and can be tailored to meet individual requirements in terms of scale, complexity and costs. The layout of the hydroponic unit will depend upon the availability of raw materials - bamboo poles, boles of small timber, availability of grains (wheat, barley, oats etc.). Steps undertaken towards development of a sustainable hydroponics system: 1. Establishment of a fodder production unit in the form of a greenhouse made up of locally available low-cost materials (small timber, bamboo) and silpaulin and green shade net (75%) for constructing 10 feet x 10 feet size chamber to provide an ideal environment for plant growth. 2. Construction of wooden shelves made of and placement of perforated trays on them to provide support for plant growth. 3. Maintenance of humidity and moisture within the greenhouse by regular watering and monitoring by farmers to ensure that grains do not dry. 4. Sowing of seeds on a daily basis under supervision and regular monitoring of growth. The time period of growth for these plants is 7-8 days, within which they reach a height of 12-15 cm and are ready to feed. Azolla is an extremely nutrient-rich substitute for other fodder sources: it is very rich in protein (25-35%), Calcium (67 mg/100g) and Iron (7.3 mg/100g). As green manure, Azolla is grown alone for two to three weeks in flooded fields. Afterwards, water is drained out and Azolla fern is incorporated in the field before transplanting of paddy. Otherwise, 4-5 q of fresh Azolla is applied in standing water one week after planting of paddy[98]. Development of Azolla cultivations includes the following steps:

[98] www.nabard.org/pdf/Model_project_on_Azolla_cultivation.pdf

	1. Levelling of area for cultivation and digging of fodder plot with adequate provisions to allow standing water. 2. Spreading of finely-sieved soil and additional nutrients, and provision of water in cemented tanks to ensure sustained provision of Azolla. 3. Spreading of Azolla over the soil beds and continuous monitoring of growth of Azolla 4. Commencing cultivation of Azolla after a period of 7-10 days.
Institutional Partners	1. AH&VS Department 2. RMDD 3. Local Gram Panchayat and SHGs
Identified barriers	1. Lack of awareness about benefits of hydroponics. 2. Lack of available schemes and funding to provide for equipment and inputs 3. Resistance to change towards such technologies. 4. Lack of expertise and capacity to develop and maintain hydroponics.
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns to sensitize local communities on the benefits of hydroponics as source of fodder. 2. Providing a platform for farmers to come together to discuss benefits and opportunities for hydroponics cultivation and utilization 3. Supporting the capacity building of local cultivators, SHGs and NGOs towards the building and maintenance of hydroponics systems
Implementation plan	1. Identification of beneficiaries in pilot villages in each district in coordination with the Gram Panchayats. Exploring possibilities of community-level greenhouses to cultivate hydroponics through SHGs and local NGOs. 2. Facilitating the procurement of relevant raw materials and equipment through convergence with the AH&VS Department. 3. Development of an Action Plan for administration and monitoring of the intervention with Gram Panchayats, RMDD, FS&AD and AH&VS Department, overseen by the REDD+ Cell.
Co-benefits	Availability of fodder around the year.
Potential schemes	Schemes on fodder development and management under various depts. mentioned above. • Accelerated Fodder Development Programme, Department of Agriculture (Government of India)

20) Development of Multi-storey Agro-Forestry Model

Name of the intervention:	Multi-storey agro-forestry model in Cardamom plantations
Code:	ALM-AGR-CARD
Description of the problem	Large cardamom is an economically valuable and ecologically-adaptive cash crop grown across Sikkim. India is one of the largest producers of cardamom, and it forms an important part of the local economy in Sikkim, contributing on average 29.2% of the income of households[99]. Cardamom is known to grow well with availability of shade. Lately, it has been found that cardamom production is declining due to environmental

[99] Declining Large-Cardamom Production Systems in the Sikkim Himalayas. Available at: www.bioone.org/doi/pdf/10.1659/MRD-JOURNAL-D-14-00122.1

	and social pressures. One of the factors responsible is a supply and demand gap in fuelwood, used in large quantities for drying of cardamom after cultivation[100]. If the growing demand of fuelwood is not met through sustainable means, then the forest carbon resources of Sikkim are expected to reduce further while having corresponding impacts on the cultivation of cardamom in the state.
Description of the solution	Development of a multi-storey agro-forestry model for cardamom plantations to focus on providing favourable environmental conditions for cardamom cultivation, while simultaneously providing adequate fuelwood for cardamom drying. This intervention, coupled with the proposed fuelwood-efficient driers, will help in provisioning for a sustainable fuelwood demand for cardamom processing.
Detailed description of the technology	Plantation of suitable canopy species (selected after local consultations) which can also be used to provide fuelwood for cardamom drying and processing after cultivation. In addition, these canopy species will be able to provide for additional ecosystem services like carbon sequestration and soil conservation. Simultaneously, fuelwood-efficient driers proposed for cardamom will bring down fuelwood demand to sustainable levels, and help in the long-term viability of the cardamom plantations in Sikkim.
Partner Institutes	1. Indian Cardamom Research Institute – Regional Research Station (Gangtok) 2. Spices Board, India 3. Horticulture department
Identified barriers	1. Lack of awareness and technical knowhow about agroforestry practices.
How will these be overcome through REDD+ project?	1. Undertaking communication campaigns on new techniques towards enhancing cardamom productivity through agroforestry 2. Training and capacity building on best agroforestry practices 3. Distribution of ecologically adaptive and agro-climatically suitable shade tree species seeds and seedlings, administered by the FEWMD and REDD+ Cell.
Implementation plan	1. Identification of land in each district suitable to advance cardamom-based agroforestry techniques. 2. Identification of private planters who are interested and willing to experiment with the agroforestry practices. 3. Development of a suitable agro-forestry model for cardamom plantations fit for local environmental conditions in Sikkim, in consultation with experts and FEWMD personnel. 4. Assessment of the willingness of farmers and existing incentives for undertaking agroforestry practices on their lands. 5. Training and capacity building of selected JFMCs and local farmers 6. Facilitating distribution of ecologically adaptive and agro-climatically suitable shade tree species seeds and seedlings with JFMC/EDCs. 7. After the success of the pilots, scale up the agro-forestry model in other cardamom plantations also.
Co-benefits	Source of fodder, timber and increased source of income through multi-tiered agriculture.

[100] Sikkim: Society, Polity, Economy and Environment; Mahendra. P. Lama, Indus Publishing Company 1994.

Potential schemes	Awareness schemes under agriculture department and agro-forestry promotion • Sub-Mission on Agroforestry (SMAF), National Mission for Sustainable Agriculture (NMSA), Govt. of India

Other Supporting Activities

Activities, other than the proposed interventions, will also be looked into in order to provide additional support to the efforts to enhance the socio-economic situation of the target stakeholders of the project.

Some of the activities proposed for this purpose are:

- Construction of Community Halls, fodder storage rooms
- Promotion of Organic Certifications
- Promotion of Solar Thermal Energy for cooking and heating water

a) Construction of Community Halls, fodder storage rooms

Validation meetings and local consultations conducted during the socio-economic survey revealed that cooking during community events like marriages and festivals on conventional stoves consumes a lot of fuelwood, which is usually sourced from local forests. This can potentially lead to depletion of forest carbon stocks. But it is not very easy to ascribe decline in forest stocks to community cooking. However, such events can be a good occasion for demonstrating efficiency of energy efficient cooking systems such as Improved Cook Stoves to the public. One way to ensure a common place for this is by **construction of community halls** in each village/cluster of villages. This can be an entry point activity, and can be a community center for demonstrations of benefits of using energy efficient cooking systems. Such a community hall will help in laying strong foundation for local community based institutional arrangement, especially the JFMCs and EDCs. Community halls will also provide a common place to the villagers for community cooking on special occasions. These demonstrations can prompt the community members to adopt these energy efficient systems at their house also. Rural Management and Development Department (RMDD), Government of Sikkim can be a potential partner in this particular activity.

b) Promotion of Organic Certifications for Crops

The Sikkim Legislative Assembly passed a resolution in 2003 on making the State India's first fully organic state. Sikkim was declared a fully organic state in 2016, after organic farming activities were adopted across the state. A variety of crops are grown all over the state – cereals, pulses, fruits, vegetables and spices. The State Policy on Organic Farming[101] mandates that the production of these crops is fully organic. These measures provide innovative opportunities for marketing of such produce in domestic and international markets. The measures undertaken by the State has led to significant decrease of emissions from the state, through sustainable land management techniques and decrease in the use of fertilizers. Along with this if organic certificates for agriculture products are encouraged, they can fetch premium prices in domestic and international markets.

In accordance with the strategies on organic certifications in the Sikkim Organic Farming Policy, accredited certification agencies, local SHGs and NGOs will be engaged in providing certification to these produce[102]. This will be decentralized to the district levels to ensure breadth of coverage.

The processes involved towards the provision of organic certification include[103]:

[101] State Policy on Organic Farming, Government of Sikkim.
[102] State Policy on Organic Farming, Government of Sikkim.
[103] Ibid.

- Village meetings and awareness programs
- Registration of farmers and formalization of agreement.
- Orientation programs and internal inspection
- Submission of application to certifying agency for external inspection
- External audit by certifying agency and issue of organic certificate

The institutional partners for this activity could include, Food Security and Agriculture Department, Horticulture and Climate Change Department, Local SHGs and NGOs in each district. Increased income of the villagers will be an important co-benefit of this activity. Awareness on organic certification will be linked to REDD+ as an activity to increase income of community and to decease dependency on forests for livelihood.

c) Promotion of Solar Cooking in the State

Community solar cooking, with Scheffler model solar cookers can be introduced in Sikkim, at monasteries and schools as a pilot. A Scheffler reflector is a small lateral section of a paraboloid, which concentrates sun's radiation over a fixed focus.[104]

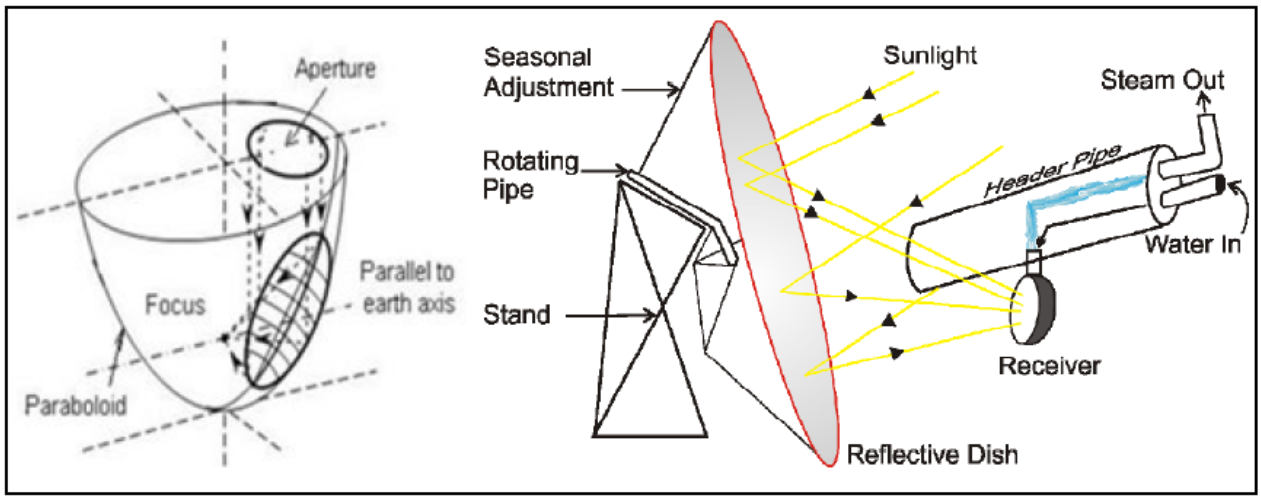

Figure 28: Solar Scheffler Dish Concentrator

The Scheffler dish system works on the following principles:

1. The parabolic reflective dish turns about north-south axis parallel to earth's axis, tracking the sun's movement from morning (East) to evening (West), and maintaining gravitational equilibrium of the dish.
2. The parabolic reflector also performs change in inclination angle while staying directed to sun, in order to obtain sharp focal point.
3. Focus lies at the axis of rotation. It remains at a fixed position, where concentrated heat is captured and transferred to water through the receiver to generate hot water or high pressure steam.
4. Water from header pipe passes to receiver (thermosyphon principle). At the receiver, the hot water or steam generated water and collected in the header pipe flows to the end use application.

Some advantages and limitations of solar cookers identified for Sikkim are:

- Will have to check the target geographies in Sikkim for cloud cover.
- It is advantageous to install solar cookers at high altitudes, as the direct sunlight increases the efficiency (similar projects in Ladakh and Himachal Pradesh report up to 80% efficiency).

[104] Scheffler Dish based Solar System, Operations and Maintenance Manual, Ministry of New and Renewable Energy, Government of India (November 2014)

- However, frequent cloud cover will bring down the efficiency, hampering the functioning of the cookers and possibly making the project unfeasible.

To address the issue of cloud cover in the State, which could cause inefficiency in the working of solar cooker, hybrid cookers that work on both biomass and solar energy could also be considered.

6.3 Convergence and Resource Mobilization

6.3.1 Integrating with the Sikkim Working Plans

The proposed interventions are being integrated with the forest working plans of Sikkim. As a pilot, the integration has been applied in the South Division Working Plan. Working circles within working plans include interventions that will enhance the stock of the existing forests and limit emissions from degradation and deforestation. These working circles are Sal Selection--cum--Improvement Working Circle, Middle Hill Forests Selection-cum-Improvement Working Circle, Plantation Working Circle and Teak and Miscellaneous Plantation Species Thinning Working Circle. Since oak restoration was also identified as a major intervention during the surveys, it has been kept separate as Oak Restoration Working Circle. Mapping, management and development of Khasmal and Gorucharan lands were also identified during the surveys, and so a specific Khasmal Forest Working Circle has been introduced in the working plan. Some of the existing working circles will help in decreasing the pressure on forests, such as the Eco-Development, Eco-Tourism Working Circle, Forest Protection Working Circle, Joint Forest Management Working Circle, NTFP Working Circle and Bamboo Working Circle. Since these are a part of the livelihood enhancement and local institution-building exercises, these have not been mentioned separately as interventions in the PDD. A final innovative circle that has been added to the working plan is called the Adaptation and Mitigation of Climate Change Working Circle, which will include all the actions on the ground on mitigation and adaptation activities.

6.3.2 Reducing Dependence on Fuelwood and Pressures on Forests

To reduce the high dependence of people on fuelwood, a potential partnership is identified between NABARD, Sikkim Government, and Forest-PLUS for promoting Smokeless Biomass Briquetting in Sikkim as part of REDD+ initiatives in the State. NABARD is supporting this intervention on a pilot basis, particularly among women SHGs and agricultural farmers.

The team also discussed with Sikkim State Cooperative Supply and Marketing Federation Ltd. (SIMFED) the development of potential market linkages for the bio-briquettes that will be produced by various SHGs and farmers for further sale. An official letter was obtained from SIMFED agreeing to collaborate with Forest-PLUS to develop market linkages for bio-briquettes and explore further investments for the same.

Forest-PLUS is also discussing potential collaboration between Forest-PLUS and Sikkim Renewable Energy Development Agency (SREDA) for promoting clean technology in Sikkim. The department is willing to provide support for improved cook stoves and solar lighting systems through available government schemes. In this context, a parallel convergence between Ecclesiastical Affairs Department and SREDA is being explored.

The Ecclesiastical Affairs department has been supporting Forest-PLUS by facilitating data collection and discussions with the monasteries in Sikkim for REDD+ interventions. Through their convergence, FPP team aims to promote the use of improved cook stoves in monasteries that can reduce the consumption of fuelwood and thereby reduce the pressures on forests. In

the proposed convergence, SREDA and monasteries could together provide for the cost of improved cook stoves.

6.3.3 Promoting Eco-tourism

Sikkim has many green tourist attractions such as snow-clad mountains including the Khangchendzonga, various lakes, dense forest areas, and valleys. As a result, a large number of tourists visit the State every year. While the flourishing tourism sector contributes a significant proportion to Sikkim's GDP, high inflow of tourists is causing substantial pressure on Sikkim's natural resources, including forests. To reduce the burden of the tourism sector, Forest-PLUS program is collaborating with the Tourism and Civil Aviation Department to undertake state-level interventions to develop a balance between tourism and conservation of natural resources in Sikkim.

The Tourism and Civil Aviation Department has designated two nodal officers to coordinate with Forest-PLUS program for REDD+ activities. An official letter was obtained from the Department in this context. Forest-PLUS is also discussing potential partnership with the Department for promoting eco-tourism and practices of sustainable tourism across Sikkim. It is also exploring potential to integrate generation and use of renewable energy in the existing and upcoming tourism areas as well as hotels.

FPP is also discussing potential collaboration with the Department under the Forest-PLUS/NABARD partnership for adoption of the bio-briquetting technology. The Tourism and Civil Aviation Department, Sikkim, can leverage the bio-briquetting technology to enhance the energy self-sufficiency of homestays and other eco-tourism entrepreneurs and contribute to the success of eco-tourism in the State.

6.3.4 Promoting Sustainability through State Policies and Laws

FPP is working closely with the Urban Development and Housing Department for promoting sustainability in the urban areas of Sikkim through the State's building bye-laws. IORA Ecological Solutions (IORA), a partner organisation under the FPP, and responsible for partnerships, has added various clauses to the Draft Building Bye-Laws of Sikkim, on the lines of the Model Building Bye-Laws published by the Ministry of Urban Development, Government of India, and other aspects that can help in integrating sustainability in already existing and new urban spaces in Sikkim. The Department is presently reviewing the inputs provided.

Sikkim is implementing Green Rating for Integrated Habitat and Assessment (GRIHA) across the State with the Building and Housing Department, Sikkim as the nodal agency for overseeing compliance. FPP is collaborating with the Building and Housing Department to suggest ways to promote the use of sustainable wood as a construction that will increase carbon sequestration in Sikkim. IORA has submitted a note to the designated nodal officer at the Department that identifies synergies between GRIHA and REDD+ and suggests ways in which REDD+ interventions can be operationalised in GRIHA. The suggested changes/additions are being reviewed by the department.

6.3.5 Disaster Management

Sikkim is prone to disasters such as landslides, flash floods and landslides. Based on the discussions in the convergence meetings, FPP team has discussed potential collaboration between Forest-PLUS and Sikkim State Disaster Management Authority (SSDMA) for interventions towards prevention and management of such disasters. The Department has shared certain reports in this regard which are being reviewed. FPP team is also exploring

opportunities for convergence between Forest, Environment and Wildlife Management Department (FEWMD), Rural Management and Development Department (RMDD) and SSDMA for afforestation and prevention of forest fires.

6.3.6 Promoting Alternative Livelihoods

FPP team initiated a discussion on potential collaboration between Department of Science and Technology, Sikkim and FEWMD to undertake joint research to identify areas suitable for sericulture in Sikkim and to promote it as an alternate livelihood in Sikkim to reduce pressures on forests.

7. Quantification of Emission Reductions

7.1 Introduction

The Jurisdictional Baseline start date and timeline has been described in Chapter 2. The baseline will be aligned every 10 years.

The six IPCC LULC classes, namely Forestland, Cropland, Grassland, Wetland, Settlement and Otherland have been distinguished and the area under each classification has been detailed.

The LULC classes have been further sub-divided into forest strata, to achieve the goal of defining classes that are homogeneous in forest carbon stock density. Predominantly, 5 forest types have been found in the forestlands of Sikkim. These forests have been further sub-divided based on canopy densities, so as to accurately pinpoint forest degradation. Land transitions within the same forest types have been mapped between different density classes and between forest classes and non-forest classes, so as to estimate rates of forest degradation and deforestation.

7.2 Historical Reference Periods

The land transitions from 2002 to 2009, and from 2009 to 2013, were analysed. The average of these two transitions were used to create the baseline transitions. The mean rate of LULC transition over the historical period has been calculated and is represented in the Emissions Reductions spreadsheet.

