Capacity Needs Assessment and Technical Capacity Enhancement for NFMS-MRV Institutionalisation in Pakistan

Final Report

TABLE OF CONTENTS

Annexes

List of Tables

ABBREVIATIONS

AD	Activity data
AFOLU	Agriculture, Forestry and Other Land Use
AJK	Azad Jammu & Kashmir (autonomous territory)
BGB	Below Ground Biomass
BN	Balochistan (province)
BRDF	Bidirectional Reflectance Distribution Function
CBO	Community Based Organization
CO₂	Carbon Dioxide
COP	Conference of Parties
DGPS	Differential GPS
EF	Emission Factor
FAO	Food and Agriculture Organization of the United Nations
FATA	Federally Administered Tribal Areas
FD	Forest Department (provincial)
FOSS	Free and Open Source Software
FREL	Forest Reference Emissions Levels
FRL	Forest Reference Levels
FSMP	Forestry Sector Master Plan
G-B	Gilgit-Baltistan (autonomous territory)
GCISC	Global Change Impact Studies Centre
GHG-I	Greenhouse Gas Inventory
GIS	Geographic Information System
GOP	Government of Pakistan
GPS	Global Positioning System
ICIMOD	International Centre for Integrated Mountain Development
ICT	Islamabad Capital Territory (federal capital territory)
IPCC	Intergovernmental Panel on Climate Change
IT	Information Technology
IUCN	International Union for Conservation of Nature
KP	Khyber Pakhtunkhwa (province)
LCCS	FAO's Land Cover Classification System
LULUC	Land Use Land Cover
LULUCF	Land Use, Land Use Change and Forestry
MBIGS	Multiple benefits, impacts, governance, safeguards
MMU	Minimum mapping unit
MOCC	Ministry of Climate Change
MOE	Ministry of Environment
MRV	Measurement, Reporting and Verification
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NGO	Non-governmental Organization
OGC	Open Geospatial Consortium

OIGF	Office of Inspector General of Forests
OBIA	Object Based Image Analysis
PB	Punjab (province)
PFI	Pakistan Forest Institute
PFRI	Punjab Forest Research Institute
QGIS	Quantum GIS
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
RS	Remote Sensing
SD	Sindh (province)
SLMS	Satellite Land Monitoring System
SOP	Survey of Pakistan
SUPARCO	Pakistan Space and Upper Atmosphere Research Commission
UNFCCC	The United Nations Framework Convention on Climate Change
WCS	Web Coverage Service
WFS	Web Feature Service
WMS	Web Mapping Service
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

This report is prepared to present the status of technical capacities of REDD+ stakeholders in the country in terms of developing and implementing the National Forest Monitoring System (NFMS) and its components. It has been conducted in scope of the assignment "Develop Forest Reference Emission Levels/Forest Reference Level and National Forest Monitoring System (NFMS) - Measurement and Reporting and Verification (MRV) System". The capacity needs assessment focuses on the institutional, infrastructure, data and human resources aspect of the components of NFMS including Satellite Land Monitoring System (SLMS), National Forest Inventory (NFI), Green House Gas Inventory GHG-I, NFMS information platform and their institutionalization.

The assessment of existing capacities[1] is based on the comprehensive consultations with the stakeholders at the provincial and national levels. With the review of existing institutional arrangement, an organizational setup framework is proposed for sustainable implementation and institutionalization of the NFMS. Based on the proposed framework and methodology for NFMS, capacity gaps and needs of the key stakeholders were identified.

Some national level, provincial and academic institutions have already good capacity for satellite-based land monitoring system and forest inventory. However, there are gaps in terms of following consistent definitions, data, coverage, standardised methodology, verification and reporting practices. Each involved institution is recommended to have their clear roles and responsibilities in NFMS implementation and they can be also expected to evolve over time

Capacity Gaps in SLMS Operationalization

Provinces have various levels of institutional capacities to implement and institutionalize SLMS functions within their monitoring workflow. National agencies such as Pakistan Space and Upper Atmosphere Research Commission (SUPARCO) and Survey of Pakistan (SOP) have well established institutional capacities and resources but are not mandated to undertake regular SLMS based monitoring to report activity data at the national or provincial levels. Academic and research institutions such as Pakistan Forest Institute (PFI) also possess institutional setup and infrastructure to undertake activities related to SLMS but lacks human resources, access to imagery data and consistent methodology.

