Measurement, Reporting and Verification (MRV) System to support REDD+ Bhutan

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Forest Resources Management Division

Department of Forests and Park Services

Measurement, Reporting and Verification (MRV) System to support REDD+ Bhutan

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EXECUTIVE SUMMARY

Bhutan, a high forest low deforestation country through the REDD+ readiness phase has been able to support and establish most of the building blocks under the four major components of REDD+ guided by the Warsaw Framework. MRV is one of the key elements under the National Forest Monitoring System required for measurement, reporting and verification of the country's forest and associated GHG emissions and removals, including their changes over time. Since 2010, the Department of Forests and Park Services, Ministry of Agriculture and Forests have been laying the foundations of MRV for REDD+ readiness phase through institutionalization of the national forest monitoring system, development of forest reference emission level and forest reference level along with the development of the national REDD+ strategy and action plan.

The measurement function of MRV is achieved through the three pillars of satellite land monitoring, national forest inventory and greenhouse gas inventory. Satellite land monitoring helps to monitor REDD+ activities and the changes in land use and land cover mainly through the generation of activity data. The national forestry inventory provides information to assess and monitor changes in forest carbon stock in different pools. Greenhouse gas inventory involves the estimation of GHG emissions and removals from the forestry sector resulting from deforestation, timber removals and forest fire. As part of the reporting and verification function, Bhutan submitted the FREL and FRL to the UNFCCC in 2020, which has been duly assessed by the UNFCCC technical assessment committee of experts.

The document also highlights the issues and challenges that have been faced during the development of the MRV system in the REDD+ readiness phase. Based on the challenges encountered and lessons learnt, future endeavors for upscaling and further development to meet the requirement of a dynamic and robust MRV system is indicated, which will complement the implementation of Bhutan's national REDD+ strategy and action plan.

ACRONYMS

AD	Activity Data
AFOLU	Agriculture, forestry and other land uses
CP	Conference of Parties
EF	Emission Factor
ER	Emission Reduction
ESMS	Environmental and Social Management System
ESS	Environmental and Social Safeguards
FAO	United Nations Food and Agriculture Organization
FCPF	Forest Carbon Partnership Facility of the World Bank
FOSS	Free and Open-Source Software
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
FRMD	Forest Resources Management Division
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse Gas
GPG	Good Practice Guidance
IPCC	Intergovernmental Panel on Climate Change
JDNP	Jigme Dorji National Park
LULC	Land Use and Land Cover
LULUCF	Land Use, Land-Use Change and Forestry
MoAF	Ministry of Agriculture and Forests

MoE	Margin of Error
MRV	Measurement, Reporting and Verification
M&MRV	Monitoring and Measurement, Reporting and Verification
NECS	National Environment Commission Secretariat
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NFP	National Forest Policy of Bhutan
NGO	Non-Governmental Organization
NRS	National REDD+ Strategy
NRSAP	National REDD+ Strategy and Action Plan
NWFPs	Non-Wood Forest Produce
PAMs	Policies & Measures
PIS	Pre-Investment Survey
PSPs	Permanent Sample Plots
QA	Quality Assurance
QAQC	Quality Assurance and Quality Control
RBP	Results-based Payments
REDD	Reducing Emissions from Deforestation and Forest Degradation
RGoB	Royal Government of Bhutan
R-PP	Readiness Preparation Proposal
SBSTA	Subsidiary Body of Science and Technical Advice
SIS	Safeguards Information System
SLMS	Satellite Land Monitoring System

SMF	Sustainable Management of Forest
SNC	Second National Communication
ToR	Terms of Reference
UNFCCC	United Nations Framework Convention on Climate Change
UWICER	Ugyen Wangchuck Institute of Conservation and Environment Research
WCNP	Wangchuck Centennial National Park

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SECTION 1: INTRODUCTION

1.1 Background

The Royal Government of Bhutan (RGoB) is signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and is a REDD+ participant country under Forest Carbon Partnership Facility (FCPF). Bhutan formally initiated the REDD+ program in 2010. The objective of REDD+ is to reduce emissions from deforestation and forest degradation and increase CO_2 sequestration through the sustainable management of forests, conservation of forest carbon stock and enhancement of forest carbon stocks. REDD+ participant countries are eligible for results-based payments (RBP) for verifiable emission reductions and/or enhanced carbon stocks.

Bhutan has previously sought support through a Readiness Preparation Proposal submission to the FCPF. An initial grant of USD 3.8 million was received in 2013, followed by an additional grant of USD 4.8 million in 2017. These grants have been utilized in the establishment of a national REDD+ framework, which is required prior to seeking REDD+ payments. The key elements of this framework are the National REDD+ Strategy and Action Plan, National Forest Reference Emission Level/Forest Reference Level (FREL/FRL), a National Forest Monitoring System (NFMS), and a safeguards framework (Safeguard Information System, Strategic Environmental and Social Assessment, and Environment & Social Management Framework), as well as corresponding institutional and implementation arrangements

Bhutan's REDD+ framework development falls into three phases, as displayed in Figure 1. Phase one is the readiness phase, during which the relevant institutional systems are established, and the national strategy is prepared. This stage is followed by a transition into phase two, which focuses on implementation of activities or the Policies and Measures (PAMs) outlined in the strategy. The third Phase involves the implementation of fully measured, reported, and verified actions, for which RBP could be received. The preparation of the National Strategy and Action Plan document signals Bhutan´s transition towards phase three.

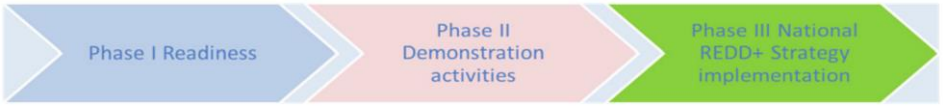

Figure 1: REDD+ Phases

Bhutan participated and implemented REDD+ to build its institutional capacity to strengthen its forest management and governance, engage stakeholders and overall support the effort of RGoB towards meeting its climate goals. Subsequently, the REDD+ readiness process in Bhutan has achieved some important milestones, which are required prior to seeking REDD+ RBP or financing for REDD+ implementation. These include:

- Establishing Institutional and implementation arrangements.
- Analysis of the drivers of deforestation and forest degradation.
- National REDD+ Strategy
- Institutionalization of the National Forest Monitoring System (NFMS), which will help to regularly monitor and report forest cover changes and account for GHG emissions and removals from forestry.
- Development of a Forest Reference Emission Level (FREL)/Forest Reference Level (FRL), which provides the necessary tool for justifying Bhutan's position on carbon neutrality and implementing measures to protect and enhance forest cover.
- Preparation of a fund mobilization strategy, a safeguards framework, and drafting of a benefit-sharing framework.

1.2 National Forest Monitoring System and the Measurement, Reporting and Verification (NFMS&MRV)

According to the Warsaw Framework, any country implementing the REDD+ activities should have following four components (Figure 2);

a. A National Strategy (NS) and/or Action Plan (AP);
b. A national (or subnational as interim) Forest Reference Emission Level (FREL) and/or Forest Reference Level (FRL);
c. A robust and transparent National Forest Monitoring System (NFMS) for the monitoring and reporting of REDD+ activities, including measurement, reporting and verification results;
d. A Safeguard information system.

Figure 2 REDD+ components

Subsequently, Bhutan developed the Framework of the Safeguard Information System (SIS) for REDD+ in Bhutan (DoFPS, 2019), National Redd+ Strategy & Action Plan (WMD, 2020), and established the FRL/FREL and NFMS. Bhutan institutionalized the NFMS following the methodological guidance and methodologies described under Decision 4/CP.15, and Decision 11/CP.19 adopted at CP15 in 2009.

Decision 4/CP.15, adopted at CP15 in 2009, provides methodological guidance on REDD+ and emphasize the need for a national forest monitoring system, wherein, developing country Parties are requested to:

Paragraph 1(d): ... *establish, according to national circumstances and capabilities, robust and transparent* ***national forest[1] monitoring systems*** *and, if appropriate, sub-national systems as part of national monitoring systems that:*

i) Use a combination of remote sensing and ground-based forest carbon inventory approaches for estimating, as appropriate, anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes;

[1] "Taking note of, if appropriate, the guidance on consistent representation of land in the Intergovernmental Panel on Climate Change Good Practice Guidance for Land Use, Land-Use Change and Forestry."

ii) Provide estimates that are transparent, consistent, as far as possible accurate, and that reduce uncertainties, taking into account national capabilities and capacities;

iii) Are transparent and their results are available and suitable for review as agreed by the Conference of the Parties.

Further Decision 11/CP.19 highlighted that the establishment of the NFMS should:

a. Build upon existing system, as appropriate;
b. Enable the assessment of different forest types in the country, including natural forest;
c. Be flexible and allow for improvement.