Organic Matter Content

For the aboveground live (AGL), aboveground dead (AGD), belowground (BG), and soil organic matter (SOM) pools, the average stock densities of stratum $\boldsymbol{i}$ and associated statistics are calculated as per the equation:

$$\mathrm{OM_o(i)} = \mathrm{average}\left(\mathrm{OM_{o,plot-wise}(i,p)}\right)$$

Stratum specific average organic matter can be estimated by summing organic matter in different carbon pools. Subsequently, the average total carbon stock is calculated by applying the carbon fraction. Summation of average carbon stock densities of LULC stratum i, pool o (Mg C ha^{-1}) shall give the average carbon content of that specific stratum. Equations 23, 24 and 25 of the applied methodology have been used to arrive at these figures.

$$\mathrm{OM(i)} = \sum_{\mathrm{o}} \mathrm{OM_o\,(i)}$$

$$\mathrm{C_o(i)} = \mathrm{CF.\,OM_o(i)}$$

$$\mathrm{C(i)} = \sum_{\mathrm{o}} \mathrm{C_o\,(i)}$$

Where:

$OM(i)$	=	Average plant-derived organic matter of LULC class or forest stratum i. [MG DM ha-1]
$OM_o(i)$	=	Plant-derived organic matter of LULC class or forest stratum i in pool o. [Mg DM ha-1]
$C_o(i)$	=	Average carbon stock density of LULC class or forest stratum i in pool o. [MT C ha-1]

CF = Carbon fraction of dry matter in wood (default = 0.5). [Mg C (Mg DM)-1]

$C(i)$ = Average carbon stock density of LULC class or forest stratum i. [MT C ha-1]

Table 42: Organic Matter content in Above Ground (AGL) and Below Ground (BG) Biomass

Class/Stratum	Stratum (i)	OM_{AGL} tdm/plot	OM_{BG} tdm/plot	OM_{AGL} tdm/ha	OM_{BG} tdm/ha
Moist Mixed deciduous Forest 10-30	**MMD 10-30**	11.4	2.9	113.7	28.7
Moist Mixed deciduous Forest 30-50	**MMD 30-50**	36.9	9.0	369.5	89.7
Moist Mixed deciduous Forest 50-70	**MMD 50-70**	55.6	13.9	555.5	138.6
Moist Mixed Deciduous Forest Above 70	**MMD Above 70**	85.1	23.0	851.3	229.9
Wet temperate Forest 10-30	**WTF 10-30**	6.3	1.8	62.9	18.0
Wet temperate Forest 30-50	**WTF 30-50**	9.8	3.1	98.3	30.6
Wet temperate Forest 50-70	**WTF 50-70**	10.5	3.1	104.7	30.6
Wet temperate Forest Above 70	**WTF Above 70**	23.0	6.0	229.9	59.9
Subtropical wet hill Forest 10-30	**SWH 10-30**	5.6	1.9	56.0	18.7
Subtropical wet hill Forest 30-50	**SWH 30-50**	9.2	3.2	91.9	31.7
Subtropical wet hill Forest 50-70	**SWH 50-70**	24.6	6.7	246.4	67.1
Subtropical wet hill Forest Above 70	**SWH Above 70**	38.5	10.4	385.0	104.0
Coniferous Forest 10-30	**CF 10-30**	6.2	2.0	61.6	19.7
Coniferous Forest 30-50	**CF 30-50**	8.5	2.7	84.5	27.4
Coniferous Forest 50-70	**CF 50-70**	16.6	4.0	166.4	40.3
Coniferous Forest Above 70	**CF Above 70**	25.7	6.1	257.2	60.9
Sub-Alpine Forest 10-30	**SAF 10-30**	15.3	4.2	153.3	41.6
Sub-Alpine Forest 30-50	**SAF 30-50**	14.1	3.7	141.0	36.8
Sub-Alpine Forest 50-70	**SAF 50-70**	20.7	5.0	206.6	49.5
Sub-Alpine Forest Above 70	**SAF Above 70**	33.2	7.5	331.7	75.2
Cropland	**Cropland**	0.0	0.0	0.0	0.0
Waterbodies	**Waterbodies**	0.0	0.0	0.0	0.0
Grassland	**Grassland**	0.0	0.0	0.0	0.0
Otherland	**OTHERLAND**	0.0	0.0	0.0	0.0
Settlement	**SETTLEMENT**	0.0	0.0	0.0	0.0

Table 43: Carbon content in all selected Carbon pools

Class/Stratum	Stratum (i)	C_{AGL} (tC/ha)	C_{BG} (tC/ha)	C_{Litter} (tC/ha)	C_{SOC} (tC/ha)	C (i) (tC/ha)
Moist Mixed deciduous Forest 10-30	**MMD 10-30**	56.8	14.4	0.6	72.6	144.4
Moist Mixed deciduous Forest 30-50	**MMD 30-50**	184.7	44.9	1.4	80.3	311.4
Moist Mixed deciduous Forest 50-70	**MMD 50-70**	277.8	69.3	1.4	79.2	427.6
Moist Mixed Deciduous Forest Above 70	**MMD Above 70**	425.6	114.9	1.5	74.9	616.9
Wet temperate Forest 10-30	**WTF 10-30**	31.5	9.0	1.2	94.6	136.3
Wet temperate Forest 30-50	**WTF 30-50**	49.2	15.3	4.0	76.4	144.9

Class/Stratum	Stratum (i)	C_{AGL} (tC/ha)	C_{BG} (tC/ha)	C_{Litter} (tC/ha)	C_{SOC} (tC/ha)	C (i) (tC/ha)
Wet temperate Forest 50-70	**WTF 50-70**	52.4	15.3	0.7	93.9	162.2
Wet temperate Forest Above 70	**WTF Above 70**	114.9	30.0	1.5	89.1	235.5
Subtropical wet hill Forest 10-30	**SWH 10-30**	28.0	9.4	0.6	89.1	127.0
Subtropical wet hill Forest 30-50	**SWH 30-50**	46.0	15.9	0.7	89.5	152.0
Subtropical wet hill Forest 50-70	**SWH 50-70**	123.2	33.5	2.0	60.4	219.1
Subtropical wet hill Forest Above 70	**SWH Above 70**	192.5	52.0	0.9	92.7	338.1
Coniferous Forest 10-30	**CF 10-30**	30.8	9.8	0.6	80.0	121.2
Coniferous Forest 30-50	**CF 30-50**	42.3	13.7	1.3	97.8	155.1
Coniferous Forest 50-70	**CF 50-70**	83.2	20.1	0.8	79.1	183.2
Coniferous Forest Above 70	**CF Above 70**	128.6	30.4	2.5	112.9	274.4
Sub-Alpine Forest 10-30	**SAF 10-30**	76.6	20.8	2.0	99.8	199.2
Sub-Alpine Forest 30-50	**SAF 30-50**	70.5	18.4	1.9	108.9	199.7
Sub-Alpine Forest 50-70	**SAF 50-70**	103.3	24.8	2.1	124.7	254.9
Sub-Alpine Forest Above 70	**SAF Above 70**	165.8	37.6	5.0	77.6	286.0
Cropland	**Cropland**	0.0	0.0	0.0	0.0	0.0
Waterbodies	**Waterbodies**	0.0	0.0	0.0	0.0	0.0
Grassland	**Grassland**	0.0	0.0	0.0	0.0	0.0
Otherland	**OTHERLAND**	0.0	0.0	0.0	0.0	0.0
Settlement	**SETTLEMENT**	0.0	0.0	0.0	0.0	0.0

Emissions Factors

The Emission Factor for AGB has been calculated as:

$$\mathbf{EF_{AGL}(CS1 \rightarrow CS2)} = \frac{\mathbf{44}}{\mathbf{12}} \cdot \left(\mathbf{C_{AGL}(CS2) - C_{AGL}(CS1)}\right)$$

Where:

$EF_{AGL}(CS1 \rightarrow CS2)$	=	Emission factor for change in aboveground live plant organic matter from an LULC Class or forest Stratum (CS) 1 to 2. [tCO2e ha-1]
$CS1 \rightarrow CS2$	=	Land transition from LULC class or forest stratum 1 to 2.
$C_{AGL}(i)$	=	Carbon density of aboveground plant organic matter of classes or forest stratum i. [MT C ha-1]

The Emission Factor for BGB must also be must be gradually spread over time. The project proponent may propose their own temporal component (e.g., an exponential equation) if the conservative nature of the temporal component can be demonstrated using peer-reviewed

literature or measurements conducted by the project proponent. Here, the default temporal component has been calculated from:

For t ≤ 10:

$$EF_{BG}(CS1 \rightarrow CS2, t) = \frac{44}{12} \cdot \frac{\left(C_{BG}(CS2) - C_{BG}(CS1)\right)}{10}$$

For t > 10:

$$EF_{BG}(CS1 \rightarrow CS2, t) = 0$$

Where:

$EF_{BG}(CS1 \rightarrow CS2, t)$	=	Emission factor for change in belowground plant organic matter from an LULC Class or forest Stratum (CS) 1 to 2 at t years after transition. [tCO2e ha-1]
$CS1 \rightarrow CS2$	=	Land transition from LULC class or forest stratum 1 to 2.
$C_{BG}(i)$	=	Carbon density of belowground plant organic matter of classes or forest stratum i. [MT C ha-1]

For this project, the default value has been chosen for the temporal component for BGB, which is 10 years.

For Emissions Factor for SOC, the applied methodology also mentions that ''…the total soil emission factor must be gradually spread over time. The project proponent may propose their own temporal component (e.g., an exponential equation) if the conservative nature of the temporal component can be demonstrated using peer-reviewed literature or measurements conducted by the project proponent. If no temporal component is proposed by the project proponent, the temporal component from the IPCC GPGLULUCF 2003 and used in following formula for the soil emission factor must be used.''

$$EF_{SOM}(CS1 \rightarrow CS2, t) = \frac{44}{12} \cdot \frac{\left(C_{SOM}(CS2) - C_{SOM}(CS1)\right)}{20}$$

For this project, the default value has been chosen for the temporal component for SOC, which is 20 years.

Similarly, **Emissions Factor for the Litter Carbon Pool** is calculated.

The Combined Emissions Factors for all Carbon Pools considered in the Baseline have also been calculated and is represented in the Emissions Reductions spreadsheet attached with the PDD.

The rates of deforestation and forest degradation over the historical reference period have been represented by **Error! Reference source not found.**5.

7.3 Baseline and Project Scenario

From the ecological and spatial analyses conducted across the State of Sikkim for the historical reference period, the REDD+ Baseline has been developed for the State, which depicts the patterns of changes in LULC per year (in Ha/year). Similarly, LULC changes in the Project Scenario have been estimated, where no LULC transitions are expected across LULC categories and land area under each category remains constant.

These scenarios have been represented in the Emissions Reductions spreadsheet attached with the PDD.

7.4 Emission Reductions and Sequestration from Identified Interventions

Projected Sequestration

Conservative estimates have been taken to account for afforestation, agro-forestry, ANR and oak regeneration activities across Sikkim over the next 20 years, considering that these activities start from the 3rd year of project initiation.

Table 44: Activities planned towards Carbon sequestration

Afforestation	Average land for Activity (Ha)	Total Land for Activity at end of 20 years (Ha)
Area under Afforestation	No land identified in 1st 2 years; 100 Ha thereafter.	1,800
Area under Agro-Forestry	No land identified in 1st 2 years; 200 Ha each in Years 3 & 4; 500 Ha thereafter.	8,400
Area under ANR	No land identified in 1st 2 years; 200 Ha each in Years 3 & 4; 500 Ha thereafter.	8,400
Area under Oak Regeneration	No land identified in 1st 2 years; 100 Ha thereafter.	1,800
Total		20,400

Considering the annual increment of broadleaved species at 5 tdm/Ha/year and oak at 3 tdm/Ha/year for Above-Ground Biomass and a conservative estimate of Buffer at 40% to account for mortality and loss of crop, the projected sequestration from afforestation activities is given as follows:

7.5 Project Emissions

Changes in LULC patterns as compared to the Baseline Scenario, along with their corresponding Emissions Factors have been estimated to obtain the emissions due to land transitions (in tCO_2/year).

Year	A/R-new/yr (ha)	Oak (ha)	A/R-cumulative (ha)	Oak (cumulative) (ha)	tC/yr (trop.)	tC/yr (Oak)	BGB-others-tC	BGB Oak tC	Total tC	Total tCO2e after buffer
Year 1	0	0	0	0	0	0	0	0	0	0
Year 2	0	0	0	0	0	0	0	0	0	0

Year 3	500	100	500	100	2,500	300	600	105	3,505	7,711
Year 4	500	100	1,000	200	5,000	600	1,200	210	7,010	15,422
Year 5	1,100	100	2,100	300	10,500	900	2,520	315	14,235	31,317
Year 6	1,100	100	3,200	400	16,000	1,200	3,840	420	21,460	47,212
Year 7	1,100	100	4,300	500	21,500	1,500	5,160	525	28,685	63,107
Year 8	1,100	100	5,400	600	27,000	1,800	6,480	630	35,910	79,002
Year 9	1,100	100	6,500	700	32,500	2,100	7,800	735	43,135	94,897
Year 10	1,100	100	7,600	800	38,000	2,400	9,120	840	50,360	110,792
Year 11	1,100	100	8,700	900	43,500	2,700	10,440	945	57,585	126,687
Year 12	1,100	100	9,800	1,000	49,000	3,000	11,760	1,050	64,810	142,582
Year 13	1,100	100	10,900	1,100	54,500	3,300	13,080	1,155	72,035	158,477
Year 14	1,100	100	12,000	1,200	60,000	3,600	14,400	1,260	79,260	174,372
Year 15	1,100	100	13,100	1,300	65,500	3,900	15,720	1,365	86,485	190,267
Year 16	1,100	100	14,200	1,400	71,000	4,200	17,040	1,470	93,710	206,162
Year 17	1,100	100	15,300	1,500	76,500	4,500	18,360	1,575	100,935	222,057
Year 18	1,100	100	16,400	1,600	82,000	4,800	19,680	1,680	108,160	237,952
Year 19	1,100	100	17,500	1,700	87,500	5,100	21,000	1,785	115,385	253,847
Year 20	1,100	100	18,600	1,800	93,000	5,400	22,320	1,890	122,610	269,742
									Total	**2,431,605**
									Average per year	**121,580**

Table 45: Projected Carbon Sequestration in Sikkim

Table 46: Emissions from the project

Net emissions from transitions where one stratum is non-forest		
Total sequestration non-forest to forest	**63,818**	tCO2e/year
Total emissions forest to non-forest (deforestation)	**81,474**	tCO2e/year
Net Degradation = Net sum of all strata transitions within the forest classes		
Sequestration due to forest enhancement	**9,760**	tCO2e/year
Net emissions from forests (considering reforestation, regeneration)	**7,897**	tCO2e/year
Net Emission Reductions per year	**7,897**	tCO2e/year

7.6 Net Emissions Reductions

Emissions Reductions from the project are given below:

Table 47: Emissions Reductions from the REDD+ Project

Year	Emission Reductions (tCO2e)	Emission Reductions after applying correction factor(tCO2e)	Potential sequestration	Cumulative reductions (tCO2e)
Year 1	-	-	0	-
Year 2	790	790	0	790
Year 3	3,159	3,159	0	3,159
Year 4	5,528	5,528	7711	13,239
Year 5	7,897	7,897	15422	23,319
Year 6	7,897	7,897	31317	39,214
Year 7	7,897	7,897	47212	55,109
Year 8	7,897	7,897	63107	71,004
Year 9	7,897	7,897	79002	86,899
Year 10	7,897	7,897	94897	102,794
Year 11	7,897	7,897	110792	118,689
Year 12	7,897	7,897	126687	134,584
Year 13	7,897	7,897	142582	150,479
Year 14	7,897	7,897	158477	166,374
Year 15	7,897	7,897	174372	182,269
Year 16	7,897	7,897	190267	198,164
Year 17	7,897	7,897	206162	214,059
Year 18	7,897	7,897	222057	229,954
Year 19	7,897	7,897	237952	245,849
Year 20	7,897	7,897	253847	261,744
Total		135,833	2,161,863	2,297,696

Year	Emission Reductions (tCO2e)	Emission Reductions after applying correction factor(tCO2e)	Potential sequestration	Cumulative reductions (tCO2e)
Average		6,792	108,093	114,885

7.7 Leakage

The jurisdiction of the REDD+ project is the administrative boundaries of Sikkim, while the area under consideration for the project is the geographic boundaries of the State. Any displacement of emissions outside these boundaries would fall outside the jurisdiction of the Government of Sikkim. Hence, leakages are not applicable for this REDD+ project.

8. Implementation Strategy and Monitoring Plan

8.1 Introduction

This chapter details the institutional arrangement of the project, implementation strategy and the monitoring plan of the REDD+ project. The REDD+ project will be implemented by the FEWMD through the REDD+ Steering Committee and REDD+ Cell. Deployment of intervention activities will be taken up after identification of beneficiaries for each of the intervention. This will be followed by convergence with any existing schemes. Each intervention will be geotagged for easy monitoring and evaluation and reporting of various project parameters, including those on mitigation.

8.2 REDD+ Institutional arrangement

The FEWMD under the Government of Sikkim is responsible for the formulation, management, implementation, and monitoring of activities under the project. The State government is also responsible for evaluating actions that seek to protect the natural resources in the state, thereby reducing the emissions of GHGs and maintaining the continued provision of ecosystem services. A robust management structure has been identified to oversee the implementation of the identified interventions. For the purposes of the overall management and implementation of the REDD+ Program, two bodies have been set up: the **Sikkim REDD+ Steering Committee** and the **Sikkim REDD+ Cell**.

The structure has taken into account all relevant stakeholders at the local and regional levels. The Management Structure is led by the REDD+ Steering Committee, which is chaired by the Chief Secretary of the State of Sikkim. Further, Nodal Officers from each department, nominated by members of the REDD+ Steering Committee, have been tasked with engaging with stakeholders on a daily basis. The State REDD+ Cell, consisting of officials from the FEWMD, has been mandated to be responsible for managing REDD+ activities in the State.

REDD+ Steering Committee

The Sikkim Jurisdictional REDD+ Steering Committee has been set up vide Government of Sikkim **Notification No. 60/Home/2015 and GOS/FEWMD/GEN/2P/4.65, dated 25 November 2015.** The details of the members of the Steering Committee is given below in Annexure to this document. Members of the Steering Committee have appointed one nodal officer each from their respective Departments to look after the day-to-day functioning of the project, and to coordinate between these Departments towards advancing the REDD+ interventions.

REDD+ Cell

The REDD+ Cell has been constituted in the FEWMD with the approval of the Government of Sikkim vide **Notification No. GOS/FEWMD/PR.SECY-PCCF/122, dated 14 August 2015.** The details of the members of the REDD+ Cell is given as Annexure to this document.

The FEMWD will be the key decision-making body, tasked with implementation of the project. However, where other government line departments are also involved, the REDD+ Steering Committee shall take necessary decisions for implementation of program activities in consultation with the FEWMD.

Monitoring of the performance and viability of the identified REDD+ interventions would be at the state level. Interventions would be subject to review and assessment at pre-specified

intervals as part of the periodic monitoring undertaken by the project proponent, the Sikkim FEWMD.

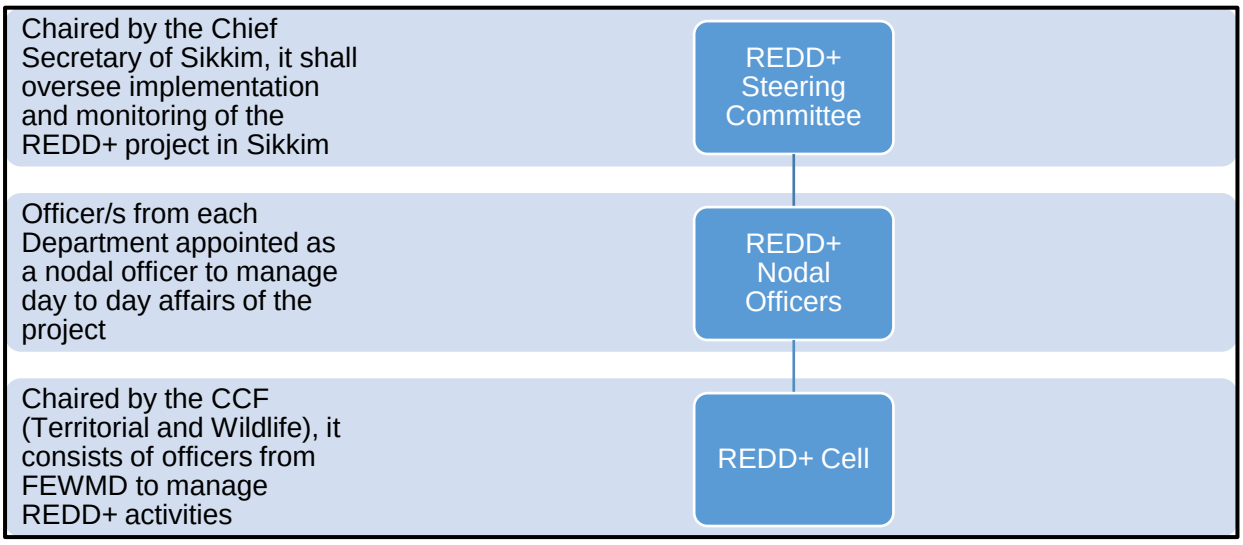

Figure 29: Management Structure of the program at state level

8.3 Implementation strategy

The implementation structure further builds on the management structure, and includes the Forest Divisions and Ranges of the FEWMD, and village-level JFMCs to oversee a community-based implementation and monitoring program. Led by the Steering Committee and REDD+ Cell at the State level, it mandates that the implementation of program activities and interventions involve local JFMCs and EDCs. This will ensure that no new implementation arrangement is required and the Department can deploy the interventions through the established and tested delivery routes.

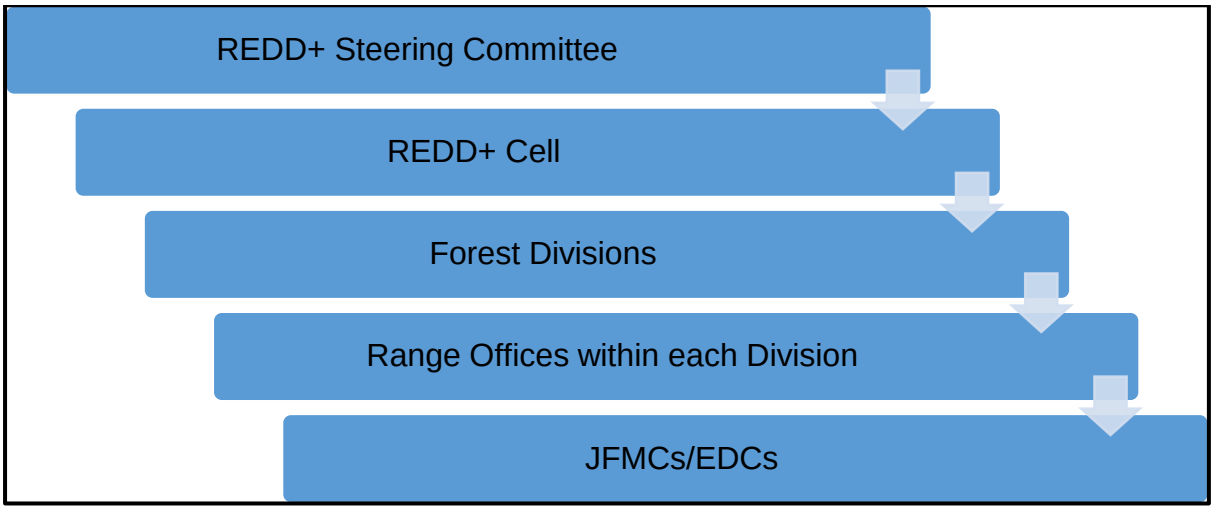

Figure 30: Implementation structure for the program

Monitoring Plan: Institutional arrangement

Once the project is initiated, it is the responsibility of the FEWMD to monitor and measure the emissions reductions accrued from the implementation of the identified interventions, and the carbon and non-carbon benefits accrued in the landscape. Concurrently, the FEWMD is responsible for disseminating all relevant information to stakeholders across the project lifetime.