---

[1] Prior to the undertaking of the assignment by Arbonaut LTD and WWF-Pakistan.

The assessment of existing capacities of the provincial forest departments and other relevant institutions shows capacity gaps in several areas. Though few FDs have required capabilities in terms of infrastructure, human resources and have gained relevant working experiences, there are still several common areas where the capacity gaps are visibly evident, these areas can be generalised as:

▪ Gaps in understanding of IPCC Guidance and requirements for SLMS based LULUC/activity data for consistency, completeness, comparability, transparent and accurate reporting.

▪ Inconsistent definitions used for forest and other land use categories, harmonization of definitions with national/international definitions not existent.

▪ Non-availability or usage of temporally consistent imagery data.

▪ Non-uniformity and inconsistency of procedural steps used for sampling, inventory, image processing, classification and analysis of LULUC data.

▪ Gaps in documentation of processes and steps implemented to demonstrate transparency and comparability.

▪ Gaps in robust process for accuracy, error and uncertainty assessment and area estimation and lack in technical capacity do the assessment.

▪ Gaps in IT, hardware infrastructure and software system with GIS/RS Units/Labs in the provincial FDs.

▪ Gaps in capacities to report in compliance to IPCC Guidance and REDD+ MRV requirements.

Capacity Gaps in NFI Operationalization

In general, institutional capacities for systematic NFI required for IPCC reporting compliances is found to be limited. Only few provinces and associated institutions have developed capacities to undertake independent NFI in compliance to the requirements of IPCC's forest carbon emission reporting. Due to the decentralisation of forestry sector to the provincial level (after 18th amendment of the Constitution), there has not been institutional framework to undertake the NFI at the national level until now.

Academic institutions, notably PFI and PFRI possess institutional setup to undertake activities related to NFI, including research and development of methodology, biometrics model and undertake the inventory, but still lacks trained human resources. The following assessment of capacities done during the first phase of the assignment demonstrates prevailing states of NFI institutional capacities of the focal organizations at the provincial levels.

The assessment of existing capacities relevant to the NFI of the provincial forest departments shows capacity gaps in several areas. Few FDs have required capabilities in terms of infrastructure, human resources and have gained exposure to the NFI requirements, there are common areas with capacity gaps. These areas can be generalized as:

▪ Non-availability of standardized protocol defining the methodology for NFI at the sub-national level

▪ Different methods of sample design used by different forest departments and inconsistency in variables/parameters collected in the inventory across the provinces for different forest types

▪ Lack of adequate numbers of trained human resources for the planning and design of inventory

▪ Lack of adequate numbers of trained human resources for inventory measurement, data management, analysis and reporting

▪ Non-availability or proper modern equipment for inventory measurements and data collection

▪ Non-availability of software tools and hardware for designing, planning, data management, analysis and reporting

▪ Gaps in documentation of processes and steps implemented to demonstrate transparency and comparability.

▪ Gaps in capacities to report in compliance to IPCC Guidance and REDD+ MRV requirements.

Capacity Gaps in GHG-I Operationalization

Green House Gas Inventory (GHG-I) is compiled at the national level by the Global Change Impact Studies Centre (GCISC) for reporting greenhouse gas emissions from agriculture, forestry and other land uses (AFOLU) at national level to UNFCCC.

GCISC has good infrastructural setup in terms of computer system hardware and other filed equipment. However, there are the following main gaps identified:

▪ data availability including remote sensing data,

▪ institutional coordination amongst the stakeholders, lack of comprehensive National Inventory Management System, data sharing mechanism, definition of institutional roles at the provincial and central levels, QA/QC mechanism, and lack of sector specific emissions factors, and

▪ capacity enhancements are required in advanced level GHG forest inventory analysis linking with remote sensing data and GIS, QA/QC procedures and reporting.

A capacity-building strategy and plan is presented including the training topics and contents targeted to the stakeholder categories. The training programmes for each stakeholder group can include a combination of the following means:

- degree programmes

- internship programmes

- short courses

- study tours / field exchange visits

- seminars / workshops

- conferences

- consultancies

- practically oriented on-job-training

.