The process of developing an NFMS should allow for incremental efforts to improve performance in recognition of countries' varied capabilities and national circumstances. In order to follow an iterative development and implementation process with well-defined steps and results, a NFMS for REDD+ should:

a) Be robust, transparent, and aim to be implemented at the national level, with subnational monitoring systems as a potential interim measure;
b) Be in line with relevant decisions of the UNFCCC on REDD+, notably decisions 4/CP.15, 1/CP.16, 11/CP.19 and all other subsequent decisions adopted by the CP;
c) Be relevant for the phased approach for REDD+ activities as set out by the UNFCCC (decision 1/CP.16, paragraph 73).

The main components or building blocks of the NFMS consists of Satellite Land Monitoring System (SLMS), National Forest Inventory (NFI), national GHG Inventory, and online platforms for information sharing and monitoring. The UN-RED document on '*National Forest Monitoring Systems: Monitoring and Measurement, Reporting and Verification (M&MRV) in the context of REDD+ activities*' further elaborates that an NFMS for REDD+ can serve simultaneous functions: a 'MRV' function and a 'monitoring' function (Figure 3).

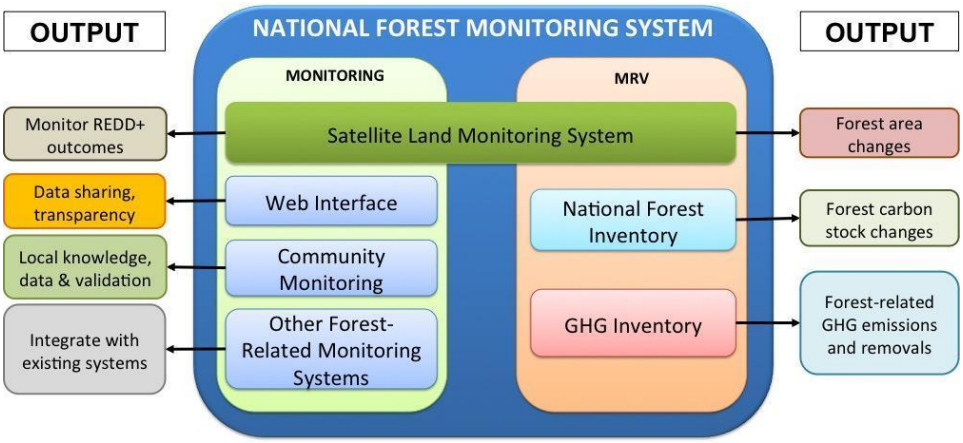

Figure 3 National Forest Monitoring System (NFMS)

Decision 4/CP.15 also specifies that countries must follow the most recent methodological recommendations issued by the IPCC, serving as a basis for estimating the sources of anthropogenic GHG emissions, and their removal by sinks, and for measuring carbon stocks and changes in forest area. In this way, emissions estimates will be based on common (IPCC) methodological approaches. This methodological guidance indicates that NFMS should be used to:

1) estimate emissions and removals from the forest sector (**measurement**);

2) report the performance of REDD+ activities to the UNFCCC through the national communication (**reporting**); and

3) allow verification of the results by the UNFCCC Secretariat (**verification**) – i.e., to fulfill the MRV function for REDD+ activities.

As part of the monitoring system, a web interface for NFMS[2] has been developed to facilitate transparent data sharing at the national and international levels. The web-portal contains national datasets that have been produced though SLMS, including global datasets on LULUCF about Bhutan. At the national level, DoFPS also has two online databases: 1.

[2] NFMS web-portal: http://www.bhutan-nfms.org/

Forest Information Reporting & Monitoring System, FIRMS[3] for forestry information maintenance and dissemination and 2. Spatial Decision Support System, SDSS[4], a web-based geospatial interactive toolkit, which allows DoFPS to rationalize and monitor forest area being lost to other developmental activities during the time of the issuance of forestry clearances.

1.1.1 Monitoring, Reporting and Verification function

The UNFCCC has created a separate page on its REDD web platform[5] with links to the relevant Intergovernmental Panel on Climate Change (IPCC) guidelines and good practice guidance that should form the basis for how developing countries to estimate and report on emission reductions from deforestation and forest degradation and changes in forest carbon stocks, as requested by the parties, in decision 4/CP.15 paragraph 1(c). Table 1 provides the overview of IPCC guidelines and Good Practice Guidance (GPG) that could be relevant to estimate emission reductions from deforestation and forest degradation and changes in forest carbon stocks.

Table 1 Overview of IPCC Guidelines and Good Practice Guidance

IPCC Guidance	
IPCC-NGGIP[6]	IPCC-National Greenhouse Gas Inventories Programme
2006 IPCC Guidelines[7]	2006 IPCC Guidelines for National Greenhouse Gas Inventories (5 Volumes)
GPG-LULUCF 2003[8]	Good Practice Guidance for Land Use, Land-Use Change and Forestry

[3] FIRMS database: https://firms.dofps.gov.bt/

[4] https://sdss.dofps.gov.bt/

[5] https://unfccc.int/methods/redd/redd_web_platform/items/6734.php

[6] http://www.ipcc-nggip.iges.or.jp/

[7] http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

[8] http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

Degradation of Forest[9]	Definitions and Methodological Options to Inventory Emissions from Direct Human-induced Degradation of Forests and De-vegetation of Other Vegetation Types
GPG2000[10]	Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (accepted and published 2000)
Revised 1996 IPCC Guidelines[11]	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (3 Volumes) (approved in 1996 and published in 1997)
Revised 1996 IPCC Guidelines Software[12]	IPCC Greenhouse Gas Inventory Software for the Workbook (published in 1997; Microsoft Excel 5.0c or later version is necessary)
-	IPCC Guidelines for National Greenhouse Gas Inventories (3 Volumes) (approved in 1994 and published in 1995, out of print, replaced by 1996 Revised Guidelines)

The UNFCCC encourages countries to follow the IPCC GPG for "land use, land use change and forestry" (LULUCF) as the basis for compiling their GHG inventory reports. GPG sets out a simple methodological approach for the development of GHG inventories: to combine information on the extent of human activities (or activity data – AD) with coefficients that quantify the emissions or removals per unit activity (or emission factors – EF). Figure 4 shows the IPCC's methodological approach to calculate anthropogenic GHG emissions by sources and removals by sinks related to forest land.

For further guidance on emission factors and activity data, see the UN-REDD NFMS guidance document and Hewson et al. (2014)

9 http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/degradation.html

10 http://www.ipcc-nggip.iges.or.jp/public/gp/english/

11 http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.html

12 http://www.ipcc-nggip.iges.or.jp/public/gl/software.html

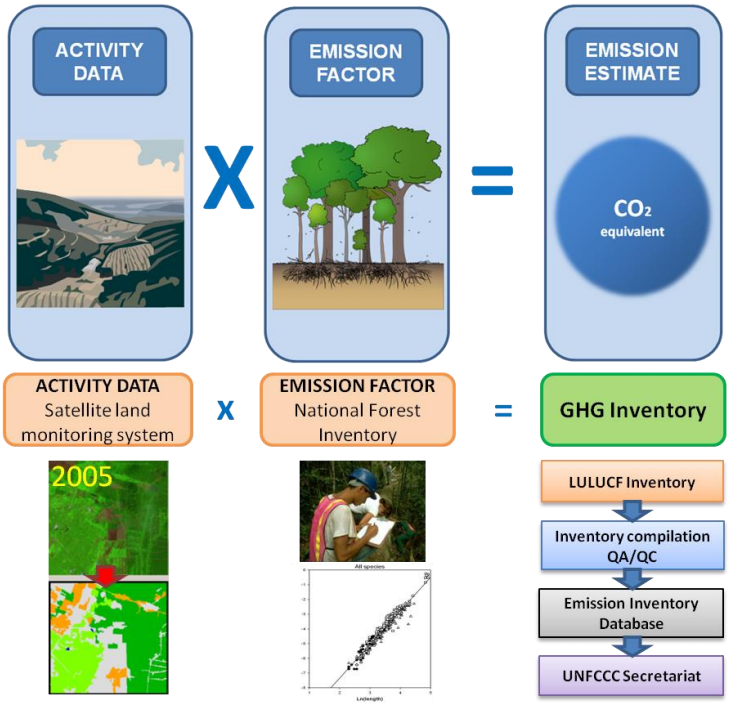

Figure 4 The IPCC's methodological approach for calculation of GHG emissions from forest land

To ensure that countries report their national greenhouse gas (GHG) inventories in a transparent, accurate, complete, comparable and consistent manner, the UNFCCC COP has requested countries to use the most recent IPCC guidance and guidelines to estimate anthropogenic forest-related GHG emissions by sources and removals by sinks, forest carbon stocks and forest area changes. IPCC guidance and guidelines relate mainly to the Measurement and Reporting aspects of the MRV component of a NFMS. MRV can be interpreted as the means to address countries' commitments to collect and share information on the progress of the implementation of provisions and/or commitments of Parties.