In particular, the REDD+ Cell would be the authority for monitoring, review and reporting of all monitoring data. A team of forestry professionals from the FEWMD, trained in monitoring, surveying and collecting data needed to implement the monitoring plan, will assist the REDD+ Cell in this activity. The relevant information and data will be documented and made accessible to the public in both paper and electronic formats. If required, external consultants may be employed to assist in the development of relevant monitoring reports. To facilitate the efficient monitoring and implementation of project activities, an Online Sikkim REDD+ Portal shall be developed, supported by the FEWMD. All monitoring reports shall be uploaded on this portal for easy access to all stakeholders.

An 'Operational Manual' will be developed by the Sikkim REDD+ Cell and distributed to monitoring personnel at the time of project initiation. The Manual will describe the SOPs for field staff and the implementation of the monitoring program, and will be used for capacity building of monitoring staff. The Manual will take inputs from FEWMD and other stakeholders as applicable.

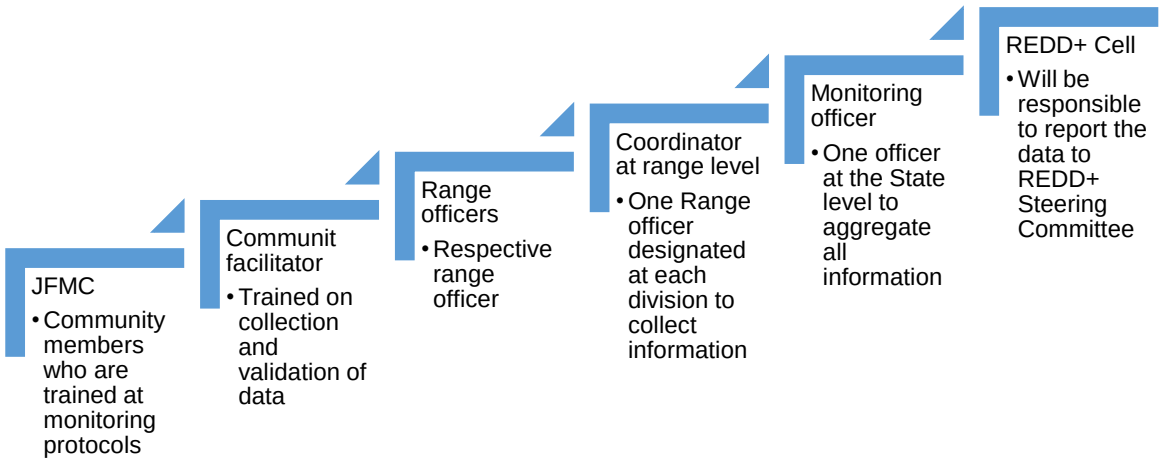

Figure 31: Flow of information during monitoring of the REDD+ project

Monitoring Plan

The Monitoring Plan that has been developed for the program will enable the FEWMD to monitor the performance of the REDD+ interventions advanced under the project, based on estimation of the achievement of given targets. The indicators measured as part of monitoring will also help in validation of the carbon (in the form of emissions reductions) and non-carbon benefits accrued to the project and assess the extent of community involvement in project activities.

In addition, evaluation of the following indicators will also be made possible by the monitoring plan:

- Effectiveness of project activities to mitigate drivers of deforestation and forest degradation
- Uptake of proposed intervention activities by the local communities

- Deployment of alternative energy technologies, grazing techniques and land use management initiatives.
- Environmental impacts of the projects.
- Socio-economic impacts of the project and participation of local communities towards monitoring.

The project has already established baselines at the start of the program, including (a) forest types and forest cover, (b) forest carbon stock based on remote sensing imagery and field surveys and (c) socio-economic surveys to evaluate forest dependency of the rural population.

The project proposes **two** stages of monitoring and assessment to be undertaken by the FEWMD:

- **Annual Monitoring**: Measurement of indicators and monitoring of activities supported by the project. This shall be documented in the Annual Progress Report.
- **Baseline Re-evaluation at 10 Years**: Re-development of the baseline to be considered for estimating emissions reductions accrued from the project activities.

The components under annual monitoring carried out by the FEWMD are summarized below.

Table 48: Parameters to be measured towards annual monitoring

Community indicators	No. of JFMC meetings in the current year and attendance
	No. of people attending JFMC meetings, % of men and women.
	No. of trainings imparted and no. of people trained for community monitoring of forests
	Funding and audit of community groups – JFMCs, VFCs, EDCs.
	Community involvement in forest management
Land use management indicators:	Methodology of site selection for plantation activities.
	Planting area (Ha) for fuelwood and fodder plantations
	Fuelwood plantations on monasteries lands
	Interventions advanced in cardamom plantations
	Species planted and planting density (tree ha^{-1})
	Survival rate (measured the following year) in %
	Information on climatic extremes which may affect stand growth
	Lands cleared to make grazing areas (Ha)
Environmental indicators:	Amount of forestlands diverted for non-forest activities (Ha)
	Amount of forestlands damaged due to fire, pests, grazing (Ha)
	Information on general forest management techniques carried out – fire prevention, pest management
Intervention activities indicators:	No. of ICS/induction plates distributed, bio-briquettes/biogas plants installed.
	No. of LPG connections installed
	No. of briquette-making equipment distributed
	Details of fodder management techniques advanced
	Details of alternative livelihoods – No. of families impacted, schemes introduced, inter-departmental convergences

	No. of induction devices and ICS distributed and installed
	No. of large ICS distributed in monasteries and schools
	No. of fuelwood depots constructed in monasteries lands
	No. of organic certifications supplied for horticultural crops

The baseline estimated for calculating emissions reductions across the landscape will be re-evaluated at an interval of every 10 years from the project start date to reflect changing environmental and socio-economic scenarios in the state of Sikkim. This will enable an accurate and up-to-date estimation of the forest carbon stocks, emissions from the forestlands and the characteristics of the forest dependency of the local rural population.

Baseline re-evaluation will include:

- Estimation of the changes in Sikkim's forest strata through spatial analysis to reflect shifts in density classes.
- Calculation of the forest carbon stock in each strata through spatial and field analysis.
- Assessment of the forest dependency of local communities, the provenance of the drivers of forest change in the landscape and the success of the REDD+ interventions.

For this activity, spatial analysis techniques shall remain consistent across baseline re-evaluation, although data sources may be updated if new and improved sources are found provided there exists reasonable consistency and overlap. At the same time, consistency and compatibility with a future national carbon accounting system (as and when developed and ratified), will be explored.

For the calculation of forest carbon stock, biomass plots have been laid in every forest strata in Sikkim as per standard methodologies detailed in the National Working Plan Code 2014. These will be adhered to for future baseline re-evaluation, until newer versions of the National Working Plan Code are introduced by the MoEFCC. The REDD+ Cell at the FEWMD may facilitate resources required for the survey (equipment, logistics etc.). Permanent plots which have been established in Sikkim will act as Random Control Plots (RCPs) to validate the baseline, and effects of the interventions on the emissions from forests.

Although annual changes in forest cover have been consistently low, it is expected that project activities result in the enhancement of forest carbon stock in Sikkim. Estimated project benefits and technical specifications may be modified contingent on the assessment of these characteristics. Going forward, since analysis of the indicators shall also be able to assess community capacity towards undertaking project activities, interventions can appropriately be readjusted appropriately.

Quality Assurance and Quality Control (QA/QC)

In addition to the Manual, a QA/QC plan, including protocols for field measurements, data collection and verification, data entry and archiving, will be developed and circulated to ensure the integrity of data collected and improve the monitoring efficiency for subsequent monitoring cycles shall be established.

For all activities, Standard Operating Procedures (SOPs) shall be developed by the FEWMD. These shall be adhered to at all times during monitoring. This will include:

- Training of field-team members on field data collection and analysis.
- Deployment of alternative energy interventions.

- Monitoring and assessment of lands identified for fodder and fuelwood plantations on khasmal, gorucharan and private forestlands.
- Monitoring of forest management techniques applied towards fire prevention and patrolling.

Parameters (fixed)

Those parameters that are available at the development stage, and are fixed during the monitoring are termed as Parameters (fixed). These do not change during the monitoring unless a more conservative value is applied based on scientifically accepted practices. These parameters are detailed below.

Data/parameter	A_{jur}
Data unit	Km^2
Description	Area of the jurisdiction (in Ha)
Data source	Official national and state records
Value applied	7096 km^2
Justification of choice of data or description of measurement methods and procedures applied	The value has been used from official government source[105].
Purpose of data	• Calculation of baseline emissions • Calculation of project sequestrations
Comments	None

Data/parameter	CF
Data unit	t C t $d.m^{-1}$
Description	Carbon fraction of dry matter in t C t $d.m^{-1}$
Data source	Values from the literature (e.g. IPCC 2006 INV GLs AFOLU Chapter 4 Table 4.3) shall be used if available (otherwise default value of 0.47 t C t-1 d.m).
Value applied	0.47
Justification of choice of data or description of measurement methods and procedures applied	Calculated as a ratio of AGB, based on 2006 IPCC Guideline to prepare National GHG inventory.
Purpose of data	Calculate carbon content in biomass, to be used in baseline and project sequestration calculations.
Comments	None

Data/parameter	f_j (X,Y)
Data unit	t d.m. $tree^{-1}$
Description	Allometric equation for species *j* linking measured tree variable(s) to aboveground biomass of living trees, expressed as t d.m. $tree^{-1}$
Data source	Equations derived using a range of measured variables like DBH and tree height based on datasets that comprise at least 30 trees. Equations must be based on statistically significant regressions and must have an r^2 that is ≥ 0.8.

[105] https://www.sikkim.gov.in/portal

	The source of equation(s) shall be chosen with priority from higher to lower preference, as available, as follows: (a) National species-, genus-, family-specific; (b) Species-, genus-, family-specific from neighboring countries with similar conditions (i.e. broad continental regions); (c) National forest-type specific; (d) Forest-type specific from neighboring countries with similar conditions (i.e. broad continental regions); (e) Pan-tropical forest type-specific such as those provided Tables 4.A.1 to 4.A.3 of the GPG-LULUCF (IPCC 2003), or in Pearson et al. (2005); Sourcebook for Land Use, Land-Use Change and Forestry Projects. Available at: *http://www.winrock.org/Ecosystems/files/Winrock-BioCarbon_Fund_Sourcebook-compressed.pdf* or in Chave et al. (2005); Tree allometry and improved estimation of carbon stocks and balance in tropical forests. Oecologia 145: 87-99. Species-, genus- and family-specific allometric equations may not always be available, and may be difficult to apply with certainty, hence it is acceptable practice to use equations developed for regional or pantropical forest types, provided that their accuracy has been validated with direct site-specific data. If a forest-type specific equation is used, it should not be used in combination with species-specific equation(s).
Value applied	Refer the emission reduction spreadsheet for the volume equations which have been applied.
Justification of choice of data or description of measurement methods and procedures applied	Peer reviewed literature.
Purpose of data	Calculation of baseline and project sequestration.
Comments	Volume equations can be changed during the life of the project based on the CDM guidance.

Data/parameter	f_j (vegetation parameters)
Data unit	t. d.m. individual^{-1}
Description	Allometric equation for non-tree species, linking parameters such as stem count, diameter of crown, height etc. to AGB of an individual
Data source	Use of allometric equations that are species-specific or group of species-specific wherever available, provided the equations have been derived using a

	wide range of diameters and heights, based on datasets that comprise at least 30 individuals. Project participants may create project location specific equation where appropriate.
Value applied	Not used for the current baseline, and hence not applicable.
Justification of choice of data or description of measurement methods and procedures applied	None
Purpose of data	Baseline and project emission reductions
Comments	Maybe included in revised baselines in the future.

Data/parameter	R
Data unit	t root d.m. t^{-1} shoot d.m.
Description	Root to shoot ratio appropriate to species or forest type. Here, this ratio is given by *belowground biomass per unit area: aboveground biomass per unit area*.
Data source	From Table 4.4 in IPCC GL AFOLU, based on ecological domain and AGB.
Value applied	0.24
Justification of choice of data or description of measurement methods and procedures applied	Based on GPG LULUCF in the absence of country specific data.
Purpose of data	Calculate carbon content in biomass, to be used in baseline and project sequestration calculations.
Comments	None

Data/parameter	Risk Maps
Data unit	Metric
Description	Describes the risk of deforestation for each pixel in project area as a numerical scale.
Data source	Satellite imagery
Value applied	NA (NRSC/USGS)
Justification of choice of data or description of measurement methods and procedures applied	Government validated data
Purpose of data	For mapping LULC change and baseline
Comments	None

Data/parameter	Baseline deforestation maps
Data unit	Metric
Description	Maps showing location of deforested areas in the project area in the last 10 years
Data source	Satellite imagery
Value applied	NA (NRSC/USGS)

Justification of choice of data or description of measurement methods and procedures applied	Government validated data
Purpose of data	For mapping LULC change and baseline
Comments	None

Data/parameter	AA_u
Data unit	%
Description	Accuracy assessment of the classification of LULC for each map.
Data source	• Existing maps and models • Literature and expert consultations
Value applied	93%
Justification of choice of data or description of measurement methods and procedures applied	Based on actual classification data.
Purpose of data	Uncertainty due to classification errors
Comments	Will be updated during every revision of the baseline.

Data/parameter	T_{hrp}
Data unit	Years
Description	Duration of the historical reference period in years
Data source	• Expert consultations • Secondary data review
Value applied	12 years (2002 to 2013)
Justification of choice of data or description of measurement methods and procedures applied	The historical time period that has been chosen for analysing change in forests is 12 years. Such analyses can choose a time horizon of more than 10 years to map changes. Further images are free of cloud cover, and takes into consideration seasonal consistency across the time horizon.
Purpose of data	To map LULC change for the baseline.
Comments	None
Data/parameter	WD
Data unit	g/cm^3
Description	Mean wood density of species
Data source	Chosen from: (a) Averaged national and commercial species-specific inventories, or from such estimates in neighbouring countries. (b) Averaged regional commercial species-specific (e.g. Table 4.13 IPCC National Guidance for Greenhouse Gas Inventories AFOLU Section). (c) Regional averages (0.58 for tropical Africa, 0.60 for tropical America; 0.57 for tropical Asia). Taken from Brown, 1997; Estimating Biomass and Biomass

	Change of Tropical Forests: a Primer (FAO Forestry Paper - 134).
Value applied	Specific to the species of trees. Refer the base volume calculation spreadsheets associated with the emission reduction spread sheet.
Justification of choice of data or description of measurement methods and procedures applied	Based on peer reviewed literature
Purpose of data	Calculation of baseline and project emission reductions.
Comments	None

Data/parameter	V_{FW}
Data unit	m^3/year/household
Description	Mean annual consumption of fuelwood in the baseline period
Data source	• Interviews/PRAs • Field measurements and expert appraisals
Value applied	As given in the emission reduction spreadsheet
Justification of choice of data or description of measurement methods and procedures applied	Based on peer reviewed literature or surveys
Purpose of data	Calculation of baseline and project emission reductions.
Comments	None

Data/parameter	GWP_g
Data unit	Dimensionless
Description	Global warming potential for gas *g*
Data source	IPCC Assessment Report 5
Value applied	As given in the emission reduction spreadsheet
Justification of choice of data or description of measurement methods and procedures applied	Based on peer reviewed literature
Purpose of data	Calculation of baseline and project emission reductions.
Comments	None

Data/parameter	A_i
Data unit	Ha
Description	Area of baseline stratum *i*
Data source	• GIS coverage and remote imagery • Ground survey data
Value applied	As given in the emission reduction spreadsheet

Justification of choice of data or description of measurement methods and procedures applied	Land Use Land Cover classification follows IPCC guidelines. Forest strata has been based on the Champion and Seth classification. Forests have been further divided into strata based on the canopy density.
Purpose of data	Calculation of baseline emissions
Comments	None

Data/parameter	U_{BSL}
Data unit	%
Description	Percentage uncertainty (expressed as 95% confidence interval as a percentage of the mean where appropriate) for carbon stocks and greenhouse gas sources in the baseline case
Data source	Field measurements and calculations
Value applied	10%
Justification of choice of data or description of measurement methods and procedures applied	Based on approved REDD+ methodology VM0006 version 2.1
Purpose of data	Calculation of uncertainty
Comments	None

Data/parameter	BD_s
Data unit	g/cm^3
Description	Bulk density of soil in soil stratum ‘s’
Data source	Field measurements and literature study
Value applied	--
Justification of choice of data or description of measurement methods and procedures applied	The value has been sourced from peer reviewed literature.
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	None

Data/parameter	F_{BE}
Data unit	Dimensionless
Description	Biomass Expansion Factor
Data source	Values from IPCC Good Practice Guidance for LULUCF (2003) Table 3A.1.10. Default values of biomass expansion factors (BEFs)
Value applied	IPCC GPG Default value
Justification of choice of data or description of measurement methods and procedures applied	BEF must be sourced from data on local ecological systems. In case of unavailability of this data, regional, national and international data must be

	used, in that order. Since no other data was available, IPCC value has been used.
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	None

Data/parameter	ROC_{NF}
Data unit	ha/yr.
Description	Rate of conversion of forest land stratum 'í' into non-forest land stratum 'í' where I is denoted by 1.2…etc.
Data source	Literature study and expert appraisals
Value applied	Please refer the emission reduction calculation spread sheet.
Justification of choice of data or description of measurement methods and procedures applied	Latest RS/GIS techniques have been used to map the LULC changes.
Purpose of data	Calculation of baseline emissions
Comments	None

Data/parameter	ROC_{OF}
Data unit	ha/yr.
Description	Rate of conversion of forest land stratum 'í' into another forest land stratum 'í' where I is denoted by 1.2…etc.
Data source	Literature study and expert appraisals
Value applied	Please refer the emission reduction calculation spread sheet.
Justification of choice of data or description of measurement methods and procedures applied	Latest RS/GIs techniques have been used to map the LULC changes.
Purpose of data	Calculation of baseline emissions
Comments	None

Data/parameter	N_{TS}
Data unit	Dimensionless
Description	Thermal efficiency of traditional stoves
Data source	Expert appraisal, market information
Value applied	10% default value based on IPCC/CDM approved methodology AMS-II.G
Justification of choice of data or description of measurement methods and procedures applied	This is considered as default value based on IPCC/CDM approved methodology.
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	None

Data/parameter	N_{FES}
Data unit	Dimensionless
Description	Thermal efficiency of fuel-efficient stoves
Data source	MNRE information for the public
Value applied	As per the model of the stove
Justification of choice of data or description of measurement methods and procedures applied	MNRE has compiled information of all stoves that are efficient and have been empanelled.
Purpose of data	Calculation of project emissions reductions
Comments	None

Data/parameter	EF_f
Data unit	Dimensionless
Description	Emission factor of fossil fuel 'f'
Data source	IPCC 2006
Value applied	Based on the fuel used (eg: LPG)
Justification of choice of data or description of measurement methods and procedures applied	IPCC 2006 lists all default values
Purpose of data	Calculation of project emissions
Comments	None

Data/parameter	ROC_{A_i}
Data unit	Ha/yr.
Description	Rate of change in area of a stratum 'I'
Data source	RS/GIS analysis and field data
Value applied	Refer spreadsheets
Justification of choice of data or description of measurement methods and procedures applied	Latest RS/GIS techniques have been used to map the LULC changes.
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	

Data/parameter	DF_d
Data unit	%
Description	Proportion of driver 'd' in causing deforestation.
Data source	Based on socio-economic surveys
Value applied	Refer spreadsheets
Justification of choice of data or description of measurement methods and procedures applied	Based on key informant interviews.
Purpose of data	• Calculation of baseline emissions • Calculation of project emission reductions
Comments	None

Data/parameter	DG_d
Data unit	%
Description	Proportion of driver 'd' in causing forest degradation
Data source	Based on socio-economic surveys
Value applied	Refer spreadsheets
Justification of choice of data or description of measurement methods and procedures applied	Same as DF_d
Purpose of data	• Calculation of baseline emissions • Calculation of project emission reductions
Comments	

Data/parameter	SR_{int-d}
Data unit	%
Description	Efficacy or success rate of an intervention activity planned on driver 'd' in completely eliminating emissions due to driver 'd'
Data source	Based on socio-economic surveys
Value applied	Refer spreadsheets
Justification of choice of data or description of measurement methods and procedures applied	Based on expert opinions and key informant interviews.
Purpose of data	• Calculation of baseline emissions • Calculation of project emission reductions
Comments	Applicable in case more than one intervention activities are planned

Data/parameter	RB
Data unit	Mg/year
Description	Demonstrably renewable biomass within the state
Data source	PRAs, expert appraisals and literature study
Value applied	--
Justification of choice of data or description of measurement methods and procedures applied	Not used in this phase, but may be used in the latter stages of the project.
Purpose of data	• Calculation of baseline emissions • Calcuation of project emissions
Comments	Estimation to be made of proportion of fuelwood that is demonstrably renewable

Data / Parameter	CF_{Tree}
Data unit	t C td.m. $^{-1}$
Description	Carbon fraction of dry matter for species of type *j*
Data source	Methodological tool: "*Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities" Latest version.* Referred in equation number 13.