1. INTRODUCTION

1.1. Capacity Building in the context of UNFCCC Framework

UNFCCC COP Decision 2/CP.13 "encourages all Parties, in a position to do so, to support capacity-building, provide technical assistance, facilitate the transfer of technology to improve, inter alia, data collection, estimation of emissions from deforestation and forest degradation, monitoring and reporting, and address the institutional needs of developing countries to estimate and reduce emissions from deforestation and forest degradation." COP further invites the Parties and relevant international organizations to enhance capacity building in relation to IPCC guidance and guidelines and to the development and assessment of reference levels (UNFCCC 2015a).

UNFCCC under its frameworks defines capacity-building as enhancing the ability of individuals, organizations and institutions in developing countries and in the countries with economies in transition to identify, plan and implement ways to mitigate and adapt to climate change. UNFCCC also defines three levels of capacity-building (UNFCCC 2015c) viz.

▪ Individual: developing educational, training and awareness raising activities;

▪ Institutional: fostering the development of organizations and institutions, including their missions, mandates, cultures, structures, competencies and human and financial resources as well as the cooperation between organizations, institutions and sectors;

▪ Systematic: creating enabling environments through economic and regulatory policies and accountability frameworks in which institutions and individuals operate.

In 2001 UNFCCC COP adopted the framework for capacity-building under the Convention that addresses the needs, conditions and priorities. There was also provided a set of guiding principles and approaches to capacity building. The guiding principles emphasized on 'country-driven' process involving 'learning-by-doing' and building on existing activities. The frameworks also set a way forward for capacity building activities, such as developing and strengthening skills and knowledge and providing opportunities for stakeholders and organizations to share their experience, increase their awareness to enable them to participate more fully om the climate change process(UNFCCC 2015c).

1.2. Capacity Needs Assessment and Capacity Enhancement Framework Development Methodology

During the REDD+ readiness phase the report *entitled Capacity Based Need Assessment* (by Hussain et al. 2014) has detailed the capacity gaps in scope of the National Forest Monitoring System in Pakistan. The subsequent Action Plan for the Implementation of the National Forest Monitoring System of Pakistan by (Jehangir et al. 2015) has outlined a framework of action plan, also addressing the capacity building needs.

In scope of the assignment "Develop Forest Reference Emission Levels/Forest Reference Level and National Forest Monitoring System (NFMS)-Measurement and Reporting and Verification (MRV) System", a capacity gaps and needs assessment was carried out again during the initial phase of the project in 2017. The capacity needs assessment focused on the institutional, infrastructure, data and human resources aspect of the components of NFMS viz. Satellite Land Monitoring System (SLMS), National Forest Inventory (NFI), Green House Gas Inventory GHG-I, NFMS information platform and their institutionalization.

Capacity needs assessment was undertaken through participatory consultations involving focussed group discussions, key informant interviews and field observations of the existing processes and institutional setups. The capacity needs and technical capacity enhancement framework design and development process is outlined in Table 1.

Table 1 Capacity needs assessment and technical capacity enhancement *framework process.*

Stage	Design and Development Process	Timeline
Stage 1	**Desk Reviews** ▪ Review of National Capacity and Needs Assessment (by Hussain et al. 2014). ▪ Review of Action Plan for the Implementation of the NFMS of Pakistan by (Jehangir et al. 2015)	
Stage 2	**Participatory Consultation** ▪ Stakeholders' discussion on National Circumstances and Forest Monitoring ▪ Stakeholders' discussion on Land Cover, Activities and Forest Definition	Inception Workshop (13-14 February 2017)