Article 4.1 (a) of the Convention, encourages to "*Develop, periodically update, publish and make available to the Conference of the Parties, in accordance with Article 12, national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not*

controlled by the Montreal Protocol, using comparable methodologies to be agreed upon by the Conference of the Parties."

In the context of REDD+, MRV is the process that countries will need to follow in order to estimate the performance of REDD+ activities in mitigating climate change – i.e. the emissions reductions and forest carbon stock enhancements – in terms of tonnes of carbon dioxide equivalents per year (tCO_2e/yr). Because of this critical role in ensuring the environmental integrity of REDD+, MRV of REDD+ results is a pre-condition to countries receiving results-based payments for results-based actions (i.e. MRV is the mechanism to assess whether actions are results-based).

The three technical pillars or building blocks of the NFMS that are essential to support the MRV function are:

> Pillar 1: A Satellite Land Monitoring System (SLMS) - including other remote sensing products such as for example Landsat satellite data – to collect and assess, over time, the AD related to forest land;
> Pillar 2: National Forest Inventory (NFI) to collect information on forest carbon stocks and changes, relevant for estimating emissions and removals and to provide emissions factors (EF);
> Pillar 3: A national GHG Inventory as a tool for reporting on anthropogenic forest-related GHG emissions by sources and removals by sinks to the UNFCCC Secretariat.

The institutions involved in MRV for REDD+ are the Department of Forests and Park Services (DoFPS) and the National Environment Commission Secretariat (NECS) at the national level and the UNFCCC at the international level (Figure 5). While the DoFPS shall lead the SLMS, NFI and the preparation of FREL/FRL. Periodic QAQC shall be carried out to review the procedures and assess and maintain the quality of the measurements. NECS is the overall lead for the national GHG inventory for the LULUCF sector and for the compilation and reporting of the National Communication to the UNFCCC.

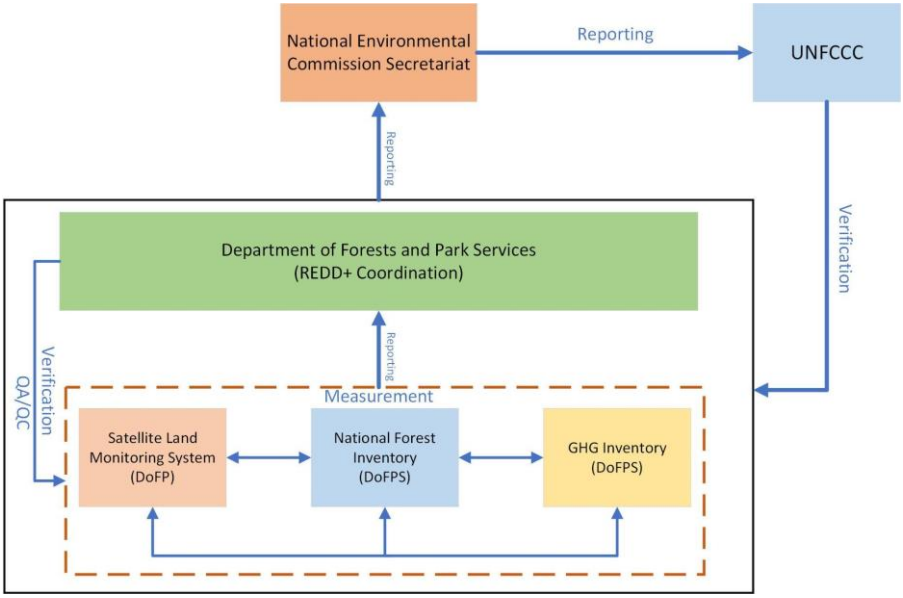

Figure 5 Proposed institutional arrangements for Bhutan's MRV

1.3.1 Satellite Land Monitoring System

Satellite Land Monitoring System (SLMS) is developed to achieve two objectives. Firstly, SLMS will help to monitor the REDD+ activities and secondly this system will be used to monitor changes in land use and land cover (LULC) over the period of time referred to as AD. SLMS emphasizes the use of remote sensing technologies to monitor the REDD+ activities and to generate the AD using satellite images. Monitoring of REDD+ activities and generation of AD can be cost effectively achieved through the use of satellite remote sensing technologies. Satellite remote sensing technique provides spatially explicit information on forest area changes over the period. Remote sensing techniques further help to maintain the principle of consistency, completeness, comparativeness, accuracy and transparency as recommended by IPCC.

Bhutan has not yet ventured into the demonstration of REDD+ activities. Should Bhutan be implementing the REDD+ activities in future for RBP, then appropriate criteria and indicators will be developed to monitor the activities. Bhutan has been monitoring the LULC through the generation of maps using satellite remote sensing techniques. The Ministry of Agriculture and Forests (MoAF) pioneered the generation of spatially explicit information on LULC using the satellite remote sensing techniques

for monitoring and policy formation. So far Bhutan has developed three LULC maps. Satellite remote sensing technique also helps to measure the annual forest area changes including historical rates of deforestation and forest degradation through consistent methodological approach. Bhutan has assessed the historical deforestation using Landsat imageries for the historical period of 2005-2014 and estimated the annual historical rate of deforestation.

1.3.2 National Forest Inventory

Assessment of the existing forest cover and growing stock in the forest is crucial for proper planning and sustainable management of forest. National Forest Inventory (NFI) is a crucial ground-based data collection exercise to assess and monitor the changes in forest carbon stock in different pools. The first nationwide NFI was formalized between 2009 to 2012 through a series of consultative workshops and meetings with both national and international experts and the fieldwork was started in 2012 and completed in 2015. NFI of Bhutan is designed to provide accurate information about the size, distribution, composition and condition of our forests including the carbon stocks and changes taking place in the forest over the time through periodic measurement. NFI entails systematic sampling design with 2424 permanent cluster plots laid at 4km x 4km grid and it is designed to be measured at an interval of 5-10 years. NFI covers both forest and non-forest land in Bhutan and it is a probabilistic sampling approach such that each land use has equal opportunity of being sampled.

Since, the forest undergoes great deal of change over the years, it is important that the information is regularly updated for planning, policy development and business. The 2nd cycle of NFI is currently ongoing (2021-2022) and field work is expected to complete by the end of June 2022. As part of second NFI, 2424 permanent sample plots (PSPs) are remeasured to provide the most reliable data for estimation of:

1. Change in the forest stands over time, in number, size and species.
2. Variations in composition and production with size.
3. The relationship between individual tree variables, stand variable and increments, which may be used for predicting future stocking and
4. Long term changes (improvements, degradation) in the site and it is productive capacity.

Bhutan's NFI will collect data and information not limited to timber but also capture wide ranging information on Non-Wood Forest Produce (NWFP), shrubs, herbs, biomass, wildlife, biodiversity, forest health and disturbances. These data shall be collected by 230 NFI crew in all Field offices in addition to the Quality Assurance and Quality Control (QAQC) crew in FRMD. These elements/necessities enhance the capacity of all the Department including technical and institutional capacity. Forest Resources Management Division (FRMD) is the main coordinating agency of the NFI and shall ensure successful implementation of the NFI. Fieldwork shall be coordinated and implemented by 24 field offices, who shall collect, cleanse and submit the data to FRMD. All 24 offices have a field crew each excluding Jigme Dorji National Park (JDNP) and Wangchuck Centennial National Park (WCNP) who have two crews each. In addition, an independent team has been formed by Ugyen Wangchuck Institute of Conservation and Environment Research (UWICER) to help enumerate the WCNP plots.

All the NFI crew and data managers are adequately trained on fieldwork and data management. Subsequently, the crew has been equipped with adequate gears and equipment to carry out the fieldwork. However, additional capacity for data analysis and report writing. Technical officers of this Unit will require knowledge and experience of spatial data analysis and database management.

1.3.3 National GHG reporting

GHG Inventory is an estimation of the GHG emissions and removals of a country and therefore an essential and mandatory element of the UNFCCC reporting. A GHG inventory comprises estimating emissions by sources and removals by sink based on the principles of Transparency, Accuracy, Consistency, Comparability and Completeness (TACCC–principles).

The emission in the forestry sector results from deforestation, timber removals and forest fire. These activities are directly linked to the national GHG inventory, which provides comprehensive emissions and removals in different sectors and cover detailed information from Agriculture, Forestry and Other Land Use (AFOLU). The emission and removal estimates generated from GHG inventory are reported as part of the National Communication and Biennial update report to UNFCCC, which constitute formal reporting.