Value applied	A default value of 0.47 is used following the AR CDM methodological tool.
Justification of choice of data or description of measurement methods and procedures applied	To convert the dry biomass into carbon weight
Purpose of Data	Project emission and project sequestration
Comments	None

Data / Parameter	D_j
Data unit	t d.m. m^{-3}
Description	Density overbark of tree stem for tree species j.
Source of data	Good Practices IPCC Guidelines, 1996 and Published literature
Value applied	Please refer to the C-calculation spreadsheet associated with the ER calculations
Justification of choice of data or description of measurement methods and procedures applied	*Dj* must be sourced from data on local ecological systems. In case of unavailability of this data, regional, national and international data must be used, in that order.
Purpose of Data	Project emission and project sequestration
Comments	

Data / Parameter	R_j
Data unit	Dimensionless
Description	Root-shoot ratio appropriate for biomass stock, for species *j*
Source of data	A default value given in the methodology or, Values from IPCC Good Practice Guidance for LULUCF (2003) Table 3A.1.8 "*Average belowground to aboveground biomass ratio (root-shoot ratio, r) in natural regeneration by broad category (tons dry matter/ton dry matter)".*
Value applied	A default value given in the methodology
Justification of choice of data or description of measurement methods and procedures applied	*Rj* must be sourced from data on local ecological systems. In case of unavailability of this data, regional, national and international data must be used, in that order.
Purpose of Data	Project emission and project sequestration
Comments	None

Parameters to be monitored

Data / Parameter	A_i
Data unit	*Ha*
Description	*Area of stratum i*
Source of data	RS/GIS analysis by the EE
Description of measurement methods	Standard land use land cover classification techniques.

and procedures to be applied:	
Frequency of monitoring/recording	*Minimum every 10 years prior to baseline renewal.*
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	All RS/GIs related SOPs to be followed including validation of classification and accuracy assessment.
Purpose of data	• *Calculation of baseline emissions* • *Calculation of program emissions* • *Calculation of leakage*
Calculation method	None
Comments	None

Data / Parameter	$A_{unplanned\_hrp}$
Data unit	Ha
Description	Total area deforested during the historical reference period in the jurisdiction.
Source of data	Remote sensing and GIS analysis imagery
Description of measurement methods and procedures to be applied:	Same as above
Frequency of monitoring/recording	Minimum 10 years prior to baseline renewal
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	Same as above
Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	None
Comments	Monitored for the purpose of baseline revisions also.

Data / Parameter	A_{deg}
Data unit	*Ha*
Description	Area potentially impacted by forest degradation processes
Source of data	GIS delineation and ground truthing

Description of measurement methods and procedures to be applied:	A_{deg} shall be composed of a buffer from all access points like roads, rivers and previously cleared areas. Extent of this buffer determined by PRA results.
Frequency of monitoring/recording	Repeated each time a PRA requests so.
Value applied	Same as above
Monitoring equipment	Same as above
QA/QC procedures to be applied	Same as above
Purpose of data	Calculation of program emissions
Calculation method	Same as above
Comments	Same as above

Data / Parameter	AP_i
Data unit	Ha
Description	Total area of degradation sample plots in stratum i
Source of data	Ground measurements
Description of measurement methods and procedures to be applied:	Plots systematically placed over the buffer zone such that they cover a reasonable area of the buffer zone.
Frequency of monitoring/recording	At least every 5 years. If verification occurs on a frequency of less than every 5 years, then before any verification event.
Value applied	None
Monitoring equipment	None
QA/QC procedures to be applied	Standard SOPs to be followed.
Purpose of data	• Calculation of program emissions • Calculation of leakage
Calculation method	None
Comments	None

Data / Parameter	C_{deg}
Data unit	t CO_2 eq
Description	Biomass of trees cut and removed through fuelwood and charcoal extraction from plots in the given strata at time t
Source of data	Field measurement
Description of measurement methods	The diameter of all tree stumps in the designated plots will be measured and conservatively assumed to be the same as the

and procedures to be applied:	DBH. If the stump is a large buttress, identify several individuals of the same species nearby and determine a ratio of the diameter at DBH to the diameter of buttress at the same height above ground as the measured stumps. This ratio will be applied to the measured stumps to estimate the likely DBH of the cut tree. The above and below ground carbon stock of each harvested tree must be estimated using the same allometric regression equation and root to shoot ratio used in the module for estimating the carbon pool in trees (CP-AB) in the baseline scenario.
Frequency of monitoring/recording	At least every 5 years. If verification occurs on a frequency of less than every 5 years, then before any verification event.
Value applied	None
Monitoring equipment	None
QA/QC procedures to be applied	SOPs if any to be followed.
Purpose of data	Calculation of program emissions
Calculation method	Please refer to relevant sections in this PDD.
Comments	Ex-ante, an estimation shall be made of likely degradation in the with-project case. Such an estimation shall be based on rates of degradation in surrounding areas and the degree of protection that will be in place (e.g. forest guards) in the with-project case.

Data / Parameter	F_{LU}, F_{MG} and F_L
Data unit	Dimensionless
Description	Land use Factor, Management Factor and Input Factor before and after conversion respectively
Source of data	Stock Change Factors are provided in Tables 5.5, 5.10, and 6.2 of the IPCC 2006GL Volume 4
Description of measurement methods and procedures to be applied:	Stock Change Factors as defined in IPCC 2006GL are equal to the carbon stock in the altered condition as a proportion of the reference carbon stock.
Frequency of monitoring/recording	Every monitoring cycle (5/10 years)
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	Calculation of program emissions
Calculation method	--

Comments	--

Data / Parameter	A_{DF_PA}
Data unit	Ha
Description	Area of unplanned deforestation in the given year
Source of data	--
Description of measurement methods and procedures to be applied:	--
Frequency of monitoring/recording	Every monitoring cycle (5/10 years)
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of program emissions • Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	A_{DG_PA}
Data unit	Ha
Description	Area of unplanned forest degradation in the given year
Source of data	--
Description of measurement methods and procedures to be applied:	--
Frequency of monitoring/recording	Every monitoring cycle (5/10 years)
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of program emissions • Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	C_{PA_t}
Data unit	t CO_2 eq.
Description	Carbon stock in all pools in given stratum
Source of data	Field measurement
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Every monitoring cycle (5/10 years)
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of program emissions • Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	$Df_{\%}$
Data unit	%
Description	% of land deforested in the given stratum at the present monitoring period
Source of data	--
Description of measurement methods and procedures to be applied:	--
Frequency of monitoring/recording	Every monitoring cycle (5/10 years)
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	Calculation of program emissions
Calculation method	
Comments	

Data / Parameter	$E_{biomass\_burn}$ (M-MON)
Data unit	t CO_2 eq.
Description	Non-CO_2 emissions due to biomass burning in given stratum
Source of data	--
Description of measurement methods and procedures to be applied:	--
Frequency of monitoring/recording	Every monitoring cycle (5/10 years)
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	Calculation of program emissions
Calculation method	
Comments	

Data / Parameter	A_{sp} (CP-AB)
Data unit	Ha
Description	Area of sample plots
Source of data	Recording of number and size of sample plots
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Every 10 years for baseline renewal. If C stock enhancement is included, it may be done once every 5 years
Value applied	0.1 ha
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	• Calculation of program emissions • Calculation of leakage
Calculation method	
Comments	Ex-ante, number and size of sample plots may be estimated based on projected effort relative to scale of emissions and growth.

Data / Parameter	N
Data unit	Dimensionless
Description	Number of sample points
Source of data	Recording of sample points during field activities
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Every 10 years for baseline renewal. If C stock enhancement is included, it may be done once every 5 years
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of program emissions • Calculation of leakage
Calculation method	
Comments	Ex-ante, number and size of sample plots may be estimated based on projected effort relative to scale of emissions and growth.

Data / Parameter	DBH
Data unit	cm
Description	Diameter at breast height of an individual in centimetres.
Source of data	Field measurements in sample plots
Description of measurement methods and procedures to be applied:	Typically measured 1.3m aboveground. Measure all trees above a minimum DBH of 10cm in the sample plots. Minimum DBH employed in inventories is held constant for the duration of the project.
Frequency of monitoring/recording	Every 10 years for baseline renewal. If C stock enhancement is included, it may be done once every 5 years
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	Use or adaptation of QA/QCs already applied in national forest monitoring, or available from published handbooks, or form the IPCC GPG LULUCF 2003, is recommended.
Purpose of data	Calculation of program emissions
Calculation method	

Comments	Ex-ante, number and size of sample plots may be estimated based on projected effort relative to scale of emissions and growth.

Data / Parameter	H
Data unit	m
Description	Height of individual in metres
Source of data	Field measurements in sample plots
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Every 10 years for baseline renewal. If C stock enhancement is included, it may be done once every 5 years
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	Calculation of program emissions
Calculation method	
Comments	Ex-ante, height shall be estimated based on projections of growth.

Data / Parameter	Pop
Data unit	
Description	Number of individuals per census
Source of data	National and state records/representative surveys
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Updated every 10 years
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	Census data to ensure adequate representation of both urban and rural households.
Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage

Calculation method	--
Comments	--

Data / Parameter	Df
Data unit	Ha
Description	Forest area cleared in Sikkim in last 10 years
Source of data	Official national and state records/representative surveys
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Updated once every 10 years
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	Any spatial feature subject to change over time – Risk Maps, Deforestation Maps
Data unit	
Description	Risk Map depicts the potential for deforestation for each pixel location on a numerical scale. Deforestation Maps shows the location of deforested hectares.
Source of data	--
Description of measurement methods and procedures to be applied:	--
Frequency of monitoring/recording	Updated each time the baseline is reevaluated (atleast once every 10 years).
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	

Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	
Comments	

Data / Parameter	AA_U
Data unit	%
Description	Accuracy assessment of the rate of unplanned deforestation
Source of data	Existing maps/models, expert consultation and literature
Description of measurement methods and procedures to be applied:	Multi-criteria analysis performed in a Geographical Information System
Frequency of monitoring/recording	Updated every time a baseline is reevaluated (atleast once every 10 years)
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	
Comments	

Data / Parameter	PAF
Data unit	Ha
Description	Area of forest available for fuelwood and charcoal extraction located within jurisdiction
Source of data	Determination of maximum distance of travel from communities for fuelwood collection/charcoal production and assessment of available forest within project boundaries
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Updated every time a baseline is reevaluated (atleast once every 10 years)
Value applied	--

Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	V_{FW}
Data unit	m^3/year
Description	Mean annual per capita consumption of fuelwood and charcoal within state boundaries
Source of data	Interviews, PRAs, field measurements and literature study. Verifiable information from anecdotal evidences may be used in some cases.
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Updated every time a baseline is reevaluated (atleast once every 10 years)
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	U_{Cpool}
Data unit	%
Description	Percentage uncertainty (expressed as 95% confidence interval as a percentage of the mean where appropriate) for carbon stocks and greenhouse gas sources in the (1) baseline case and (2) project case
Source of data	Calculations from field measurements

Description of measurement methods and procedures to be applied:	Uncertainty in pools derived from field measurement with 95% confidence interval calculated as the standard error of the averaged plot measurements in each stratum multiplied by the t-value for the 95% confidence level.
Frequency of monitoring/recording	Updated every time a baseline is reevaluated (atleast once every 10 years)
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	FG_{PA}
Data unit	m^3/year
Description	Volume of fuelwood gathered within the given strata in project area in the given year
Source of data	Interviews, PRAs, field measurements and literature study. Monitoring should be conducted in communities within the project boundary as well as in communities outside the boundary but potentially collecting fuelwood or producing charcoal from within the project boundaries.
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years, examination must occur prior to any verification event
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	--

Comments	--

Data / Parameter	GHG_{DG}
Data unit	t CO_2 eq.
Description	Greenhouse gas emissions as a result of degradation activities within the project boundaries
Source of data	Field measurements, expert appraisals
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years, examination must occur prior to any verification event
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	GHG_{DF}
Data unit	t CO_2 eq.
Description	Greenhouse gas emissions as a result of deforestation activities within the project boundaries
Source of data	Field measurements, expert appraisals
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years, examination must occur prior to any verification event
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	

Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	FOR
Data unit	Ha
Description	Total area of forest cover available nationally and within the state of Sikkim, which is under active management as a protected forest, National Park, Wildlife Sanctuary, Biosphere Reserve etc.
Source of data	Official data, peer reviewed publications and other verifiable sources
Description of measurement methods and procedures to be applied:	A demonstration is required that areas will be protected against deforestation. Such a demonstration may include the existence of forest guards in sufficient numbers to prevent illegal colonization and an active management plan detailing harvest plans and return intervals, and/or evidence that the concession owner has previously evicted illegal colonists/squatters from the forest areas. Ex-ante, it can be assumed that FOR remains constant.
Frequency of monitoring/recording	Must be monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• Calculation of baseline emissions • Calculation of program emissions • Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	C_{JUR_GHG}
Data unit	t CO_2 eq.
Description	Net emissions in the jurisdiction in the given year
Source of data	Field measurements

Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	Calculation of program emissions
Calculation method	--
Comments	--

Data / Parameter	$C_{PA\_unplanned}$
Data unit	tCO_2 eq.
Description	Net GHG emissions due to activity shifting for projects preventing forest degradation and unplanned deforestation
Source of data	Calculations from field measurements
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	Calculation of leakage
Calculation method	--
Comments	--

Data / Parameter	C_{actual}
Data unit	t CO_2 eq.
Description	Net GHG emissions by sinks, in the given year
Source of data	Calculations from field measurements

Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	Calculation of project emissions
Calculation method	--
Comments	--

Data / Parameter	A_{LU}
Data unit	Ha
Description	Total area of a specific land use that has shifted from the last monitoring (forest to non-forest).
Source of data	RS/GIS based analysis and ground validation
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	Refer to attached spreadsheet
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	Calculation of project emissions
Calculation method	--
Comments	--

Data / Parameter	$A_{F\text{-}LU}$
Data unit	Ha
Description	Total area of forest land that has shifted from one strata to another from the last monitoring
Source of data	RS/GIS based analysis and ground validation

Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	Refer to attached spreadsheet
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	Calculation of project emissions
Calculation method	--
Comments	--

Data / Parameter	C_{AGB-i}
Data unit	t CO_2 eq./Ha
Description	Carbon stock per hectare in aboveground biomass in given stratum *i*
Source of data	Estimation through data collected from field studies and sample plots. Please refer to the attached worksheet.
Description of measurement methods and procedures to be applied:	Most accurate estimation is based on Tier-3 data collected. Appropriate methodology has been applied. Where applicable Tier-3 data has been used. Tier-2 or Tier-1 data has been applied in the order based on availability. Allometric equations are based on Forest Survey of India estimates, and applicable for Sikkim.
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	Refer to attached spreadsheet
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	• *Calculation of project emissions* • *Calculation of emissions credits*
Calculation method	--
Comments	--

Data / Parameter	C_{BGB-i}
Data unit	t CO_2 eq./Ha

Description	Carbon stock per hectare in belowground biomass in given stratum *i*
Source of data	Estimation through data collected from field studies and sample plots. Please refer to the attached worksheet.
Description of measurement methods and procedures to be applied:	Most accurate estimation is based on Tier-3 data collected. Appropriate methodology has been applied. Where applicable, Tier-3 data has been used. Tier-2 or Tier-1 data has been applied in the order based on availability. Allometric equations are based on Forest Survey of India estimates, and applicable for Sikkim.
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	*Refer to attached spreadsheet*
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	• *Calculation of project emissions* • *Calculation of emissions credits*
Calculation method	--
Comments	--

Data / Parameter	C_{DW-i}
Data unit	t CO_2 eq./Ha
Description	Carbon stock per hectare in deadwood in given stratum *i*
Source of data	Estimation through data collected from field studies and sample plots. Please refer to the attached worksheet.
Description of measurement methods and procedures to be applied:	Most accurate estimation is based on Tier-3 data collected. Appropriate methodology has been applied. Where applicable, Tier-3 data has been used. Tier-2 or Tier-1 data has been applied in the order based on availability. Allometric equations are based on Forest Survey of India estimates, and applicable for Sikkim.
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	Refer to attached spreadsheet
Monitoring equipment	
QA/QC procedures to be applied	
Purpose of data	• *Calculation of project emissions* • *Calculation of emissions credits*

Calculation method	--
Comments	--

Data / Parameter	C_{LI-i}
Data unit	t CO_2 eq./Ha
Description	Carbon stock per hectare in litter biomass in given stratum *i*
Source of data	Estimation through data collected from field studies and sample plots. Please refer to the attached worksheet.
Description of measurement methods and procedures to be applied:	Most accurate estimation is based on Tier-3 data collected. Appropriate methodology has been applied. Where applicable, Tier-3 data has been used. Tier-2 or Tier-1 data has been applied in the order based on availability. Allometric equations are based on Forest Survey of India estimates, and applicable for Sikkim.
Frequency of monitoring/recording	*Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event*
Value applied	*Refer to attached spreadsheet*
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	• *Calculation of project emissions* • *Calculation of emissions credits*
Calculation method	--
Comments	--

Data / Parameter	C_{SOC-i}
Data unit	t CO_2 eq./Ha
Description	Carbon stock per hectare in the soil organic matter in given stratum i
Source of data	Estimation through data collected from field studies and sample plots. Please refer to the attached worksheet.
Description of measurement methods and procedures to be applied:	Most accurate estimation is based on Tier-3 data collected. Appropriate methodology has been applied. Where applicable, Tier-3 data has been used. Tier-2 or Tier-1 data has been applied in the order based on availability. Allometric equations are based on Forest Survey of India estimates, and applicable for Sikkim.
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event

Value applied	Refer to attached spreadsheet
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	• Calculation of project emissions • Calculation of emissions credits
Calculation method	--
Comments	--

Data / Parameter	C_{-i}
Data unit	t CO_2 eq./Ha
Description	Carbon stock per hectare in total in given stratum *i*
Source of data	Estimation through data collected from field studies and sample plots. Please refer to the attached worksheet.
Description of measurement methods and procedures to be applied:	Most accurate estimation is based on Tier-3 data collected. Appropriate methodology has been applied. Where applicable, Tier-3 data has been used. Tier-2 or Tier-1 data has been applied in the order based on availability. Allometric equations are based on Forest Survey of India estimates, and applicable for Sikkim. Summation of all carbon pools considered in the study – AGB + BGB + DW + SOC + LI
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	*Refer to attached spreadsheet*
Monitoring equipment	--
QA/QC procedures to be applied	--
Purpose of data	• *Calculation of project emissions* • *Calculation of emissions credits*
Calculation method	--
Comments	--

Data / Parameter	A_{UDF}
Data unit	Ha
Description	Projected area for unplanned deforestation within jurisdiction
Source of data	Field investigations and remote sensing data
Description of measurement methods	

and procedures to be applied:	
Frequency of monitoring/recording	*Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event*
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	*Calculation of project emissions*
Calculation method	--
Comments	--

Data / Parameter	A_{UDg}
Data unit	Ha
Description	Projected area for unplanned forest degradation within jurisdiction
Source of data	Field investigations and remote sensing data
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	*Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event*
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	*Calculation of project emissions*
Calculation method	--
Comments	--

Data / Parameter	LB
Data unit	Ha
Description	Area of leakage belt for the jurisdiction
Source of data	Field investigation and remote sensing data
Description of measurement methods	

and procedures to be applied:	
Frequency of monitoring/recording	Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	• *Calculation of project emissions* • *Calculation of leakage*
Calculation method	--
Comments	--

Data / Parameter	FW_D
Data unit	Kilometers
Description	Distance travelled to collect fuelwood
Source of data	PRAs, FGDs, socio-economic surveys
Description of measurement methods and procedures to be applied:	
Frequency of monitoring/recording	*Monitored at least every 5 years or if verification occurs on a frequency of less than every 5 years examination must occur prior to any verification event*
Value applied	--
Monitoring equipment	--
QA/QC procedures to be applied	
Purpose of data	*Calculation of project emissions*
Calculation method	--
Comments	--

9. REDD+ Safeguards and Benefit Sharing Mechanism

Safeguard mechanism is an important aspect of REDD+ component. Safeguards are the technical measures and precautionary arrangements to address any unforeseen circumstances during the lifetime of the project activity. The safeguards which are discussed here will help to Executive Entity to avoid any risk arising out of project activity to communities or environment or both. This REDD+ project not only reduces GHG emissions but also deliver social and environmental benefits such as livelihood generation, biodiversity conservation etc. potential risks which may arise during the lifetime of the project activity could be land tenure and property rights, project area under cultural heritage area, corruption, conversion of forest lands into plantations and land use changes etc.

9.1 National Safeguard Policy

India being a party to the United Nations Framework Convention on Climate Change (UNFCCC), the Government of India has developed a reference document to facilitate REDD+ implementation in the country[106]. Government of India also formulated a National REDD+ Policy and Strategy where a National REDD+ Authority will be established in MoEFCC under a national steering committee on REDD+. The policy also aims at developing a mechanism for the fund flow to the communities and to put in placer safeguards against all the risks and for protecting rights and livelihoods of communities[107].