Stage 3	**Capacity Needs Assessment** • Key stakeholder consultation meetings at MOCC National REDD+ Office, Provincial FDs, PFI and other stakeholders • Key Informant Interviews on National Forest Inventory (NFI) • Key Informant Interviews on Satellite Land Monitoring System (SLMS) • Key Informant Interviews on Green House Gas inventories (GHG-I)	Visits to Provincial FD's, national and provincial stakeholders, academic institutions, other stakeholders (March-June 2017)
Stage 4	**Assessment of Existing Systems/Institutional Capacities** • Assessment of existing system being implemented at provincial level (KP and G-B) and by supporting institutions (PFI) • Assessment of international best practices	July-August 2017
Stage 5	**Development of SLMS and NFI** • Design, development and piloting of SLMS and NFI for Pakistan • Development of SLMS and NFI Protocol	August-October 2017
Stage 6	**Capacity Building** • Training of SLMS and NFI protocol to REDD+ national and provincial stakeholders • Feedback and inputs from the participating stakeholders on SLMS and NFI design	August-November 2017
Stage 7	**Development of Institutional Framework** • Development of Institutionalisation Framework • Development of action plan for technical capacity enhancement for institutionalization of NFMS and its components	March – June 2018

1.3. Scope and Contents of this Document

This document is prepared to present the status of technical capacities of REDD+ stakeholders in the country in terms of developing and implementing the National Forest Monitoring System (NFMS) and its components. The assessment of existing capacities[1] is based on the comprehensive consultations with the stakeholders at the provincial and national levels. With the review of existing institutional arrangement, an organizational setup framework is proposed for sustainable implementation and institutionalization of the NFMS. Based on the proposed framework and methodology for NFMS, capacity gaps and needs of the key stakeholders were identified.

A capacity-building strategy was developed, and corresponding trainings were designed and delivered to the stakeholders at various stages of the assignment. Action plan for technical capacity building for sustainability and implementation of the NFMS at provincial level is proposed.

This report is presented to guide the future technical capacity and institutional enhancement programs especially related to implementation of NFMS and its components under the REDD+ initiative at the national and provincial levels. This report contains six associated chapters giving as brief overview of existing capacities, capacity requirements for the new NFMS, capacity enhancement initiatives undertaken under this assignment and further action plan for the long-term sustainability of NFMS and its implementation at the provincial levels.

---

[1] Prior to the undertaking of the assignment by Arbonaut LTD and WWF-Pakistan.

2. ASSESSMENT OF EXISTING CAPACITIES AND GAPS

Under the framework for the development of FREL/FRL and National Forest Monitoring System for MRV in Pakistan, an assessment was made for institutional framework, existing capacities in terms of infrastructure; data availability; human capacity to process, analyse and report; human capacity to verify data. The following sub-section summarizes the capacity assessment for SLMS, NFI and GHG-I conducted under this assignment.

2.1. National Framework and Institutional Mandates for NFMS

2.1.1. National Definition of Forest

The different definitions of forest are being used at provincial levels in Pakistan. Until recently there has not been existing a consistent definition of forest throughout all the provinces and by various organizations involved in mapping of land use/land cover (LULUC) and forests. The summary of assessment[1] of the usages of forest definitions by various provinces is shown in the following table:

Table 2 Forest definition parameters used by various organizations

SN	Organizations/Institutions	Min. Area (ha)	Crown Cover (%)	Height (m)
1	Forest Department, AJK	2.0	30	N/A
2	Forest Department, FATA	0.05	10	2
3	Forest Department, G-B	0.5	10	2
4	Forest and Wildlife Dept. Balochistan	N/A	N/A	N/A
5	Forest Department, KP	0.05	10	2
6	Pakistan Forest Institute (PFI)	0.05	10	2
7	Forest Department, Punjab	N/A	N/A	N/A
8	Forest Department, Sindh	N/A	N/A	N/A

2.1.2. Existing National and Sub-National Forest/Land Use Mapping Products

Under this project a detailed review of relevant land use and cover data has been undertaken to assess the applicability and relevance of their

---

[1] Assessment done based on the group discussions during kick-off workshop on 14th February 2017 in Islamabad and subsequent Key Informant Interviews at the Provincial Forest Departments

usages for determining the baseline for FREL/FRL required for REDD+ in the country. The identified national and sub-national initiatives and datasets are listed in Table 3 and Table 4.