Bhutan submitted initial national communication to UNFCCC in 2000, for the inventory year 1994, second national communication in 2010 for the inventory year 2000 and third national communication in 2020 for the inventory year 2015. Currently, Bhutan is in the process of developing the first biennial update report and is expected to be submitted at the end of 2022.

SECTION 2: MEASUREMENT REPORTING VERIFICATION SYSTEM

2.1 Monitoring Forests and Forest Area Change

The Constitution of Kingdom of Bhutan, 2008 mandated the need to maintain 60% total land area under forest cover for all times to come[13] and this provision features in the National Forest Policy of Bhutan (NFP) 2011. The NFP further emphasizes the need for the periodic monitoring of the forest and accordingly, the National Forest Inventory (NFI) is identified as an important program of the Department and accordingly, featured as a program for 10th, 11th and 12th Five Year Development plan of the Department. Further, constitutional mandate of maintaining 60% forest cover and need for conduct of regular NFI is provisioned in the draft Forest and Nature Conservation Bill (2021)[14] and there are plans to mainstream the program into regular plans. In view of this, central offices play the coordination role while field offices plan and implement the field work.

Further, Bhutan rectified the Paris Agreement in 2015 and submitted the first nationally determined contribution in 2015, which reaffirmed our initial commitment to remain carbon neutral with global support in 2009. Further, carbon neutral commitment forms the premise of updated NDC of Bhutan 2021. Therefore, monitoring, measuring and reporting forest and forest carbon will be a regular phenomenon.

In Bhutan, as part of its Readiness Preparation Proposal to the World Bank's FCPF, initially, national level quick assessments were done on the drivers of deforestation and forest degradation: a qualitative assessment based on national sectoral analysis, and a quantitative assessment based on GIS and Remote Sensing Data.

The current understanding of processes affecting forest carbon is not suitable for defining and implementing REDD+ actions. An assessment is required to be conducted, using these initial assessments, on the drivers of deforestation and forest degradation and will include the following key areas:

- Assessing drivers of deforestation

[13] Article 5 of The Constitution of the Kingdom of Bhutan

[14] The draft bill can be downloaded and reviewed at https://www.nab.gov.bt/dz/business/view_bill_detail/88 (last accessed on 25.05.2022)

- Identifying causes of forest degradation
- Identifying the likely impacts on carbon stocks from both deforestation and forest degradation
- Assessing areas of forest subject to logging
- Quantifying degradation of carbon stocks by forest fire

2.1.1 Satellite Land Monitoring System (SLMS)

SLMS is designed to capture AD resulting from both anthropogenic and natural causes using freely available satellite imagery based on the national definition of forest. Furthermore, SLMS is intended to generate periodic LULC maps that detail forest type as well as canopy density map to supplement NFI in understanding the forest dynamics in Bhutan. SLMS integrates remote sensing methods to assess AD related to land use/land use change and forest degradation processes over large areas. SLMS is one of the three functions of Monitoring, Reporting and Verification to continuously monitor land by establishing the National Forest Monitoring System (NFMS).

Bhutan has so far developed three national LULC data sets using satellite remote sensing techniques. The first LULC map was produced in 1995 using a combination of SPOT image and aerial photographs with the support from DANIDA. Second LULC map was generated using an ALOS image in 2010 and the third LULC was developed in 2016 using Landsat 8. Due to the inconsistency in the datasets for historical LULC, the national LULC were not used for the generation of AD. Therefore, to generate AD for Bhutan and to assess the forest degradation, Global Forest Change (GFC) datasets (Hansen et al., 2013) were used (Figure 6 & Figure 7).

The GFC dataset consists of annual tree cover loss since 2000, tree canopy density map of 2000 and forest gain for the period of 2000-2012 at the pixel level. In order to align the pixel level analysis with the definition of forest in Bhutan, fine scale level information on disturbance (pixel level gain and losses) were aggregated to the minimum mapping unit resulting in a larger scale element. The process was executed within a systematic grid by down sampling the product to reach the minimum mapping unit (Stibig et al., 2016). Two multi-temporal layers were created by stacking Landsat images of 2005-2009 (Landsat 7) and 2010-2014 (Landsat 7 & 8).

The segmentation for the two multi-layer stacked images was carried out in eCognition version 9.2 to achieve the minimum mapping unit of 0.5 ha. The yearly loss GFC dataset was combined with multi- temporal segmentation using zonal statistics to produce information at the polygon level. This process was executed in System for Earth observations, data access, Processing & Analysis of Land monitoring (SEPAL[15]) through a decision tree, using a full set of available libraries. The iterative computation of data for the tree canopy cover for each year was based on the following formula. Since the gain in GFC is available only for the whole period (2000-2012), the changes were assumed to be equally distributed between the different years.

$$TreeCover_{n+1} = TreeCover_{n} - Losses_{n+1} + \frac{\mathbf{Gain}}{\mathbf{14}} \qquad \text{(Equation 1)}$$

The area estimates of total and annual average deforested Area (ha) during reference period is provided in Table 2.

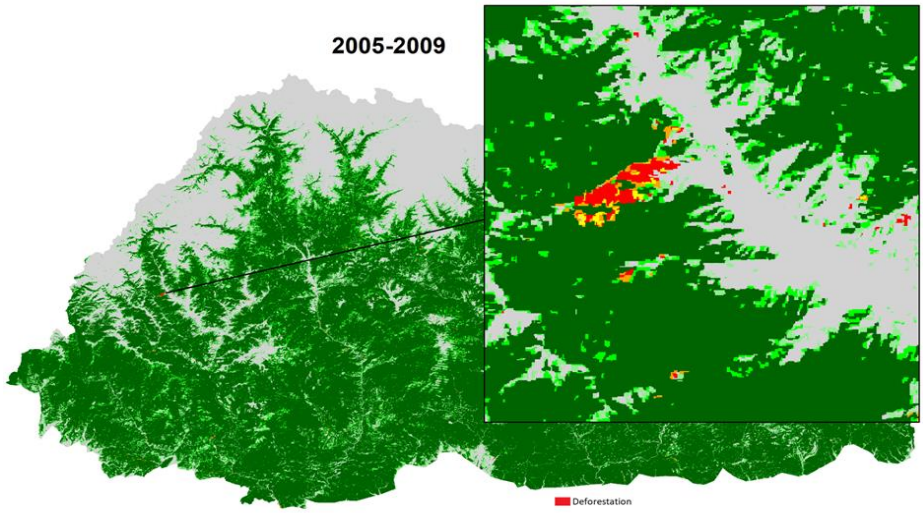

Figure 6 Deforestation map 2005-2009

[15] System for Earth observations, data access, Processing & Analysis of Land monitoring, SEPAL: https://sepal.io/

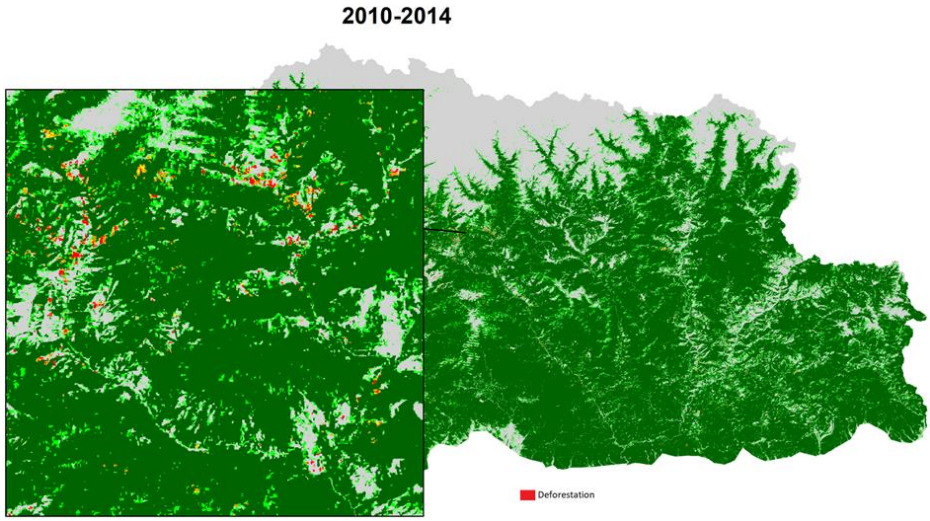

Figure 7 Deforestation map 2010-2014

The overall accuracy of the map and area estimates was carried out using the STRATIFIED AREA ESTIMATOR-ANALYSIS tool in SEPAL. An error matrix was used to compare the map classes against the reference data. The overall accuracy of the map is calculated by dividing the samples where the map and reference data agree (the bold sample counts in diagonal) divided by the total number of samples (sum of sample counts in all cells in the matrix). The overall map accuracy for 2005-2009 and 2010-2014 time period is 70% and 72% respectively.