9.2 Compliance with Laws

The following are the laws or conventions where India has ratified and will be a part of safeguard mechanism of the project activity.

National Acts and Laws

The Wildlife (Protection) Act, 1972, Amendment 1991

The WPA (Wildlife Protection Act), 1972, is for protection of the listed species of flora and fauna and establishes a network of ecologically-important protected areas.

The proposed project is in compliance with the Act as it aims to protect the wildlife and biodiversity of the proposed project area.

The Forest (Conservation) Act, 1980 (Amended 1988)

The act is aimed for protection of forest and its resources. The act restricts the power of the state in conversion or use of forest land into non-forest purpose.

The proposed project is in compliance with the Act and will assist India in achieving its goals of forest conservation. There is no conversion or use of forest land for non-forest purposes.

Environment (Protection) Act, 1986 (EPA)

The act protects and improves the environment condition by setting standards and regulating emissions and discharges; management of hazardous waste and public health and welfare protection. The project complies with requirements of the Act and promotes sustainable use and management of natural resources of the proposed project area.

[106] http://envfor.nic.in/sites/default/files/press-releases/Reference%20Document%20For%20REDD+%20in%20India.pdf
[107] http://envfor.nic.in/sites/default/files/Draft%20National%20Policy%20&%20Strategy%20on%20REDD.pdf

International Agreements

Convention on International Trade in Endangered Species of wild fauna and flora (CITES), 1973

The aim of CITES is to control or prevent international commercial trade in endangered species or products derived from them.

The project complies with this convention and aims to promote faunal conservation in the proposed project area.

UN Framework Convention on Climate Change (UNFCCC), 1992

The primary goal of the UNFCCC is to stabilize GHG emissions at levels that would prevent dangerous anthropogenic interference with the global climate.

The main objective of the proposed project is to reduce GHG emission via implementing the REDD+.

Convention on Biological Diversity, 1992

The CBD aim is conservation of biodiversity sustainable use of biological resources and equitable sharing of benefits arising from their sustainable use.

The project complies with this convention by promoting sustainable management of forest, conservation of forest and its resources and improving the livelihood of the dependent communities.

Convention on Wetlands of International Importance (Ramsar – 1971)

Convention is to conserve wetlands and waterfowl habitat. The Convention encourages training of personnel in the field of wetland research, management along with research.

The proposed project complies with this convention, evidenced via conservation of the wetland sites within the project area.

Stockholm Declaration of the United Nations Conference in Human Environment (1972)

The Stockholm Declaration talks about the person's right to freedom, adequate condition of life; responsibilities towards environment and sustainable future of the planet.

The proposed project provides a framework whereby the project proponent, local communities and the other relevant stakeholders can protect the proposed project area's ecosystems & environment and sustainably manage the resources available therein, and lead to an improvement in the socio-economic conditions of the community.

Human Rights

India has signed the Universal Declaration of Human Rights (UDHR)[108]. There are no risks that the project will breach the safeguarding principles.

United Nations Declaration on the Rights of Indigenous Peoples

India has voted in the favour of the declaration on rights of indigenous people[109]. So there will be protection to the rights of indigenous people in the project area.

Convention for the Safeguarding of the Intangible Cultural Heritage

[108] http://mha.nic.in/uniquepage.asp?Id_Pk=235
[109] http://www.un.org/press/en/2007/ga10612.doc.htm

The Government of India is a party to UNESCO's "The States Parties to the Convention for the Safeguarding of the Intangible Cultural Heritage (2003)[110]" which aims at protection of cultural heritage and safeguards any violation of the safeguarding principle. Hence, this project does not involve and is not complicit in the alteration, damage or removal of any critical cultural heritage.

ILO Convention

India has signed the International Labour Standard Convention and is a member of ILO[111]. The Indian Government has not ratified the ILO Convention 87 and 98[112]. The project activity does not involve production, trade or other commercial activity requiring large labour force. The project activity does not deal with setting up a factory and recruiting employees and hence not complicit in restrictions of these freedoms and rights.

India has ratified ILO convention 29 and 105 on elimination of forced and compulsory labour[15]. The project is owned by Sikkim Forest Department (FEWMD), a government agency. This project activity involves communities through VFC/JFMCs who will assist in overall management of the project activity. Monitoring personnel will be adults and will be involved in monitoring voluntarily and does not involve and is not complicit in any form of forced or compulsory labour.

India has ratified ILO Convention 100 (equal remuneration) and Convention 111 (discrimination in employment / occupation). The project does not involve and is not complicit in any form of discrimination based on gender, race, religion, sexual orientation or any other basis.

Child Labour

India has not ratified ILO convention 138 (minimum age) and convention 182 (worst form of child labour)[113]. But India has its own Child Labour (Prohibition & Regulation) Act, which prohibits employment of children in certain specified hazardous occupations and processes and regulates the working conditions in others[114].

Currently, in the absence of a National REDD+ Strategy, states like Sikkim are free to develop their own suitable mechanisms towards REDD+ programs. These state-level initiatives would be integrated nationally in the light of future directives from the central government and the subsequent finalization of a National REDD+ Strategy.

The Sikkim FEWMD is the government department with jurisdiction over the forests of Sikkim. The activities of the Department are in consonance with the laws, policies and regulations evolved under the Government of Sikkim and the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India.

Currently, this program is not rewarded under any other GHG emissions reductions mechanism. Registration of the program (or any parts thereof) under any other mechanism in the future shall be communicated to the concerned authority.

Specifically, the environmental or ecosystem services under the program are:

[110] http://www.unesco.org/culture/ich/index.php?pg=00024
[111] http://www.ilo.org/dyn/normlex/en/f?p=1000:11110:3115744615707331::NO:11110:P11110_COUNTRY_ID:102691
[112] http://labour.nic.in/upload/uploadfiles/files/footergallery_pdf/List%20ofILO%20Conventions%20Ratified%20by%20India.pdf
[113] http://labour.nic.in/upload/uploadfiles/files/footergallery_pdf/List%20ofILO%20Conventions%20Ratified%20by%20India.pdf
[114] The Policy of the Government on the issue of Child Labour , Ministry of Labour and Employment, Govt. of India.

- Sequestration, maintenance and enhancement of forest carbon stock, and decreasing carbon flux.
- Conservation of biodiversity in the state.
- Climate regulation.
- Conservation of hydrological systems and other related ecosystem services.

The Sikkim Government would be supported by a series of guiding principles, including:

- Responsible use of natural resources
- Respect for the knowledge and rights of local communities
- Promoting cooperation and best practices across similar programs in the rest of the country
- Just and equitable sharing of benefits with stakeholders
- Transparency in the administration of financial resources.

Combining the legal objectives of the program with the guidelines that it would be governed by, it can be said that the project proponent, FEWMD, is responsible for the valuation and management of the environmental services generated within the State so that they are protected and preserved and become a source of sustainable funds towards furthering low emissions development in the state.

This REDD+ program is not a part of any other GHG program, and no credits shall be issued from non-forestry projects.

9.3 Safeguards Monitoring System

The development of safeguards in REDD+ activities during the program has been modelled on a criteria and indicators approach. Criteria are the standards that defines high performance of REDD+ to be met including conditions related to processes, impacts and policies in order to deliver the program objectives.

Environmental Safeguards

Name of the indicator	**Absence of exotic species in plantations**
Synergy with Cancun Safeguards	1/CP.16 Safeguard 5
Parameter	Species selected for plantation under REDD+ project
Unit of measurement	NA
Source of Data	Plantation records/collated data with the FEWMD regarding plantation activities under REDD+ interventions.
Methodology of data collection	Recording of species planted during plantation under REDD+ interventions
Measuring/Recording Frequency	During Annual Monitoring
Calculation/analysis method (where applicable)	None
Additional Comments	Plantations under REDD+ activities should contain no such species that are considered to be exotic or invasive to local environmental conditions.

Name of the indicator	**Biodiversity within the REDD+ project area**

Synergy with Cancun Safeguards	1/CP.16 Safeguard 5
Parameter	Calculation of the Biodiversity Index in selected sites across Sikkim based on standard indices.
Unit of measurement	Based on Index applied
Source of Data	Field data collected during Monitoring
Methodology of data collection	Same as field inventory techniques during periodic monitoring
Measuring/Recording Frequency	During Annual Monitoring
Calculation/analysis method (where applicable)	Based on the relevant Index applied
Additional Comments	The Biodiversity Index of the project area should not fall after the implementation. There should be no perverse incentive for REDD+ activities that focus only on increase in carbon stock.

Name of the Indicator	**Afforestation activities taken up as REDD+ interventions**
Synergy with Cancun Safeguards	1/CP.16 Cancun safeguard 6
Parameter	Record of the plantation activities carried out in FEWMD land and private lands – area covered, species planted etc.
Unit of measurement	Based on relevant criteria measured
Source of data	- Annual Monitoring Report - Audit report and ledgers maintained at JFMCs/EDCs levels
Methodology of data collection	- Key Informant Interviews of FEWMD personnel - Annual Monitoring Report.
Measuring/recording frequency	During Annual Monitoring
Calculation/analysis method where applicable	Area under new plantations every year
Additional comments	None

Social Safeguards

Name of the Indicator	**Community participation in REDD+ activities**
Synergy with Cancun Safeguards	1/CP.16 Cancun safeguard 4
Parameter	Evaluation of local community involvement per district in REDD+ activities towards ensuring transparency and access to information, and effectiveness and efficiency of systems for feedback, oversight and accountability.
Unit of measurement	% of local community involvement No. of committees involved in REDD+ activities
Source of data	- Annual Monitoring Report

	- Audit report and ledgers maintained at JFMCs/EDCs levels
Methodology of collection of data	- Key Informant Interviews of some local community members - Annual Monitoring Report.
Measuring/recording frequency	Shall be reported for compliance at the formulation stage and reported at every periodic monitoring of the REDD+ project.
Calculation/analysis method where applicable	Number of committee formed to the total villages in the project area
Additional comments	It is not expected that 100% of JFMCs will be involved in REDD+ implementation; FEWMD can decide on the benchmark figure. Uploading information on online portals or databases should be encouraged to make information easily available and up to date. Availability of information in local languages can help increase accessibility.

Name of the Indicator	**Fund utilization and disbursement mechanism**
Synergy with Cancun Safeguards	1/CP.16 Cancun safeguard 4
Parameter	Implementation of a benefit sharing mechanism towards specifying how funds are being distributed and utilized at all levels
Unit of measurement	INR
Source of data	- REDD+ Project Design Document - Annual Monitoring Report - Audit reports and ledgers maintained at JFMCs/EDCs levels
Methodology of collection of data	Data should be collected through study of existing annual report, audit reports and ledger books to ensure that a benefit sharing mechanism is in place; and that system is being followed.
Measuring/recording frequency	During Annual Monitoring
Calculation/analysis method where applicable	Percentage of people from indigenous and under-served communities who participate in meetings and activities as a percentage of total number of members from these communities.
Additional comments	NA

Procedural safeguards

Name of the Indicator	**REDD+ actions and interventions being in-line with the existing policies, laws and regulations (PLRs)**
Synergy with Cancun Safeguards	1/CP.16 Cancun safeguard 1

Parameter	No of REDD+ actions found to be convergent with existing policies, Laws and Regulations. All REDD+ actions planned in the REDD+ design are to be listed. Among these actions those which diverge significantly from the national/sub-national/regional PLRs are to be listed. In case of any such divergence, remedial steps are to be taken in amending either the action or the associated PLR.
Unit of measurement	Number
Source of data	- REDD+ Project Design Document - Annual Monitoring Report
Methodology of collection of data	Through survey for PLRs and monitoring reports of the REDD+ project
Measuring/recording frequency	Shall be reported for compliance at the formulation stage and reported at every periodic monitoring of the REDD+ project.
Calculation/analysis method where applicable	NA
Additional comments	None

Name of the Indicator	**Transparent forest governance structure for REDD+**
Synergy with Cancun Safeguards	1/CP.16 Cancun safeguard 2
Parameter	Information on the REDD+ program to be available on FEWMD website. REDD+ activities can be updated on the FEWMD website on a regular basis. This will ensure transparency. A bottom-top feedback loop also should be a part of this system to ensure transparency.
Unit of measurement	NA
Source of data	Government reports/website
Methodology of collection of data	Key Informant Interviews of FEWMD personnel
Measuring/recording frequency	Shall be reported for compliance at the formulation stage and reported at every periodic monitoring of the REDD+ project.
Calculation/analysis method where applicable	None
Additional comments	Uploading information on online portals or databases should be encouraged to make information easily available and up to date. Availability of information in local languages can help increase accessibility.

Name of the Indicator	**Established grievance mechanism to address concerns and conflicts**
Synergy with Cancun Safeguards	1/CP.16 Cancun safeguard 2
Parameter	Existence of a grievance redressal mechanism for the REDD+ program. Such a mechanism may be notified at the inception of the REDD+ project and

	an official from the FEWMD to be identified to act as the nodal officer.
Unit of measurement	None
Source of data	- Annual Monitoring Report - Record of grievances and action taken
Methodology of collection of data	None
Measuring/recording frequency	During Annual Monitoring
Calculation/analysis method where applicable	None
Additional comments	None

Name of the Indicator	**Options for alternative livelihoods**
Synergy with Cancun Safeguards	1/CP.16 Cancun safeguard 4 and 5
Parameter	Institutionalisation of handholding people who may have to opt out of existing sources of livelihood due to implementation of REDD+. Shall include alternative income sources, capacity building and knowledge transfer.
Unit of measurement	None
Source of data	Annual report
Methodology of collection of data	None
Measuring/recording frequency	At every monitoring
Calculation/analysis method where applicable	None
Additional comments	None

9.4 Benefit Sharing Mechanism

The Sikkim Jurisdictional REDD+ project not only generates carbon credits based on the reduction of GHG emissions but also social and environmental benefits. It is very important to share benefits among all the stakeholders of the project. It is necessary to incentivize communities to change deforestation and forest degradation actions on the ground. A well-designed benefit-sharing mechanism will be devised with support of all the stakeholders to increase the efficiency of this REDD+ project. In order to maintain the transparency and involvement of stakeholders in the benefit sharing allocation, the decisions regarding investments of assets will require the approval of the Sikkim REDD+ Steering Committee and REDD+ Cell.

International REDD+ benefit sharing mechanism must be:

- Equitable, so that benefits are shared among stakeholders
- Cost-efficient in delivering benefits
- Effective in providing incentives and rewards that change the behaviour of resource users over the long term in order to reduce emissions.

Each phase of REDD+ can and should be designed and implemented to maximize benefits to indigenous people, local communities, small holders, and other partners while maintaining the effectiveness and efficiency of the program.

India has well-developed institutional mechanisms and several policies, laws and regulations to support the system. Therefore, it would be better to adopt and improve the existing benefit sharing mechanism rather than developing totally new system. The benefit of adopting existing institution and legal frameworks is that it can reduce the costs of founding and operating new institutions and could receive more political support at the national as well as at local level.

However, the ideal benefits sharing mechanism will be finalised after having a detailed discussion through stakeholder consultations, workshops, focus group discussions, bilateral meetings and individual consultations at local level. It will allow insights to be obtained from stakeholders, including their concerns, experience and knowledge relevant to the REDD+ benefits sharing mechanism, and to integrate their needs, claims, roles and responsibilities into the formulation of such mechanisms to ensure effectiveness, equity, efficiency and transparency.

The following is one such mechanism which could be considered for this project.

Fund flow through FEWMD and proposed Benefit Sharing

As discussed in above sections, REDD+ has the potential to generate a variety of benefits. Direct financial incentives (e.g., carbon credits payments) are the primary mechanism for achieving emissions reductions, and REDD+ proponents hope that these payments will flow to local forest communities and others directly contributing to REDD+. There are also a number of (monetary and non-monetary) 'co-benefits' that can also arise from REDD+.

Decision-making process for REDD+ benefit sharing should include effective engagement of state level government agencies (i.e. FEWMD) and local/village level community institutions (i.e. JFMCs/VDCs) to help maintain the legality of REDD+ and to lead to solutions suited to different local contexts. Benefits then distributed horizontally by states agency to local level constituencies could be either monetary or non-monetary, allocated based on efforts made to address the drivers of deforestation and forest degradation, reduce barriers to sustainable natural resource management, and support sustainable rural development.

> "A local investment plan should be an instrument that allows communities to agree with government agencies and civil society as a whole on their sustainable development proposals to strengthen local management, add incentives and economic support," (Rafael Obregon, CONABIO).

A standard fund flow process and sharing of benefit among the stakeholders in Forest-PLUS landscapes is drawn based on the learning from REDD+ projects of Indonesia, Mexico, Tanzania, and other African countries. The vertical fund flow involve fund received by the FEWMD from the international funding agencies/national level agencies and its movement down to the Sikkim REDD+ Cell and to district level forest agencies (FDA). The horizontal fund flow includes fund flows from FDA to Gram Panchayat, village communities (JFMCs/EDCs) and finally to beneficiaries.

Local stakeholders should have the opportunity to develop their own investment plans that specify how they intend to reduce deforestation and forest degradation. Multi-stakeholder committees should be formed at the state level to select investment plans based on state-level REDD+ strategies, guided by the central/state government. Safeguards will guide the development and implementation of investment plans, government policies and benefit sharing.

Sharing of funds should be finalized after consultation with all the stakeholders and following existing policy/norms. However, a generalised fund sharing mechanism is projected for

various forest areas of India based on the benefit sharing mechanism proposed for various REDD+ project across the globe[115,116,117]. The existing resource sharing mechanisms in community managed forest lands of India was also taken into consideration[118].

Integrating Safeguards in Benefit Sharing Mechanisms

Safeguard policies often provide a platform for the participation of stakeholders in assessing impacts, as well as mitigating negative impacts. An appropriately designed safeguard system could identify potential positive impacts of REDD+ activities, and actions that could support positive move. An important element of any REDD+ safeguard system is broad participation and open access to information.

REDD+ benefit sharing should be designed, implemented and monitored in accordance with the developing national safeguards system. Drawing on international safeguards, relevant considerations may include:

- Full and effective participation;
- Free, prior and informed consent;
- Effective representation;
- Transparency;
- Accountability;
- Gender equality;
- Respect for human rights;
- Secure land, forest and carbon tenure;
- Dispute resolution; and monitoring

In India, a broad institutional framework for implementing REDD+ safeguards is already in place. This includes the central ministry, the MoEFCC, and the state government department, the Sikkim FEWMD (also the project proponent). The State Forest Development Agency (FDA), which is a federation of all Forest Development Agencies of the state, will further assist the FEWMD in carrying out their roles and responsibilities.

Grievance Mechanism

Feedback and grievance redress procedure will be through the VFC/EDC meetings that would be held on periodic basis at the village level. The minutes of the meeting are maintained which will include the issues heard and the response to the issue and eventually addressing the issue. The annual general meeting of the village will also be a platform to address the grievances of the village communities. These meeting books with minutes of the meeting will be accessible to the village communities.

A handbook[119] on Joint Forest Management has been developed by MoEFCC where in chapter number 12 it is clearly mentioned on conflict resolution or grievances are addressed arising in VFCs and EDCs. The same model will be adopted in this project since the project participate intends to use VFC and EDC in all the project activities.

[115] Institutional and Cost-Benefit-Sharing Arrangement for Implementation of Emission Reductions Program in 12 TAL Districts of Nepal. REDD Implementation Centre, Ministry of Forests and Soil Conservation, Nepal.
[116] Developed comparing REDD+ case study of Tanzania, Africa, Indonesia, Nepal.
[117] USAID (2012). Institutional assessment tool for benefit sharing under REDD+.
[118] Vemuri A (2008). Joint Forest Management in India: An Unavoidable and Conflicting Common Property Regime in Natural Resource Management. Journal of Development and Social Transformation.
[119] http://rtmoef.nic.in/Docs/JFM_Booklet.pdf (page number 44 and 45)

10. Other Project Details

10.1 Start Date and Crediting Period

The start date for project crediting is to be determined based on the actual emissions saving activities on ground. Expected date is 15/08/2017. The Program-crediting period is 20 years 00 months. It will be renewed every 10 years.

10.2 Details of Project Design

Sikkim, a hilly state nestled in the eastern Himalayas is dominated by forestlands, where a majority of the people depend on resources from forests for one thing or another. Hence sustainably managing forests, reducing emissions, and ensuring continuity of the flow of services from forests is critical for the State. The REDD+ design includes many components that addresses sustainable management and enhancement of forest resources. Under the USAID funded Forest-PLUS Program, many activities have been initiated in the landscape to conserve forests. Major drivers of forest change in the jurisdiction were identified through intensive socio-economic surveys and consultations with personnel from FEWMD. Socio-economic analysis included the use of household surveys and focussed group discussions in villages in all 4 Forest Divisions, to evaluate the forest dependency of local communities.

10.3 Activities and Consultations in the Program

The landscape for the Project in Sikkim was finalized in 14 June 2013, as part of the USAID funded Forest-PLUS program. It was approved by the Ministry of Environment, Forest and Climate Change (MoEFCC), after a joint decision taken by the MoEFCC, FSI, ICFRE, IGNFA and USAID based on the selection criteria.

It was further decided that a jurisdictional REDD+ project will be promoted as the 1st jurisdictional REDD+ project in India (at a sub-national level), covering the whole state of Sikkim as the jurisdiction. The evidence and capabilities in favour of this decision was:

- India's Draft National REDD+ Policy endorses the development of jurisdictional REDD+ at sub-national scales.
- International REDD+ negotiations are increasingly focussing towards the development of jurisdictional REDD+ Programs.
- It will be the first jurisdictional-level REDD+ Program in India, and one of the first in the world.
- It would help develop national jurisdictional REDD+ methodologies.
- It would be able to capture Sikkim's accomplishments in forest regrowth and associated carbon credits.

A summary of the activities and consultations in the landscape have been described below.

In 2013-2014

After finalization of the landscape, further meetings and consultations were held to discuss planned activities. The Sikkim landscape represents significant forest types, unique biophysical conditions and a distinct socio-economic contexts. The first consultation was held in Gangtok, Sikkim (19-22 March 2014) on planned activities with the FEWMD, attended by senior FEWMD personnel, including the PCCF cum PS and CCF (T & WL).

Further meetings organized with the FEWMD during the year focussed on:

- Preparing list of important NTFPs in the landscape and its status, uses and threats in the landscape.
- Exploring scope of NTFP development in the community and private lands and details of market and trade links.
- Field study on *Cordyceps sinensis* (caterpillar fungus, or *kidajhar*) involving local communities to understand carrying capacity, life cycle, existing harvest techniques to address the issue.
- Understanding the scope of highlighting apiculture and mushroom farming as a sustainable livelihood option.
- Conducting studies to assess the impact of forest conservation efforts.
- Conducting training for frontline staff and community members on NTFPs.

Grazing practices in Sikkim were analysed and some recommendations were developed improve grazing management in ways that will decrease emissions from forests. The methodology included collecting primary and secondary data from different sources, FGDs and interviews with JFMC members, women groups, field level forest staff and meetings with Divisional Forest Officer (DFOs) and Conservators of Forests (CFs) to discuss about livestock management issues. Recommendations of the study have been presented to the FEWMD. There have been many community-based communication programs to disseminate tools, techniques and methods to the community.

Consultations in 2014

- State Consultation with FEWMD: March 20, 2014
    - Program details and Action Plan discussed, shared and finalized with FEWMD
- State Consultation with FEWMD: September 25, 2014
    - Decision taken that FEWMD will sponsor a Sikkim Jurisdictional REDD+ project and seek, as appropriate, a formal MoEFCC endorsement.
    - FEWMD and Forest-PLUS will work together to plan and carry out several communication campaigns on human-wildlife conflict and forest fire in Sikkim in 2015.
    - FEWMD and Forest-PLUS will work together to plan and carry out training program in Sikkim in FY 2015
    - Forest-PLUS will provide FEWMD with technical assistance to include chapters on Carbon Management for Working Plans currently under revision.
- Local consultation: Meeting with members from Namthang and Rabongla JFMCs to discuss forest management issues

Trainings conducted in 2014

- For Forest Officials in Gangtok, May 12-13, 2014
    - Participants: 66 - Female: 16, Male: 50
- For Forest Officials in Gangtok, July 1-2, 2014
    - Participants: 14 - Female: 6, Male: 8

- For CBOs in Gangtok, July 3-4, 2014
    - Participants: 36 - Female: 12, Male: 24

In 2014-15

The following activities have been undertaken in 2015:

- Study of improved dryers for *Cardamom.*
- Field assessment and GIS mapping of NTFP pressure in Sikkim.
- Field assessment and GIS mapping of grazing pressure in Sikkim.
- Development of Remote Sensing models for carbon estimates: Data Normalization, Vegetation Index, Fractional Cover, Tier 2 Carbon Mapping, Deforestation and Degradation.
- Development of Remote Sensing protocols for Carbon estimates: Optical data normalization, deforestation and degradation monitoring protocol, enhancement baseline and ex ante protocol, enhancement monitoring protocol.
- Development of Forest Carbon inventory sampling methods: pre-sampling protocols, determining emission factors, Monitoring carbon stock changes.
- Development of Community-level forest inventory protocol 1: Plot design protocol, Forest carbon plot inventory and measurement protocol, Integrating REDD+ and local institutions, Community-based MRV system.

Table 49: Other Programs in the landscape

Forest inventory 03: Optical RS models and protocols to measure, map, and monitor forest carbon	In FY 2015 Michigan State University (MSU) has trained staff in the GIS cell under the Forest-PLUS program.
Forest inventory 04: DMS to receive, organize, analyse, and report forest carbon stocks	In FY 2015 Michigan State University trained staff in the GIS cell under the Forest-PLUS program.
EAFM curriculum 01: EAFM for SDF frontline officers	In FY 2016 Forest-PLUS developed an Ecosystem Approach to Forest Management (EAFM) curriculum. This material is used in subsequent ToT trainings and EAFM trainings for ACF/DFO level SFD staff
Pilot program 02: Mitigating Human-Wildlife Conflict in Sikkim	This pilot program is working on conflict resolution mechanisms, remedial technologies, good management practices and innovative solutions with regard to Human-Wildlife Conflict with various stakeholders in Sikkim and promote dialogue amongst them. The existing wildlife damage compensation mechanism has resulted in widespread dissatisfaction among the villagers; this pilot would therefore work towards providing key policy inputs for framing an inclusive policy on Human-Wildlife Conflict mitigation and management
Outreach/communication program 11: Monks for Climate	This campaign engaged the Rumtek Monastery in Gangtok, Sikkim. Forest-PLUS introduced participant monks the concepts of climate change and its impacts, the role of forests, and gave an overview of technical activities, particularly in Sikkim. The

	campaign follow-up is for a core group of monks to collaborate with Forest-PLUS in implementing activities in Sikkim, including establishing a native species nursery on the grounds of the Rumtek monastery for forest restoration. Along with this, an activity on a series of wall paintings conveying messages relevant to the landscape would also be undertaken with the support of the monks. More than 200 monks and 100 school children from the Karmae Dharma Chakra Center School along with members from the community have participated in the 'Monks for Climate' campaign.
Outreach/communication program 18: Sikkim Training on Climate Change	The Forest-PLUS program completed a program on Global Climate Change, GHG inventories, Vulnerability, Mitigation and Adaptation in 12 villages in Sikkim that reached 666 women, 533 men = 1199 total participants.
Outreach/communication program 22: Hello Forest - IVR System	In order to reach out to the general population of Sikkim and convey to them the diversity of its forests, Forest-PLUS proposes a pilot campaign in Sikkim in the form of an Interactive Voice Response Solution (Smart IVR).
Outreach/communication program 23: Street Theatre on Forest Ecosystem Services-Drishyam Progress	Forest-PLUS intend to carry out a state level communication campaign "People for Forests" in Sikkim landscape. The campaign would enhance the Forest-PLUS objectives to impart to the general population in the Sikkim landscape awareness of the connection between forests and climate change and the critical role well-managed forests can play in combating global warming.
PPP 017: PPP with Sikkim Forest Department	Training of their personnel on Forest Carbon and Tools, Techniques and Methods to prepare forest carbon inventory, Sikkim Forest Department
Carbon monitoring training 04: Forest-PLUS Data Management System	20-22 June 2015 8 men, 5 women = 13 total
Carbon monitoring training 05: TTMs for Forest Carbon Stock Estimation/FPP (Sikkim)	20-21 April 2015 11 men, 9 women = 20 total
Carbon monitoring training 07: Training of forest officials on basics of climate change, ecosystem system approach and carbon monitoring	17-19 Jan 2015 12 men, 8 women = 20 total
Sikkim regional hands-on program:	Masters Training on Bio-briquette making, Chandaney, East Sikkim August 16 – 18, 2015 Training on Apiculture, Chandaney, East Sikkim August 19 – 21, 2015 Village level training on Bio Briquette making, Chujachen, East Sikkim 10 Sep 2015

	Village level training on Bio Briquette making, Changeylakha, East Sikkim 11 Sep 2015 Village level training on Bio Briquette making, Lingtam, East Sikkim 16 Sep 2015
GCC training 11: Senior Officials	11-12 May 2014, 28 men, 16 women = 44 total
GCC training 12: Frontline officials of SFD	1-2 July 2014, 9 men, 3 women = 12 total
GCC training 13: CBOs/JFMC/VFC	3-4 July 2014, 28 men, 7 women = 35 total
Institutional Assessment of JFMCs Lingdok JFMC	Lingdok, Rathe Chu, Central Pendam, Dochung-Sirwani, Raley-Khasey, Sorok-Syampani, Mellidara-Payong, Sadam-Suntaley, Damthang-Joubari, Chuba-Perbing, Mamley-Kamrang, Asangthang, Nagi-Maneydara, Donok-Mamring, Rayong-Tinkitam, Barfung-Jarung, Lamateng-Tingmoo and Wok Omchu

In 2015-2016

Silviculture TTM:

Direct Sowing of Acorns – Discussion with an Indian NGO to adapt their technique of direct sowing of acorns to HP and Sikkim based on their successful experience in Uttarkhand. FEWMD team along with Forest-PLUS Regional Team in Sikkim visited Uttarakhand in February, 2016.

Outreach/communication Program:

Monks for Climate – Forest-PLUS Regional Team in Sikkim organized a follow-up to the first session of 'Monks for Climate' conducted with monks of Dharma Chakra Centre of Rumtek Monastery, on 26 November, 2015. The program was attended by 60 monks with sessions on the issue of global climate change and its impact specifically on the flora and fauna of the state of Sikkim. Post these sessions, participating monks also took part in a cleanliness drive in and around the premises of Rumtek Monastery followed by a plantation drive for which important local species of the region were selected.

Figure 32: Monks participating in the Monks for Climate Program

A pilot campaign "Hello Forest" in the form of an Interactive Voice Response Solution (Smart IVR) cutting across various stakeholder groups such as, youth, women, community members, reaching out to both rural and urban populations to disseminate information on the broad subject of 'Forests in Sikkim and its Sustainable Ecosystem Management', which would not be possible on a physical or one-on-one basis.

REDD+ Cell Meeting and Steering Committee: A State Level Steering Committee for the development of the Jurisdictional REDD+ project in Sikkim by providing technical inputs. The Steering Committee is headed by the Chief Secretary and members include secretaries of various government departments. The mandate of this committee is to facilitate capacity building within various sectors of the government to implement REDD+, effective coordination between sectors and monitor progress and advice the government on issues relating to REDD+. A roadmap is being prepared for Jurisdictional REDD+ project development in Sikkim for better understanding of various departments who can be involved for conservation and better management of forest in Sikkim. An Inter-Departmental Convergence Workshop has been planned for January 22, 2016 in Gangtok, Sikkim. The workshop will involve the participation of Secretaries from various government departments. The purpose of the workshop is to look for potential resources that could be leveraged for the development of the project.

The Inter-Departmental Convergence Workshop in Gangtok, Sikkim was held on January 22, 2016 to discuss opportunities for coordination between government line departments in Sikkim towards developing India's first Jurisdictional REDD+ project in the state. The aim of the roundtable was to leverage resources for Sikkim Jurisdictional REDD+ projects by involving and creating awareness amongst Government Line Departments regarding the project. The attendees included Secretaries from various Government line departments and has led to a doorway for the implementation of the Jurisdictional REDD+ project in Sikkim through convergence with various State and Central Government schemes.

The abovementioned Government Departments have extended their cooperation and have accordingly appointed nodal officers from each department for convergence and coordination purposes. The future course of action involves mapping of schemes and mission along with nodal officers to identify potential convergence opportunities for the Sikkim Jurisdictional REDD+ project.

As a follow up, a meeting of the Nodal Officers for REDD+ Convergence in Sikkim was held on March 2, 2016 at Gangtok. The purpose of the meeting was to apprise the nodal officers identified from various departments about the Jurisdictional REDD+ project and opportunities of convergence of the departmental schemes towards implementation of the REDD+ interventions. The meeting was chaired by Dr. Thomas Chandy, PCCF and Principal Secretary, Department of Forest, Environment and Wildlife, Government of Sikkim.

Figure 33: Members attending the Convergence Workshop

A one-day follow-up training had been organised on apiculture at Chandaney village of Dalapchand GPU, East Sikkim on November 22 for 90 farmers from 5 different Gram Panchayat Units of East Sikkim. Modern bee keeping equipment like boxes, extractor machine, bee vail, smoker, gloves, queen cage etc was also distributed to the farmers. On November 23 a follow up training on converting bio waste into alternate energy (briquette) was conducted in Chandaney village, for various SHGs, EDCs, JFMCs, FD staffs and Gram Panchayat members of 5 GPUs of Rongli and Rhenock area. A total of 80 participants with a large number of women participated in the program.

Figure 34: Bio-briquette making in progress

Bio-Briquette can be promoted as an alternative to fuelwood where the weeds and bio waste will be converted into alternate energy (briquette). The Regional Team of Forest-PLUS conducted a training program on bio-briquette making for SHGs, EDCs, JFMCs, FD staffs and Gram Panchayat members from five GPUs of Rongli and Rhenock block, East Sikkim. Master trainers from the TOT conducted by Forest-PLUS earlier were the resource persons for the program.

To raise levels of understanding about climate change and forests, forest management, REDD+, and carbon markets, two of the biggest festivals organized in Sikkim-the Lachen Losar Festival in Lachen (North Sikkim) and the Maghey Mela Sankranti in Jorethang (South Sikkim) had been targeted.

A ToT on Community-based Forest Carbon Measurement in Gangtok, Sikkim from January 19-21, 2016 had been organised. Total 13 participants including two females completed the three days course. During the training, the participants were trained on carbon measurement techniques, *mForest* app, forest survey equipment, slope correction, community involvement and carbon plot design.

Forest-PLUS organized a two day Training Program on Forest Carbon Inventory from March 10-11, 2016 in Gangtok for 128 participants comprising field staff of Sikkim Forest Department and local communities. The first day of the training consisted of classroom exercises that included sessions on Global Climate Change, REDD+, Carbon Plot Design, Forest Survey Equipment etc. The second day of the training consisted of field demonstrations of carbon plots.

Hands on training programs for the local communities had been carried out in their respective landscapes as part of the landscape demonstration programs.

Table 50: Briquette-making training programs organized in Sikkim

	Date	Place	Participants (M)	Participants (F)	Total
1	23 Jan, 2016	Chandaney, East Sikkim	36	13	49
2	3 Feb, 2016	Dalapchand, East Sikkim	46	11	57
3	16 March, 2016	Dalapchand, East Sikkim	27	19	46
Total			109	43	152

Ecological Data Collection

- In continuation to the Carbon Forest Inventory Training, Carbon Field Inventory exercise was held across Sikkim for collection of ecological data. During the exercise biomass plots were laid using random stratified sampling techniques.
- Strata were created on the basis of Champions and Seth's broad forest type categories and canopy density maps. In total, 5 forest types (Mixed Moist Deciduous Forests (MMD), South Wet Hill Temperate forests (SWH), Wet Temperate Forests (WTF), Coniferous Forests (CF) and Sub Alpine Forests (SAF)) and 4 canopy density classes (10-30, 30-50, 50-70 and Above 70) were considered for creating 20 strata.
- 62 biomass plots were laid across strata to collect carbon forest inventory data. During the field exercise, forest officials trained during the carbon forest inventory training were involved in plot laying exercise to detail their understanding in the field. The field team laid plot from elevation varying from 800 - 4000 meters ASL. Equipment used during field survey were namely geo-positioning system, geo-tag cameras, 50 meter tape, 5 meter tape, Ravi altimeter, Clinometer, Hypsometer, Compass, marking chalks, trowel for soil sample collection.

Figure 35: Images from the ecological data collection

LULC matrix validation: In order to calculate the accurate carbon baseline for the project, the Land Use Land Cover and the Forest Canopy Density maps which had been prepared using geo-spatial techniques at Michigan State University (MSU) and IORA Ecological Solutions (IORA), require a second phase of field validation with the state forest department. The FEWMD showed keen interest to perform the second phase validation of the LULC and forest canopy density maps and therefore, these maps were composed according to the territorial ranges and wild life sanctuaries so that these maps can be circulated to the respective Divisional Forest officers/Range Officers for detailed ground validation. This innovative step will help us to improve classification accuracy significantly and will also assist us in the calculation of final degradation and Land use Land Cover change matrix.

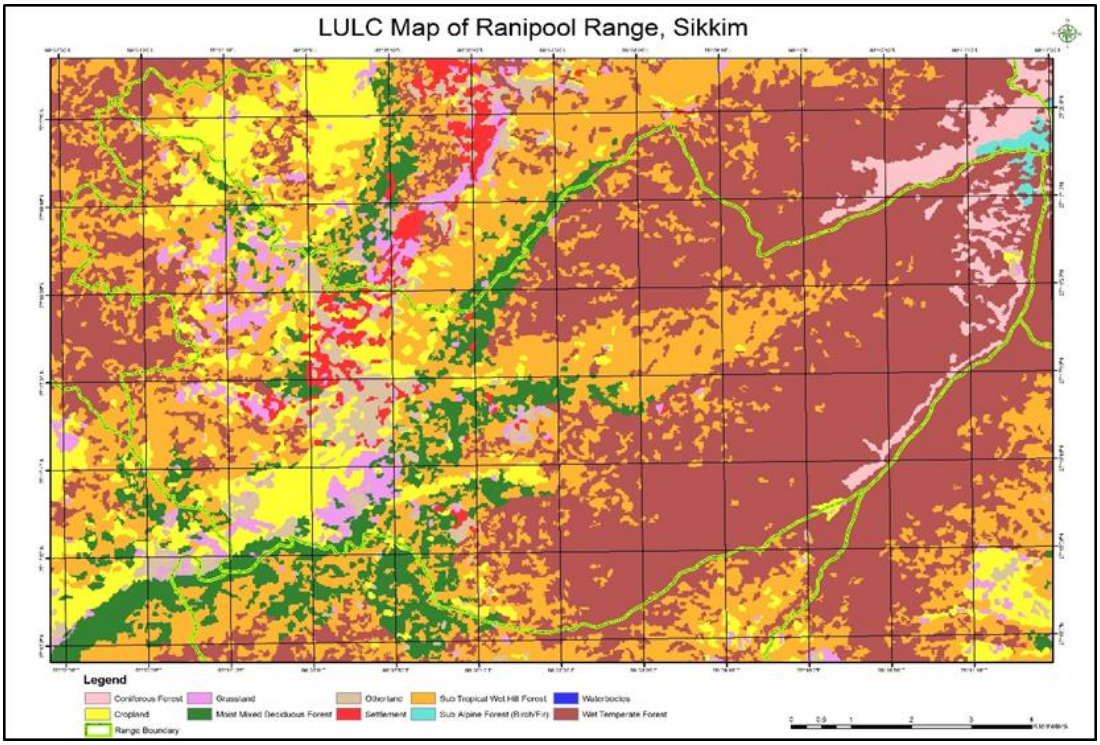

Figure 36: LULC Map of a Forest Range

Preparation of detailed convergence matrix: To identify relevant schemes of various government line departments for potential FPP interventions is under progress. The convergence matrix specifically incorporates schemes in the govt. line departments against the drivers of forest change in Sikkim. The matrix will be a very comprehensive document

focusing on leveraging funds across the government sectors for development of Jurisdictional REDD+ in Sikkim.

SIMFED was approached to gauge its interest in bio-briquetting. They agreed to provide a market base for briquettes, which can further help in value chain and market chain development.

20 major monasteries were selected from across the State and letter was issued to them from Gendrung (Coordinator) of the department to the concerned official. The visits to the identified monastic schools have started and information on fire wood, area available for afforestation, introduction of bio- briquettes, improved stoves is being collected

Policy suggestions have been submitted to the Buildings and Housing Department, Sikkim for promoting REDD+ initiatives as part of Green Rating for Integrated Habitat Assessment (GRIHA) implementation in the state.