Table 2 Area estimates of total and annual average Deforested Area (ha) during reference period

Forest land converted to	2005-2009 (ha)	Annual Average (ha)	2010-2014 (ha)	Annual average (ha)
Cropland	125.00	25.00	272.34	54.47
Grassland	312.47	62.49	363.12	72.62
Settlement	312.47	62.49	607.11	121.42
Other land	187.48	37.50	453.90	90.78
Total	**937.42**	**187.48**	**1696.47**	**339.29**

2.1.2 Monitoring Forest Carbon Stocks

The first national field-based forest assessment, referred to as the Pre-investment Survey (PIS) was carried out from 1974 to 1981 with major focus assessment of timber resources for establishing wood-based industries in the country[16]. It was driven by the need to pursue economic development in the country. PIS provided the first ground-based estimate of forest cover as well as growing stock in the country. Since then, only forest management inventories were carried out in the country which provided information at management level or about 5% of the total forest of Bhutan[17].

Bhutan committed to remain carbon neutral at the 15th Conference of Parties (CP 15) of UNFCCC at Copenhagen in 2009[18] and reported the annual net sequestration of 6.3 million tonnes of CO_2 in 2010 for the GHG inventory year 2000[19] using IPCC default factor. However, forest carbon stocks were not estimated. Thus, assessment and monitoring of forest carbon stock became paramount to validate the carbon sequestration capacity and carbon stock of Bhutan's forest and Bhutan embarked on national forest inventory. The field work for first NFI started in 2012 and completed in 2015 and field work for 2nd NFI started in July 2021 and it is anticipated to be completed by June 2022.

2.1.2.1 Inventory Design

Bhutan adopted the systematic sampling design to collect comprehensive and holistic quantitative and qualitative information on forest resources for assessment of growing stock, forest carbon stock, growth and increment, forest health and disturbance and biodiversity among others. There are 2424 sampling cluster plots laid at 4 km by 4 km grid across the landscape. Each cluster plot consists of three circular plots on a L-shaped transect spaced at 50 meters apart, called Elbow, North and East plots (Figure 8).

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[16] FRMD, Field Manual: NFI Field Manual. Thimphu (Bhutan): Department of Forests & Park Services, Ministry of Agriculture & Forests, Royal Government of Bhutan, 2020.

[17] According to the information maintained by the Forest Resources Management Division, DoFPS only about 5% of forest is managed under forest management units and community forest, for which forest inventories are conducted on regular basis.

[18] RGoB, Bhutan: In Pursuit of Sustainable Development: National Report for the United Nations Conference on Sustainable Development, 2012. (Available at https://sustainabledevelopment.un.org/content/documents/798bhutanreport.pdf, accessed on 29.01.2022)

[19] RGoB, Second National Communication to the UNFCCC, National Environment Commission, Bhutan (Available at http://unfccc.int/resource/docs/natc/snc_bhutan.pdf, last accessed on 29.01.2022).

Each circular plot has a radius of 12.62 meter with a surface area of 0.05 hectares.

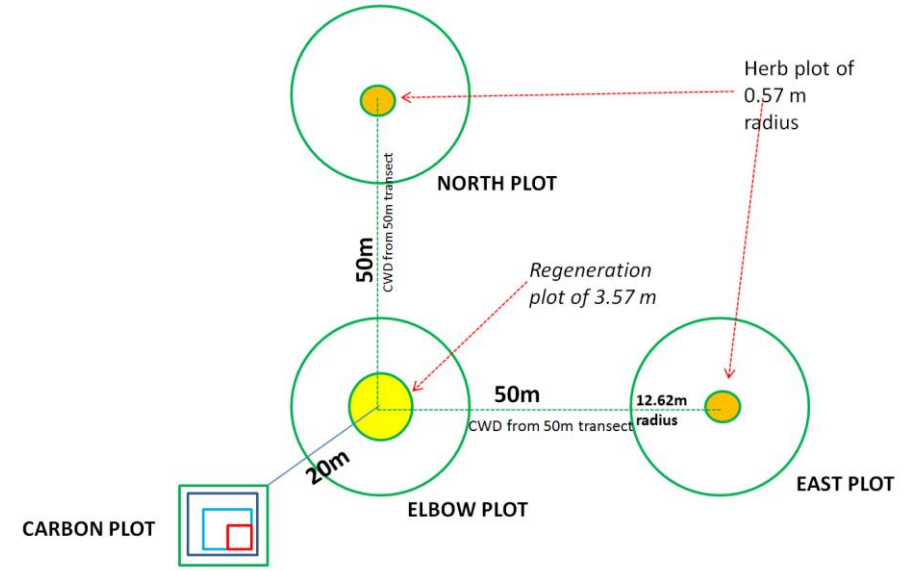

Figure 8 NFI plot design

2.1.2.2 Sampling of the carbon pools and estimation

NFI of Bhutan collects samples for following forest carbon pools for forest carbon stock assessment.

a) Aboveground Biomass: Trees, sapling, shrubs and herbs
b) Dead Wood: All fallen and dead trees
c) Litter: Litters (undecomposed)
d) Soil Organic carbon: Forest Soil

The living belowground biomass is not sampled in the Bhutan's forest inventory but the national estimate is obtained using the root to shoot ratio formula of Mokany et al. (2006) which is applied at stand level.

$$\mathbf{BGB = 0.489 \times AGB^{0.8}} \qquad \text{(Equation 2)}$$

For plot design and data collection procedures for the different carbon pools are described in detail in Field Manual NFI 2020[20].

[20] FRMD, Field Manual NFI 2020. Department of Forest and Park Services, MoAF.

The aboveground biomass of the trees and sapling are estimated using 14 species specific biomass models and two general models for broad-leaved and conifer tree species while shrubs and herbs biomass is estimated using oven dry method in laboratory drying until constant dry weight is obtained[21].

The biomass of dead wood is estimated using the biomass conversion and expansion factor while litter samples are subjected to over drying to estimate the dry matter. The soil samples are analyzed using Walkley and Black Method, and CHN Analyzer in three different layers of 0-10 cm, 10-20 cm and 20- 30 cm depth.

Bhutan also collected the tree core samples to estimate the basal area increment and are converted into annual biomass increment in forest as there was no prior data to estimate the biomass increment.

Carbon fraction of 47% is applied to biomass estimates to generate an equivalent estimate of carbon content in all biomass carbon pools which provided the base carbon stock of Bhutan's forest.

2.1.2.3 Baseline Forest Carbon Stock of Bhutan

The first NFI provided much needed information on forest carbon stock of Bhutan's forest when the detailed report was published in 2018. This report was used to generate the EF for development of forest reference emission level (FREL), forest reference level (FRL) and national GHG inventory of Bhutan for the land sector. The total carbon stock of Bhutan's forest is 645.12 million tonnes and grows annually at a 2.01 tonnes of dry matter per hectare[22]. The tables (Table 3 & Table 4) below show the baseline estimates of carbon stock in different carbon pools.

[21] Laboratory Manual for Aboveground Understory and Soil Organic Carbon Analysis published by FRMD in 2017

[22] NFI Report Volume II: https://www.dofps.gov.bt/download/2216/

Table 3 Carbon stock in different carbon pools

Carbon pools	Carbon Pool component	Biomass (t d.m. ha^{-1})	MOE	Carbon (t C ha^{-1})	MOE
Above ground	Trees	241	14	113.74	6.58
	Shrubs	1.61	0.27	0.7567	0.1269
	Herbs	0.71	0.15	0.3337	0.0705
	Sapling	26	10	12.22	4.7
BGB	Tree Roots	64.46	3.33	30.3	1.56
	Sapling roots	8.88	3.04	4.1736	1.4288
Litter	Litter	13.25	2	6.2275	0.94
Dead wood	Coarse woody Debris	6.44	3	3.0268	1.41
Soil	Soil (0-30cm depth)	Forest		64.07	4.2

Table 4 Carbon stock in different carbon pools

Carbon pools	Carbon Pool component	Total Biomass (Million tonnes)	MoE	Total carbon (Million tonnes)	MoE
Above ground	Trees	657.15	40	308.86	6
	Shrubs	4.72	0.78	2.22	16
	Herbs	2.07	0.44	0.97	21
	Sapling	72.31	28	33.99	39
BGB	Tree Roots	157.41	8.53	73.98	5.419
	Sapling roots	22.08	7.61	10.38	34.45
Litter	Litter	39.03	6	18.34	16
Dead wood	Coarse woody Debris	18.14	7.51	8.53	41
Soil	Soil (0-30cm depth)	Forest		187.85	8
				645.12	

The biomass and carbon estimates generated from the NFI are made available online. The reports can be assessed at DoFPS website[23].

2.1.2.4 Data Collection and Monitoring of Carbon Pools

NFI collects data for estimation of carbon stock of four of the five forest carbon pools. Theses pools are;

- Aboveground biomass

[23] https://www.dofps.gov.bt/reports/

- Dead Organic matter (wood)
- Dead Organic Matter (litter)
- Soil Organic carbon

The below ground carbon stock is computed using the shoot to root ratio as the collection of the data in this pool is not only expensive but also laborious.

Aboveground biomass

The aboveground biomass consists of three components

1. Trees: All trees with dbh of 10cm or more. Collect from 2424 cluster plots
2. Saplings: All trees with dbh range from 5 cm to 9.99 cm. Collected from 2424 cluster plots
3. Shrubs: destructive sampling of shrubs in 5 m x 5 m square plots in 20% of 2424 cluster plots
4. Herbs: destructive sampling of shrubs in 1 m x 1 m square plots in 20% of 2424 cluster plots

The biomass of the trees and saplings are estimated using the allometric biomass equations while shrubs and herbs are subject to laboratory drying until constant dry weight is obtained[24].

Coarse woody debris

All dead standing trees in the circular plots and down woods on the transect from Elbow plot to North Plot and Elbow Plot to East Plots are recorded. For all down woods, the biomass is obtained

Litter

The surface organic litter data and samples will be collected from a 20 cm x 20 cm plot which will be placed within the herb plot.

Soil Organic Carbon

The samples were collected from 20% of 2424 cluster plots up to depth of 30 cm from the plot laid south-west of Elbow plot center by excavation method in 10 cm by 10 cm square plot in three different layers of 0-10 cm, 10- 20 cm and 20- 30 cm. The details of the sampling design and field data collection methodology refer NFI field manual[25] and data is analyzed using Walkley and Black Method, and CHN Analyzer[26].

[24] Laboratory Manual for Aboveground Understory and Soil Organic Carbon Analysis published by FRMD in 2017

[25] NFI Field Manual, 2021

[26] Laboratory Manual for Aboveground Understory and Soil Organic Carbon Analysis published by FRMD in 2017

Accordingly, the total carbon stock of Bhutan's Forest is 645 million tonnes[27] with aboveground biomass contributing more than 70% of the total forest carbon stock. The biomass of Bhutan's forest grows annually at 2.01 t d.m. per hectare ha per year[28].

2.2.3 Greenhouse Gas Inventory

In pursuant to the UNFCCC guidelines and CP decision, Bhutan submitted initial national communication to UNFCCC in 2000, second national communication in 2010 and third national communication in 2018. In each of these communications, the national GHG inventory was carried out for the year 1994, 2000 and 2015 respectively. IPCC Guidelines 1996 was used for preparation of GHG Inventory report for 1994 and 2000, while IPCC Guidelines 2006 was used for the 2015 GHG inventory report which was submitted in 2020.

Currently GHG inventory reports of forest and other land use sectors are prepared and reported using the Approach 1 and Tier 1 method using the gain loss method in absence of the country specific carbon density. Further, it has been noted that in the first communication there is relatively small area undergoing deforestation.

Bhutan is currently preparing a biennial update report (BUR) which will be subject to the Technical Assessment by UNFCCC and International Consultative Assessment.

2.2.4 Method of Estimating CO_2 Emissions

There are two commonly used and equally robust approaches used in the GHG inventory based on availability of data. The stock change method looks at the ratio of the difference in the stock estimates at two points in time, and, gain-loss method looks at the difference in carbon density of two land use categories and the land undergoing change as AD. Bhutan currently uses the Gain Loss method in estimating the GHG emission from the forest sector. The UNFCCC recommended guidelines and IPCC guidelines are adopted for estimation of the CO_2 emissions and removals.

[27] Forestry Facts and Figures (2020), NFI Report Volume II, 2018, Forest Reference Emission Level and Forest Reference Level (2020).

[28] NFI Report II, 2018: https://www.dofps.gov.bt/download/2216/

Periodic measurement is important for estimating the future GHG emission. However, the ground-based inventories are physically challenging and very resource extensive. Therefore, there is need to develop country specific biomass allometric equations, study the specific gravity and wood density, conduct chemical analysis of tree to determine the carbon content and develop growth and yield models

2.2 Reporting

The total carbon stock of Bhutan's Forests is 645.12 million tonnes with carbon density of 170.77 tonnes per hectare and annual biomass increment of 2.01 t d.m. per hectare per year[29]. Total of 2,634 ha of forest was deforested between 2005-2014 with an average annual emission of 0.16 million tonnes CO_2. After considering the national circumstances, an upward adjustment of 0.1% biomass carbon stock spread over five years and delayed emission of soil, the benchmark emissions from deforestation are set at 0.51 million tonnes CO_2 annually[30] and Bhutan strives to maintain emissions from deforestation below this benchmark (Table 5), which is termed as National Forest Reference Emission Level (FREL).

Table 5 Forest emission reference level

REDD+ Activity	Reference period		Historical annual average emission	0.1% adjustment of carbon stock	Delayed soil emission	FREL (tCO2-e)
	2005-2009	2010-2014				
Deforestation emission (t CO_2e yr^{-1})	**110,209**	**209,352**	**159,781**	**335,331**	**10,725**	**505,837**

Further, Bhutan has also developed the separate FRL taking into account carbon sequestration on forest land remaining forest land and non-forest land converted to forest land through plantation. These activities are

[29] NFI Report II: https://www.dofps.gov.bt/download/2216/

[30] Forest Reference Level of Bhutan: https://redd.unfccc.int/files/final_bhutan_frel_frl_20201207_for_webposting.pdf

termed as Sustainable Management of Forest (SMF), Conservation of Forest Carbon Stock and enhancement of Forest Carbon Stock. The emissions from wood removals and forest fire disturbance are accounted as part of SMF and conservation of carbon stock. However, it is noted that there is no fire in the conservation areas and all emissions from fire are reported as emission from SMF. The average annual sequestration between 2005 to 2014 is 9,210,630.945 tonnes of CO_2 and average annual emission of 671,546.155 tonnes of CO_2e from timber harvesting and fire disturbance of forest. The net average sequestration (Table 6) termed as FRL is **-8,539,085.79** tonnes of CO_2 per year.

Table 6 Forest reference level

REDD+ Activity:	Emission		Removal		Net Removal		Historical average Million ($tCO_2e\ yr^{-1}$)
	Million ($tCO_2e\ yr^{-1}$)		Million ($tCO_2e\ yr^{-1}$)		Million ($tCO_2e\ yr^{-1}$)		
	2005-2009	2010-2014	2005-2009	2010-2014	2005-2009	2010-2014	
SMF	0.2873	0.2610	-6.7032	-6.4441	-6.4159	-6.1831	0.2873
SMF-Fire	0.3732	0.3440			0.3732	0.3440	0.3732
Conservation	0.0413	0.0364	-2.4232	-2.8323	-2.3820	-2.7959	0.0413
Enhancement			-0.0089	-0.0095	-0.0089	-0.0095	
FRL (tCO2e yr-1)							**-8,539,085.79**

2.3 Verification

FREL and FRL of Bhutan were submitted to the UNFCCC in 2020. The report was technically assessed by the UNFCCC experts and noted that the data and information used for constructing FREL and FRL are transparent, complete and in consistent with UNFCCC guidelines[31] including consistency with GHG inventories.

[31] https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/greenhouse-gas-inventories-annex-i-parties/reporting-requirements

SECTION 3: REDD+ STRATEGY AND SAFEGUARDs MEASURES

3.1 REDD+ Strategy and Action Plan

Bhutan has developed a National REDD+ Strategy and Action Plan (NRSAP), through an extensive consultative process, to address the drivers of deforestation and forest degradation and to enhance forest conservation and sustainable forest management for contribution towards the carbon neutrality pledge of the country. An assessment of the drivers done through "the Drivers of Deforestation and Forest Degradation in Bhutan" included the following key areas:

- Assessing drivers of deforestation
- Identifying causes of forest degradation
- Identifying the likely impacts on carbon stocks from both deforestation and forest degradation
- Assessing areas of forest subject to logging
- Quantifying degradation of carbon stocks by forest fire

Accordingly, the drivers and barriers for REDD+ activities were identified and prioritized to develop the NRSAP through an extensive consultative process. The national REDD+ strategy (NRS) has identified four strategy options that will be delivered via ten determined cross-cutting policies and measures (PAMs). The strategy presents an opportunity for Bhutan to strengthen a number of climate change response measures across a range of areas, as articulated in Policies and Measures (PAMs) in the strategy. As Bhutan is a carbon negative country with low historical deforestation and forest degradation, it is unrealistic for emissions to be substantially reduced beyond the current level. Instead, the focus is on continuing to strengthen the preservation of its existing forests and improve economy and livelihood through implementation of the REDD+ strategy. Figure 9 outlines the vision, strategy options and the PAMs as provided in the NRSAP.