Figure 37: Demonstration of bio-briquetting

Table 51: Major activities and consultations under the Program in Sikkim

25 September 2014	Program Initiation Meeting with Dr. Mainra, (PCCF-cum-Principal Secretary) and other officials from FEWMD
18 December 2014	Meeting with Dr. Thomas Chandy (PCCF-cum-Principal Secretary) and other officials from FEWMD
Jan 2015	- Meeting with State Government Departments in Sikkim
Feb 2015	Training conducted on the use of the Data Management System (DMS)
10 April 2015	Visioning Workshop for the Program at the India Habitat Center, New Delhi
April - December 2015	Forest Canopy Density Mapping and Land Use Land Cover (LULC) Mapping
August 2015	Validation of Forest Canopy Density Mapping
August 2015	Training conducted on the use of the Data Management System (DMS)
3 September 2015	First meeting of the Sikkim REDD+ Cell

January 2016	Training on Monitoring, Reporting and Verification (MRV) systems at the community level
22 January 2016	Inter-Departmental Roundtable on Inter-Department Convergence for Jurisdictional REDD+ in Sikkim
2 March 2016	First Nodal Officers Meeting for Inter-Department Convergence of REDD+
March 2016	Meeting with State Government Departments
11-12 March 2016	Forest Carbon Inventory Field Data Collection Training
March - April 2016	Carbon Forest Inventory Field Exercise
18 July 2016	2nd Nodal Officers Meeting
19 July 2016	LULC Validation Workshop
19th Sep 2016	Consultation Workshop on Project Design Development for Jurisdictional REDD+ Project

Annexure 1: Accuracy Assessment of LULC Classification

Table 52: Accuracy analysis including emission and commission errors for year 2002

Classified Data	MMD	WTF	STW	CF	SAF	CL	Water	GL	OL	SL	Total	Users Accuracy	Commission Error
Moist Mixed Deciduous Forest	44	0	2	0	0	4	0	0	0	0	50	88.00	12.00
Wet Temperate Forest	0	46	0	2	1	0	0	1	0	0	50	92.00	8.00
Sub-Tropical Wet Hill Forest	1	1	47	0	0	1	0	0	0	0	50	94.00	6.00
Conifer Forest	0	1	1	47	2	0	0	0	0	0	51	92.16	7.84
Sub-Alpine Fore	0	1	0	1	46	0	0	0	2	0	50	92.00	8.00
Cropland	1	0	1	0	0	45	0	1	2	0	50	90.00	10.00
Waterbodies	0	0	0	0	0	0	48	0	2	0	50	96.00	4.00
Grassland	0	0	0	1	1	0	0	48	1	0	51	94.12	5.88
Otherland	0	0	0	0	0	0		0	48	2	50	96.00	4.00
Settlement	0	0	0	0	0	0	0	0	1	49	50	98.00	2.00
Column Total	46	49	51	51	50	50	48	50	56	51	**502**		**93.23**
Producers Accuracy	95.65	93.88	92.16	92.16	92.00	90.00	100.00	96.00	85.71	96.08			
Omission Error	4.35	6.12	7.84	7.84	8.00	10.00	0.00	4.00	14.29	3.92			

Table 53: Accuracy analysis including emission and commission errors for year 2009

Classified Data	MMD	WTF	STW	CF	SAF	CL	Water	GL	OL	SL	Total	Users Accuracy	Commission Error
Moist Mixed Deciduous Forest	45	0	2	0	0	3	0	0	0	0	50	90.00	10.00
Wet Temperate Forest	0	46	1	2	1	0	0	0	0	0	50	92.00	8.00
Sub-Tropic Wet Hill Forest	1	1	45	0	0	2	0	1	0	0	50	90.00	10.00
Conifer Forest	0	0	0	47	2	0	0	1	0	0	50	94.00	6.00
Sub-Alpine Fore	0	0	0	0	47	0	0	2	1	0	50	94.00	6.00
Cropland	2	0	1	0	0	44	0	1	2	0	50	86.27	13.73
Waterbodies	0	0	0	0	0	0	48	0	2	0	50	96.00	4.00
Grassland	0	0	0	0	0	1	0	48	1	0	50	96.00	4.00
Otherland	0	0	0	0	0	1	1	0	47	2	51	92.16	7.84
Settlement	1	0	0	0	0	0	0	0	1	48	50	94.12	5.88
Column Total	49	47	49	49	50	51	49	53	54	50	501	92.81	
Producers Accuracy	91.84	97.87	91.84	95.92	94.00	86.27	97.96	90.57	87.04	96.00			
Omission Error	8.16	2.13	8.16	4.08	6.00	13.73	2.04	9.43	12.96	4.00			

Table 54: Accuracy analysis including emission and commission errors for year 2013

Classified Data	MMD	WTF	STW	CF	SAF	CL	Water	GL	OL	SL	Total	Users Accuracy	Commission Error
Moist Mixed Deciduous Forest	46	0	2	0	0	1	0	0	1	0	50	92.00	8.00
Wet Temperate Forest	0	48	1	1	1	0	0	0	0	0	51	94.12	5.88
Sub-Tropic Wet Hill Forest	1	1	46	0	0	2	0		0	0	50	92.00	8.00
Conifer Forest	0	0	0	46	2	0	0	1	1	0	50	92.00	8.00
Sub-Alpine Fore	0	0	0	0	47	0	0	1	2	0	50	94.00	6.00
Cropland	2	0	1	0	0	44	0	1	2	0	50	88.00	12.00
Waterbodies	0	0	0	0	0	0	49	0	1	0	50	98.00	2.00
Grassland	0	0	0	0	0	1	0	48	1	0	50	96.00	4.00
Otherland	0	0	0	0	0	0	0	1	48	1	50	96.00	4.00
Settlement	0	0	0	0	0	2	0	0	1	47	50	94.00	6.00
Column Total	49	49	50	47	50	50	49	52	57	48	501	**93.61**	
Producers Accuracy	93.88	97.96	92.00	97.87	94.00	88.00	#####	92.31	84.21	97.92			
Omission Error	6.12	2.04	8.00	2.13	6.00	12.00	0.00	7.69	15.79	2.08			

Annexure 2: Thematic Maps of Sikkim

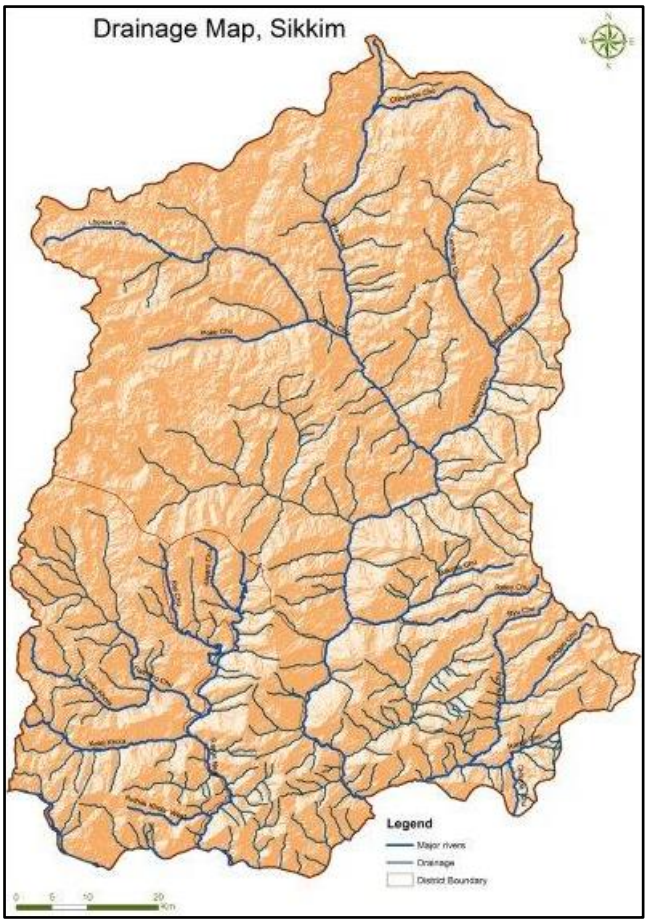

Figure 38: Drainage system in Sikkim

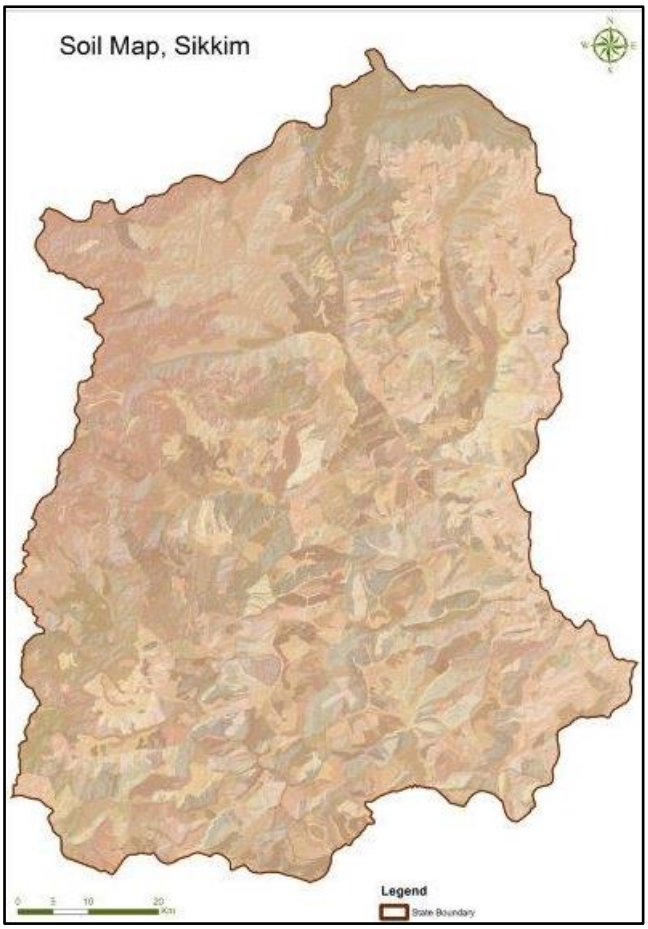

Figure 39: Soil Map, Sikkim

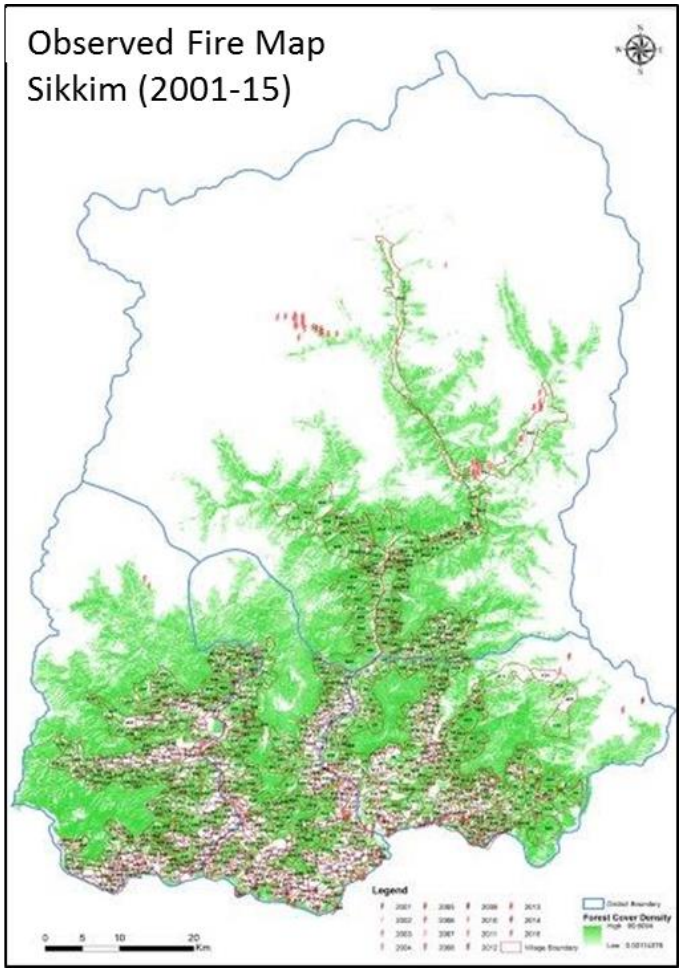

Figure 40: Observed Fire Occurrences in Sikkim (2001-15)