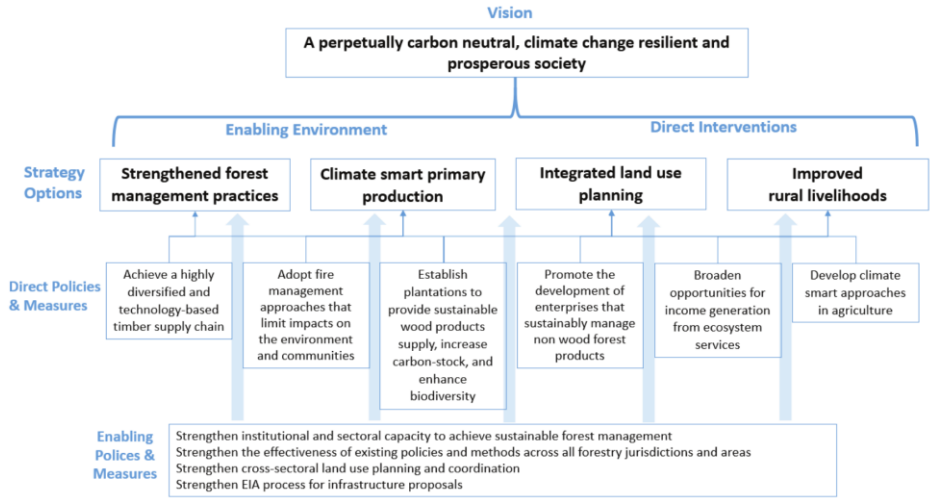

Figure 9 Outline of vision, strategy options and PAMS

Each PAM consists of a set of proposed actions, which will be implemented by different organizations/agencies. Some of these interventions are entirely new, while others seek to build on existing initiatives. It must be emphasized that from the 10 PAMs, 6 of the PAMs are direct interventions resulting in a direct change in the carbon stock, while the other 4 PAMs are enabling interventions, aimed at facilitating the implementation of direct interventions by putting in place the conditions (institutional and policy reforms, and increased human and financial resources) that will improve the likelihood of success of the direct interventions.

In this regard, PAM1 to PAM4 seek to strengthen the institutional capacity for policy development, regulatory enforcement, and operationalization of the NRS. These four enabling PAMs are essential in providing the platform for the transformative actions in PAM5 to PAM10 which focus on implementing a range of transformative actions. In the NRSAP, two out of the 52 target actions under PAMs 1.3 and 2.5 reflect capacity development and strengthening of NFMS and MRV for REDD+ with a total cost estimate of USD 2.425 million.

Costing of REDD+ Strategy has been carried out based on a combination of expert consultation involving all the stakeholders that will be implementing the respective PAMs, cost modeling, emission reductions

potential and potential monetary benefits. While the detailed cost and action plan is presented in the REDD+ Strategy document, the PAMs and budget for implementing each of them is as provided below (Table 7):

Table 7 Cost estimates to achieve each of the PAMs

Enabling PAMs	Estimate Cost (USD)	Direct Intervention PAMs	Estimate Cost (USD)
PAM 1 Developing institutional and sectoral capacity building to achieve sustainable forest management	3,000,000	PAM 5 Achieving a highly diversified and technology-based timber supply chain	5,800,000
PAM 2 Strengthening the effectiveness of existing policies and methods across all forestry jurisdictions and areas	1,670,000	PAM 6 Adopting fire management approaches that limit impacts on the environment and communities	5,000,000
PAM 3 Strengthened cross-sectoral planning and coordination	4,600,000	PAM 7 Establish plantations to provide sustainable wood products supply, increase carbon-stock, and enhance biodiversity	21,600,000
PAM 4 Harmonized EIA process to ensure infrastructure proposals are assessed and monitored as a package	1,600,000	PAM 8 Promoting the development of enterprises that sustainably manage NWFPs	1,075,000
		PAM 9 Broadening opportunities for income generation from ecosystem services	2,250,000

		PAM 10 Develop climate smart approaches in agriculture	8,000,000
Total Estimate	10,870,000		43,725,000
Grand Total, USD	**54,595,000**		

Implementing the strategy will contribute to conserving Bhutan's rich biodiversity for centuries to come for the wellbeing and happiness of Bhutanese and the global community.

3.2 REDD+ Safeguards

Social and environmental safeguards are critical in helping to ensure that the proposed strategy options and PAMs in the NRSAP are implemented successfully while ensuring that the potential risks are reduced or avoided, rights and benefits are optimized and good practices are adopted.

As part of its REDD+ Readiness process, Bhutan has developed the Safeguards framework consisting of Strategic Environment & Social Assessment (SESA), Environmental & Social Management Framework (ESMF) and Safeguard Information System (SIS). The safeguard framework identifies the possible social and environmental impacts that might arise during the implementation of REDD+ activities (SESA) and accordingly proposes the measures to minimize the negative impacts (ESMF) and finally culminating into an information system (SIS) for collection, analysis and provision of information to demonstrate that all safeguard provisions are respected or addressed. Bhutan's REDD+ safeguard framework is designed to fulfill the requirements of FCPF, World Bank, UNFCCC and Green Climate Fund (GCF) amongst others.

The review of Policies, Legislations and Regulations (PLR) indicated that the safeguard systems in the existing national PLR are in perfect complementarity to the safeguard requirements of UNFCCC, GCF and FCPF and therefore provide a solid foundation for addressing the various safeguard requirements.

SIS is a system for providing information on how the safeguards are being addressed and respected and is one of the elements to be developed by developing country parties implementing REDD+ activities (according to paragraph 71 of decision 1/CP.16). Therefore, the SIS is developed under the REDD+ framework following the guidelines set in by 'Cancun Safeguards' of UNFCCC (DoFPS, 2019) to ensure that the implementation of REDD+ PAMs do "no harm" and instead "do good" and achieve e multiple benefits.

The Cancun Safeguards

The countries implementing REDD+ activities must ensure that the following are promoted and supported;

- That actions complement or are consistent with the objectives of national forest programmes and relevant international conventions and agreements;
- National forest governance structures are transparent and effective, taking into account national legislation and sovereignty;
- Respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, national circumstances and laws, and noting that the United Nations General Assembly has adopted the United Nations Declaration on the Rights of Indigenous Peoples;
- The full and effective participation of relevant stakeholders, in particular indigenous peoples and local communities;
- That actions are consistent with the conservation of natural forests and biological diversity,
  ensuring that [REDD+] actions are not used for the conversion of natural forests, but are instead used to incentivize the protection and conservation of natural forests and their ecosystem services, and to enhance other social and environmental benefits;
- Actions to address the risks of reversals;
- Actions to reduce displacement of emissions.

Source: Decision 1/ CP 16, UNFCCC

The Cancun Safeguards provides general guidelines on safeguards systems and a great level of flexibility for countries to develop the safeguards systems taking into account the national circumstances. Besides UNFCCC safeguards guidelines, Bhutan's SIS development followed guidelines outlined by both the FCPF and GCF, since Bhutan's REDD+ activities are being supported by FCPF and GCF. Their requirements regarding SIS include:

- For the GCF Environmental and Social Safeguards (ESS), countries are required to establish procedures to monitor and measure the effectiveness of the Environmental and Social Management System (ESMS), as well as compliance with any legal and/or contractual obligations and requirements. Where appropriate, countries must consider involving affected FCPF community representatives in monitoring activities. In cases where significant impacts have been identified, countries may need to allow external experts to verify its monitoring information. Countries must use 'dynamic mechanisms' to verify the compliance and progress towards the desired outcomes. Monitoring requires recording information to track performance and comparing this to previous benchmarks.
- For the FCPF Methodological Framework, countries are required to promote the UNFCCC REDD+ safeguards, in part, though not solely, demonstrated through having a SIS in place. It also requires countries to report on the implementation of the Emission Reduction (ER) Program Safeguards Plans. Hence, the FCPF expects countries to have a SIS in place, which can provide information on compliance with both UNFCCC REDD+ safeguards and World Bank Operational Policies.

Bhutan's SIS highlights functions and institutional arrangements including identification of SIS information needs and sources in order to meet the requirements of all three, namely; UNFCCC, FCPF and GCF safeguards guidelines. The development of the SIS is an iterative process and its institutional arrangements will be flexible to evolve as REDD+ implementation is further changed and refined. The institutional arrangement for SIS, source and sharing of information and submission of

Summary of information on Safeguards to the UNFCCC has been proposed in the framework of the SIS for REDD+ in Bhutan (DoFPS, 2019).

In relation to the MRV, SIS has two safeguard requirements (safeguards 6 & 7) based on UNFCCC standards, which will help to ensure that the MRV system addresses the risk of reversals and reduce or prevent the displacement of emissions during the implementation of REDD+ activities.

SECTION 4: CHALLENGES AND WAY FORWARD

4.1 Strengthening the institutional arrangement

The institutional arrangements exist in principle and are fully operational achieving the international standards in measuring and reporting of various programs under REDD+ mechanism. Through the REDD+ Readiness process, effort was made to streamline and strengthen the existing institutional mechanism for REDD+ and related activities. However, there is still a need to improve documentation and define clear Roles and Responsibilities (R&R) of each institution and/or agencies to ensure data sharing and make information accessible.

The current practice of information gathering, management and sharing is more likely to become redundant over time with other competing priorities, limited by human and financial resources, for implementation of the forest management and conservation activities. Therefore, the current institutional arrangement has to be strengthened to facilitate smooth and timely collection and sharing of information, reporting and verification. This can be brought about by clearly defining the roles and responsibilities including the frequency of measuring and reporting as well as defining the proper communication channels. Further, R&R of each institution should be legislated and /or agreed through a memorandum of agreement.

4.2 Resource and Capacity Requirement

Bhutan has received substantial funding from the FCPF for REDD+ readiness phase and achievements are beyond the initial expectations, both in the terms of development of REDD+ Readiness documents and technical capacities. However, as we graduate from the least developed country to developing country in 2023, the donor support may diminish gradually and financing the REDD+ activities may become a major challenge with other priorities.

Although required capacity was built both at institution and individual levels during the course of REDD+ readiness implementation, there is still a capacity gap, in particular at the local level. There is also a need to continuously update the existing capacity to meet the information reporting requirement of GHG inventory. This situation is aggravated by the transfer of officials to different agencies on one hand and trained officials leaving the system after heavy investment. Therefore, activity data development of

proper financing mechanisms, human resources planning and institutional capacity building over individual capacity development needs review and further streamlining.

4.3 Stakeholder engagement plan

Stakeholder engagement is the key for the successful implementation of the MRV besides capacity building and training. However, it is common practice that the stakeholders are undervalued and quite often, consultations are suboptimal and/or disorganized. More so, the critical comments are disregarded and parties do not receive adequate time to review and comment. On the other hand, some stakeholders either do not attend the consultation or provide feedback within the stipulated time frame and issues crop up at the time of implementation. These issues could be addressed through proper stakeholder engagement planning, making the information more transparent, accessible and encouraging open discussion.

4.4 Development and Integration of database

There are two online databases hosted at the government data center, which helps to manage and monitor all forest related information for the department. One of them is a geo-spatial database (Spatial Decision Support System, SDSS[32]) that stores all the spatial layers and another is a non-spatial database (Forest Information Reporting & Monitoring System, FIRMS[33]) for collection of non-spatial information from respective forest offices. Currently, all the NFI data is stored in individual desktops and laptops, thus, the development of a database system for NFI has become very crucial. Further, integration of all these databases under one platform would enhance information extraction for efficient monitoring of LULC changes as well as to formulate real-time policies.

4.5 Generation of Activity Data

Satellite remote sensing techniques proved to be the most cost-effective approach for generation of the AD. The spatial resolution of satellite images actually determines the quality of the AD. Higher the spatial

[32] https://sdss.dofps.gov.bt/

[33] https://firms.dofps.gov.bt/

resolution of satellite images, better is the quality of data generated. However, the high-resolution satellite images are mostly commercial and come with a higher cost, making it unaffordable. The AD for Bhutan was generated using Landsat imagery, which is a moderate spatial resolution satellite imagery. The time series analysis from Landsat images depicts that historical deforestation is very low in Bhutan and the baseline emission estimated for Bhutan indicated that the deforestation rate is only about 0.1% which is one of the lowest in the region. The use of high-resolution satellite images for LULC change mapping would improve the accuracy of the change area estimates for acidity data in future.

Bhutan has produced three LULC datasets for monitoring the land use changes so far. However, the LULC maps developed were project based and driven by external funding and consistent intervals for generation of datasets were not maintained. Since all the LULC maps are generated from different satellite images with different LULC classes, the use of national LULC datasets for generation of the AD were not comparable. Therefore, there is a need to maintain consistent intervals (either annual or biannual) for generating LULC maps based on the same satellite imagery or images with the same spatial resolution to comply with the data consistency and comparability requirements of the IPCC guidelines.

Forest is subject to various forms of disturbance such as timber harvesting, fire disturbance and pest and disease infestation. The information on timber harvesting and fire disturbance are published annually, while information on pest and disease infestation is not properly reported or recorded. Further, there is risk of double or under-counting of the volume of timber harvested through sustainable forest management as the quantity is reported in different units such as number, cubic feet, or in different product forms such as standing trees, logs, lops, tops, firewood, etc. In view of this, the volume of timber harvested should be properly recorded and verified for solid volume, stack volume (e.g. firewood), whole tree and tree parts, by species, etc.

4.6 Generation of Emission and Removal Factors

UNFCCC guidance and 2006 IPCC Guidelines for National GHG Inventories encourage the use of the country specific EF for estimating the

emission and removals. Currently, 14 species specific biomass quotations and 2 general equations are used for generating the carbon stock of Bhutan's forest; there is further need of additional biomass equations for estimating the tree specific carbon.

NFI is only a national source of information for estimating the carbon stocks and carbon stock changes. However, this exercise is very resource intensive and will be difficult to repeat at regular intervals as much as desired. Therefore, the NFI cycle as well as the modality of the implementation needs to be studied without over burdening the national exchequer while national carbon stock, carbon stock changes and forest health is continuously monitored, reported and verified.

4.7 Greenhouse Gas Inventory

Third National Communication (TNC) to UNFCCC reported the emission and sequestration for the inventory year 2015. The emission from deforestation was estimated to be 203,581.817 tonnes of CO_2 while emission from wood removals and fire disturbance is estimated to be 1,426,796 tonnes of CO_2. On verification of the estimates, it observed that the FRL has not accounted the CO_2 emission from fire disturbance, which has contributed 859,285.511 tonnes of emission from forest remaining forest and for non-CO_2 emission was converted into CO_2e using AR2 in case of third NC and AR5 for FRL. These two estimates are not comparable. Therefore, there is an opportunity to ensure consistency between two estimates. While efforts are made to make the GHG inventory and FREL/FRL consistent, there is need to:

1. Model the carbon sequestration and emission from forest and other land uses
2. Estimate the harvested wood products: *Any structural timber which is harvested from the forest is assumed to be oxidized immediately after removal.*
3. Improve record keeping: *There is a high possibility of double counting and leakage in estimation of emission.*

4.8 Sustainable forest management plan

Forest management and operation inventory are regularly carried out in the forest management units, local forest management area and community

forest. And while the management areas use the same sampling strategy, they vary slightly in the method for selecting the trees that will be measured and accordingly the approach to computing the volume per ha and basal area per ha. This results in either over or underestimation of the volume per ha, basal area per ha and number of trees per ha. Standardizing the data collection methodology would result in generation of correct and consistent data for future reporting and verification.

4.9 Record Keeping

From 2015 to 2020, about 38,233.53 ha of state reserve forest land has been allotted for development activities as per the statistical data but there is no data to verify what percent of land allotted for development were forested and its impacts on the forest cover. Further, substantial forest land under private ownership is being cleared annually for agriculture production as per the data maintained with the Department. However, impact of these practices on forest cover are not documented and there is a need to assess the impact of land allotment and private land clearing on forest cover.

The incidences of pest and disease infestation of forest is frequently reported in western and central part of Bhutan. However, no proper study has been carried out to know the exact extent of forest infested by the pest and diseases and its impact on the forest cover and its dynamics. Therefore, the extent of forest damage by pests and diseases needs proper assessment and management interventions.

In an effort to enhance the carbon stock of the forests, DoFPS carried out 1000 ha of plantation[34] and more areas are expected to be brought under plantation. However, there are studies on growth models concerning the growth of the plantation. Further land use prior to plantation is poorly recorded and reported. Therefore, there is a need to enhance the monitoring of the success of the plantation and properly record initial land use prior to plantation. Further, the monitoring of plantation in terms of biomass gain and enrichment of soil carbon should be enhanced.

[34] Forest

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