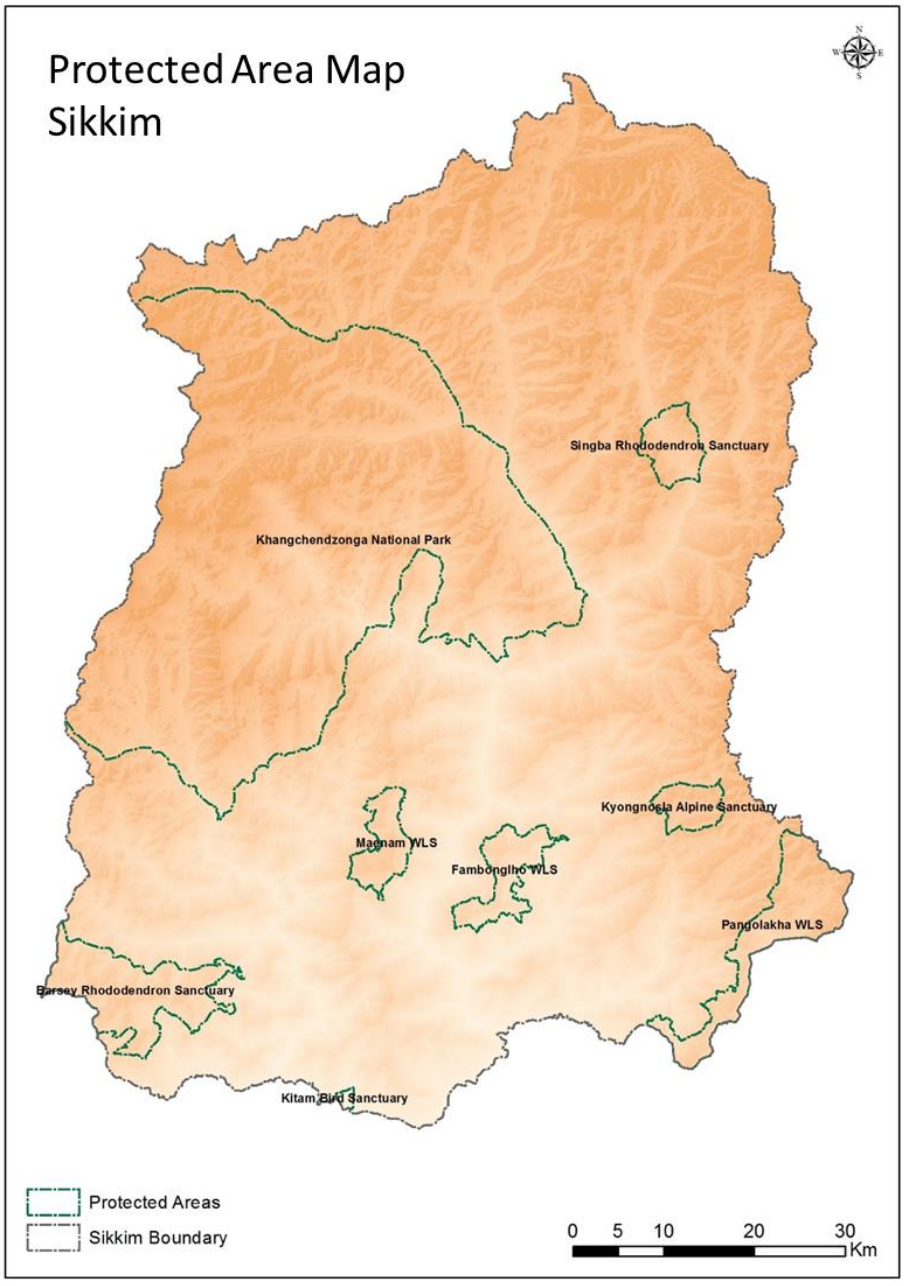

Figure 41: Protected areas in Sikkim

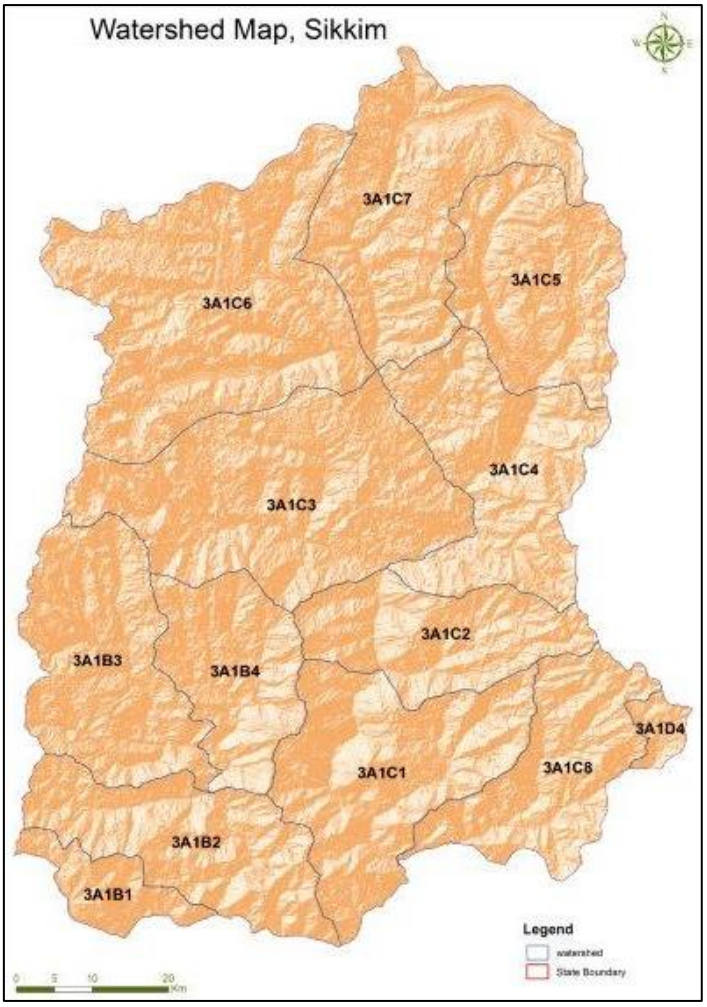

Figure 42: Watershed map of Sikkim

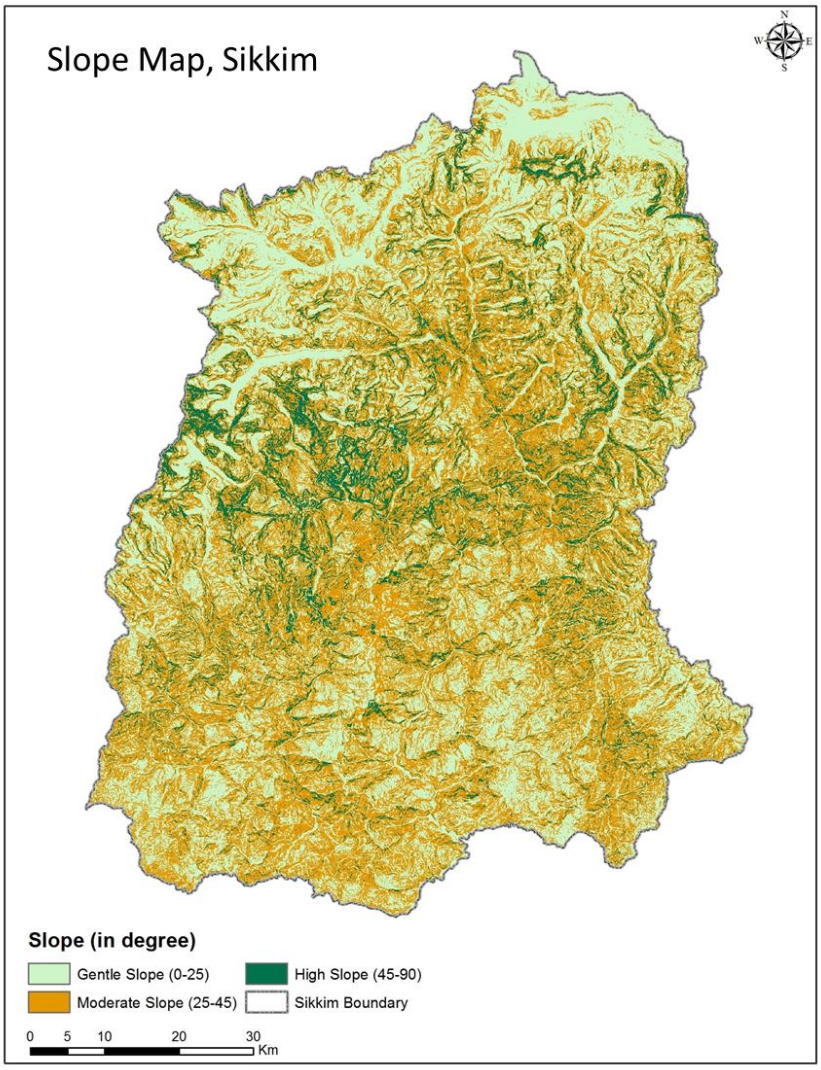

Figure 43: Slope map of Sikkim

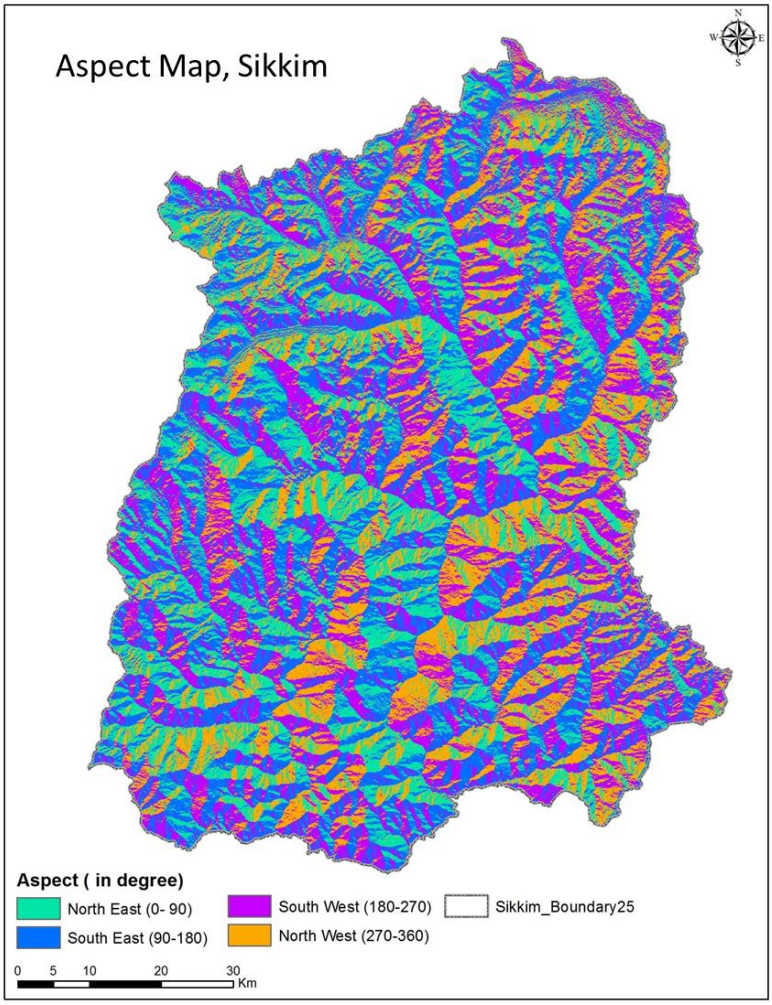

Figure 44: Aspect map of South Sikkim

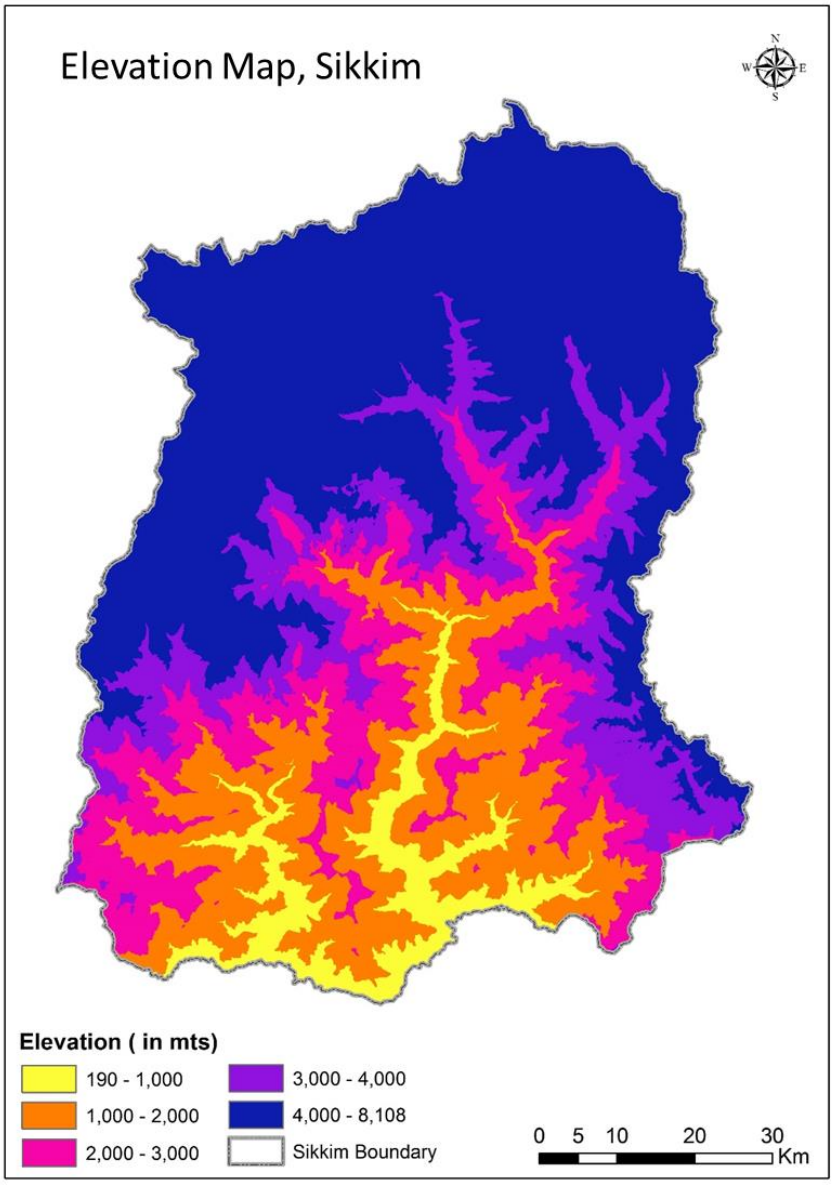

Figure 45: Elevation map for Sikkim

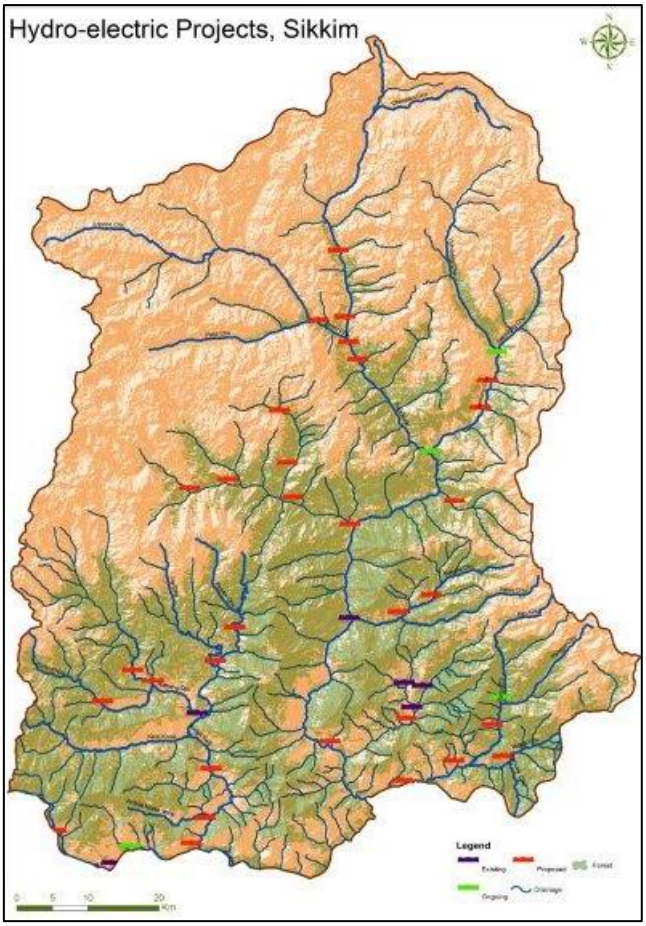

Figure 46: Hydro-electric projects in Sikkim

Annexure 3: Project Chronology/milestones

The start date of the project is 10/01/2015. The start date for project crediting is 01/01/2017. The program-crediting period is 30 years 00 months. Baseline will be re-validated after every 10 years.

Table 55: Major milestones during project development

Date	Event
25 September 2014	Program Initiation Meeting with Dr. Mainra, PCCF-cum-Principal Secretary and other officials
18 December 2014	Meeting with Dr. Thomas Chandy, PCCF-cum-Principal Secretary and other Officials
10 Jan 2015	Meeting with Departments: First activity on ground, Data procurement from DST.
Feb 2015	Data Management System Training
10 April 2015	Visioning Workshop
April - December 2015	Forest Canopy Density Mapping and Land Use Land Cover Mapping
August 2015	Forest Canopy Density Mapping Validation
August 2015	Data Management System Training-II
14 August 2015	Formation of REDD+ cell in the FEWMD
3 September 2015	First REDD+ Cell Meeting
25 November 2015	Formation of state level REDD+ Steering Committee
January 2016	Community MRV Training
22 January 2016	Inter-Departmental Roundtable on Convergence for Jurisdictional REDD+ in Sikkim
2 March 2016	First Nodal Officers Meeting for Convergence of REDD+
March 2016	Meeting with Departments Schemes
11-12 March 2016	Forest Carbon Inventory Field Data Collection Training
March - April 2016	Carbon Forest Inventory Field Exercise
18 July 2016	2nd Nodal Officers Meeting
19 July 2016	LULC Validation Workshop
September 2016	Meeting on Safeguards and Benefit Sharing Mechanism
September 2016	Key Informant Interviews on drivers and interventions

Date	Event
September – October 2016	Household Surveys and Focussed Group Discussions (FGDs) in selected villages in Sikkim
December 2016	Social survey results: Validation exercises at every range
January – February 2017	Training of JFMCs on bio-briquette manufacturing through co-financing from NABARD

Annexure 4: Large Unavoidable Infrastructure Projects in Sikkim

MoEFCC is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and Programs. As part of its responsibilities, MoEFCC maintains a state-level directory of all proposals submitted at the state and central levels to divert forestlands for non-forest purposes[120]. These actions are mandated under the Forest (Conservation) Act 1980.

These provisions are applicable for the state of Sikkim as well, the jurisdictional area under the REDD+ Program. From the start of the baseline period in 2003, there have been 426 proposals submitted to the concerned Nodal Officers in Sikkim till 1 August 2016. A year-wise break-up of the number of proposals submitted is given in 5.

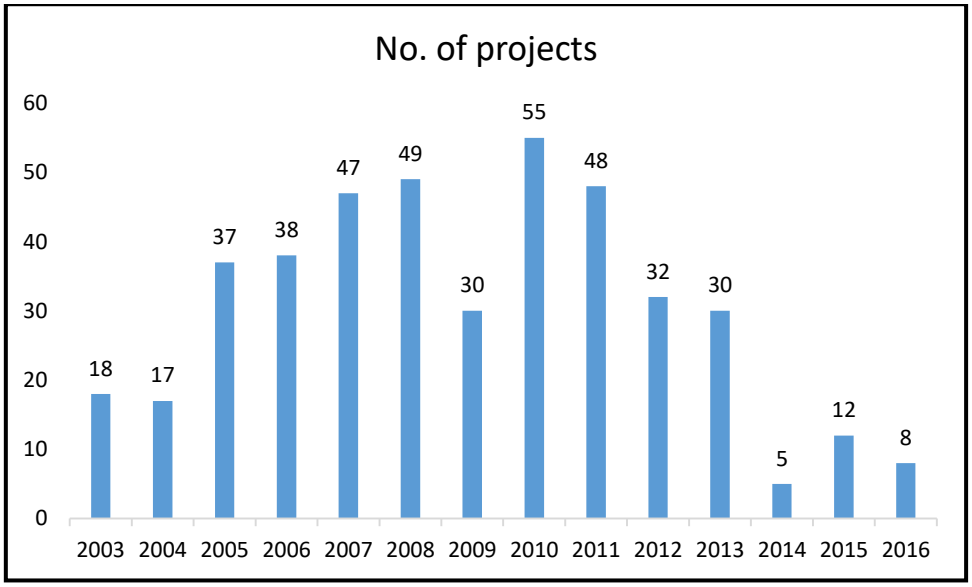

Figure 47:No. of projects received by Nodal Officers in Sikkim per year.

For all proposals reaching to concerned Nodal Officers in Sikkim, appropriate internal mechanisms exist to evaluate the significance and suitability of the project. These activities are only allowed to commence once all requisite approvals are in place at the state as well as central levels. Since Forestry is a Concurrent subject under the Indian Constitution (signifying the involvement of both the central and state governments in legislative actions and management), projects undergo a comprehensive assessment at both levels.

Figure 486 depicts the current status of all proposals submitted. While a significant amount of projects have gained approval for diversion of forestlands, about a third of the proposals are still being evaluated by the officials within the FEWMD, including the Chief Conservator of Forests (CCF), Division Forest Officer (DFO) and Range Officer (RO). These projects are currently at various stages within this approval process. Necessary actions for diversion of forestlands have already commenced for the projects which have gained approvals.

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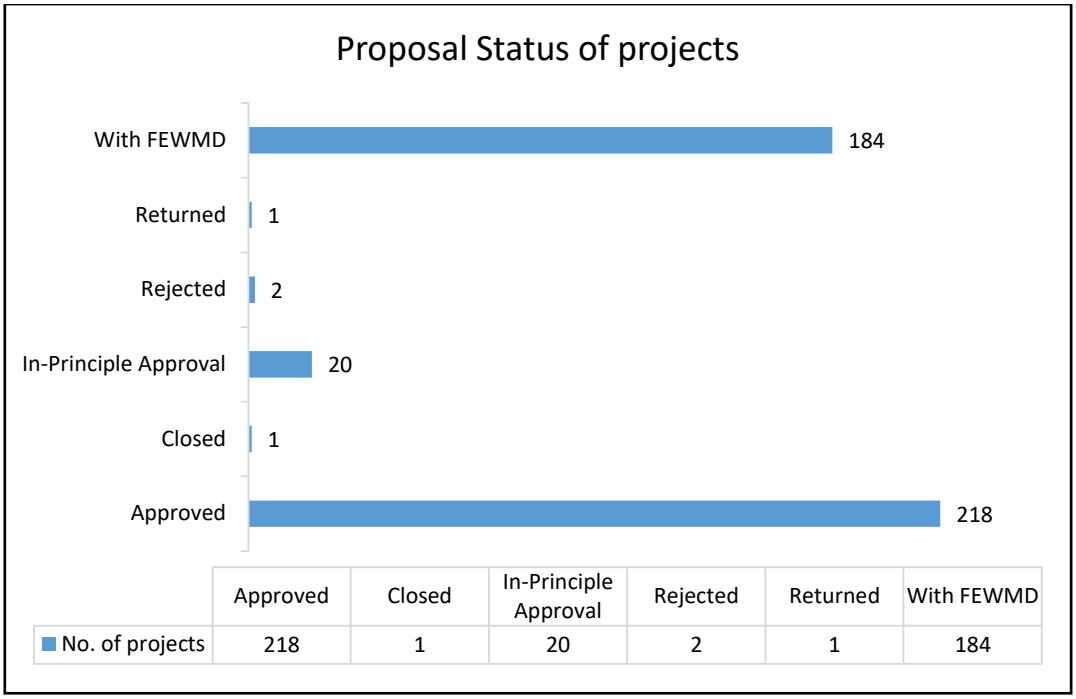


Figure 48: The status of the proposals submitted to the respective Nodal Officer for diversion of forestlands

These non-forest purposes fall under the categories of Defence, Mining and other infrastructural activities (*Table 56*). The most number of approved projects for diversion of forestlands is for the construction of Roads, followed by diversion for miscellaneous activities (Figure 49). In total, the total forestlands diverted for non-forest purposes from 2003 to August 2016 amount to an area of **2071.25 Ha**, with an average of 5.12 Ha of forestlands diverted per approved project.

Table 56: Forest clearances based on the categories of non-forest diversions

Category	No. of Projects	Avg Area Diverted (Ha)
Defence	30	28.07487
Drinking Water	37	0.192
Hydel	57	8.496
Mining	1	0.046
Road	171	3.022
School	2	0.584
Transmission Line	32	5.054
Village Electricity	1	0
Others	95	0.615

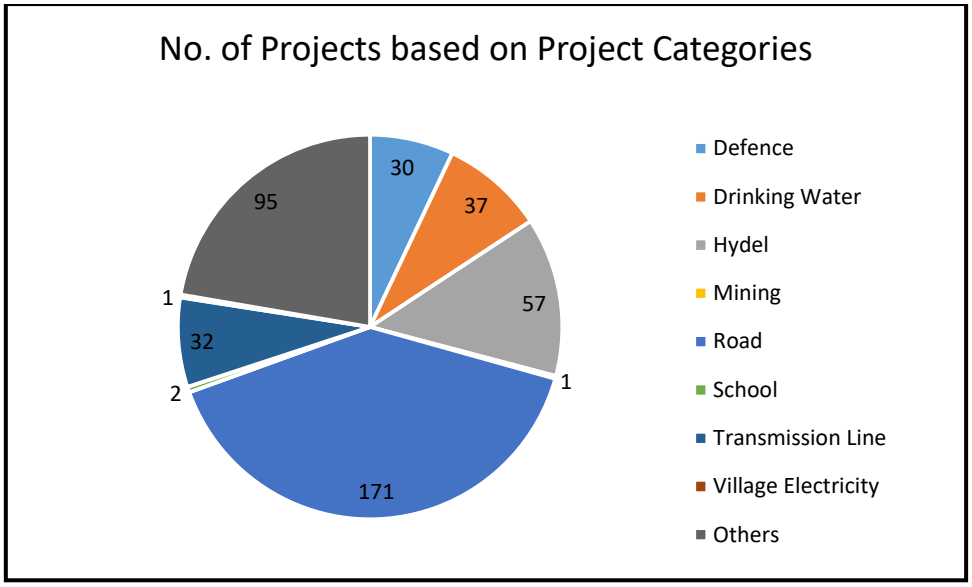


Figure 49: Forest clearances under different categories in Sikkim

It has been seen that over the baseline period, most forestlands have been diverted for projects related to national security and defence on an average, followed by the construction of hydel power projects in Sikkim (Figure 50).

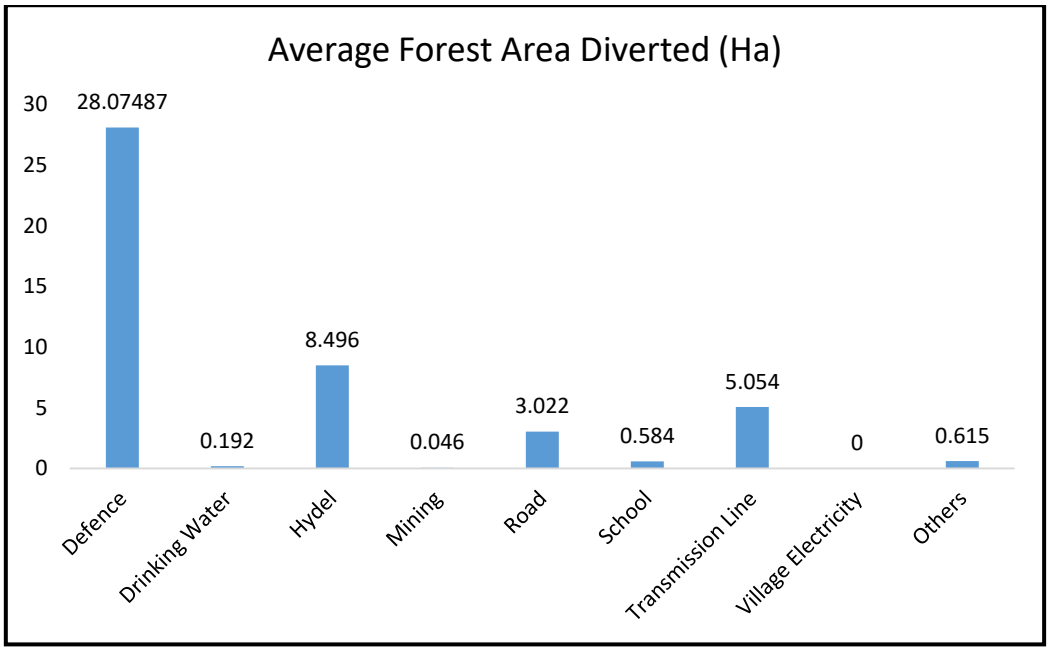


Figure 50: Average diversions of forestlands for different categories of non-forest purposes

Annexure 5: Pictures

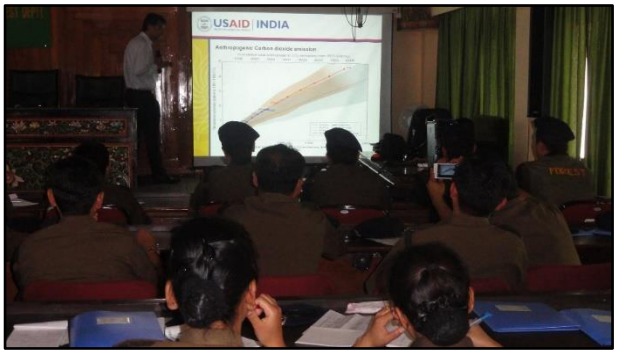
Figure 51: Monks during the Monks for Climate communication campaign conducted in Sikkim

Figure 52: LULC Validation Workshop, conducted on 19 July 2016

Figure 53: Ecological field data collection exercise conducted in March-April 2016

Figure 54: Glimpse from the socio-economic survey conducted in September-October 2016 in Sikkim

(a)



(b)

(c)

Figure 55: Capacity building activities conducted in Sikkim: (a) Participants of the field Carbon inventory workshop; (b) Theory sessions in progress and (c) Field Training

Figure 56: Validation of the socio-economic surveys; December 2016

(a) (b)

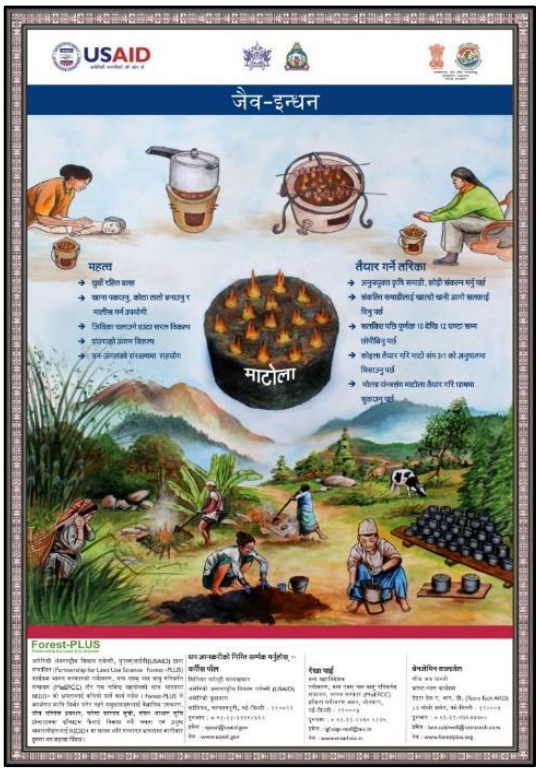
Figure 57: Inter-Departmental Convergence Meetings in Sikkim, (a) 1st Inter-Departmental Convergence on 2 March 2016; (b) 2nd Inter-Departmental Convergence on 18 July 2016

(a) (b)

(c)

(d)

Figure 58: (a) Bio-briquette making underway during an Exposure Visit on 13 December 2016; (b) Bio-briquette making workshop in Lingzey; (c), (d) Bio-briquette making workshop in Rey Mindu;



(a)

(b)

Figure 59: (a) Poster for sensitization towards the use of Bio-briquettes in Sikkim; (b) News article on bio-briquettes training in the Sikkim Express