Forestry Sector Master Plan (FSMP) in 1992, adopted remote sensing techniques to prepare nation-wide land use and cover map of Pakistan. FSMP defined six land use and cover categories to represent land mass area of the country. Few other nation-wide land use and cover classification exercises were undertaken between 2000 to 2012, notably by the National Land Use Plan 2004, National Forest and Rangeland Resources Assessment Study 2004, and most recently, by Land Cover Atlas of Pakistan 2012, both by the Pakistan Forest Institute.

Besides these national studies and mapping exercises, there are several land-use, land cover, carbon stock assessment and change analysis exercises completed. They have been conducted by different government and non-governmental organizations such as Pakistan Forest Institute (PFI), Space and Upper Atmospheric Research Commission (SUPARCO), International Center for Integrated Mountain Development (ICIMOD), World Wide Fund, Pakistan (WWF-Pakistan), International Union for the Conservation of Nature (IUCN); and researchers at micro-level covering valleys, watersheds, protected areas, provincial, district or sub-districts (Government of Pakistan 2015).

WWF-Pakistan conducted land use and cover study and mapping for 54 districts during 2010 using Landsat 5 TM and Landsat 7 ETM+ imageries, adopting FAO's Land Cover Classification System (LCCS) based classification system. WWF-Pakistan also conducted provincial level forest cover mapping for KP, FATA and G-B in 2009-2010. FAO and SUPARCO prepared Land Cover Atlas of Pakistan for the provinces of Punjab, Sindh, Khyber Pakhtunkhwa (KP) and Federally Administered Tribal Areas during (FATA) 2014-2016. These provincial atlases used Spot-5 high resolution images and adopted FAO's LCCS classification approach.

Among various research studies, ICIMOD has conducted a study and mapped deforestation and forest degradation patterns in the Western Himalayan region of Pakistan. This study by (Qamer et al. 2016) has mapped time series forest and land covers of 1990, 2000 and 2010 and assessed deforestation and forest degradation in Khyber Pakhtunkhwa (KP), Gilgit-Baltistan (G-B) and Azad Jammu & Kashmir (AJK).

Table 3 Summary of land-use and cover and forest types in previous nationwide mapping products

Land Use/Land Cover Product/Year	Land Use/land Cover Classes	Forest Types
Forestry Sector Master Plan (FSMP), 1992	Forest, Agriculture land, Rangeland, Barren land (including snow/glacier), Water bodies, Urban, and Unclassified lands	Coniferous Forest, Scrub, Riverain, Mangroves, Irrigated Plantation
Land Use Atlas of Pakistan, National Land Use Plan Project (NLUP), 2004	Forest, Rangeland, Agriculture land, Bare soil, Exposed rocks, Desert, Built-up area, Waste land, Water bodies, Snow/glacier	Coniferous Forest, Scrub, Riverain, Mangroves, Plantation
National Forest and Rangeland Resources Assessment Study (NFRRAS), 2004	Forest and Rangelands	Coniferous Forest, Scrub, Riverain, Mangrove and Plantation
Land Cover Atlas of Pakistan, 2012	Forest, Shrubs and bushes, Rangelands, Snow and glaciers, Agriculture lands, Barren lands, Fruit orchards, Settlements, Water bodies	Alpine pasture, Sub Alpine, Dry Temperate, Temperate (Oak), Moist Temperate, Sub-tropical Chir Pine, Sub-tropical Broad-leaved Evergreen, Tropical Thorn, Plantation (including irrigated and un-irrigated), Riverain, Mangrove

Some differences in the forest area and land area can be observed in all the foregoing statements and tables. This might be due to the differences occurring in the conflict zones (for example, in AJK, G-B, and FATA) that border with Indian-held territories and Afghanistan where even well-referenced GIS datasets are not in agreement with one another. This may also be because of the different boundaries used by, for example the UN agencies or the Survey of Pakistan when both the agencies define boundaries in accordance with their own mandates. Moreover, the official territorial area of Pakistan excludes G-B and AJK.

In terms of differences in area of land use and cover classes, each of these studies have adopted different definitions (especially forest) and classification schemes (Table 3), used different materials (satellite data) and have adopted different approaches of mapping. These have most likely contributed to significant variations in area calculations. Therefore, it is imperative that the definition, data and method for land use and land use change estimation are consistent overtime.

At the sub-national (provincial) level, various satellite imagery-based mapping products have been developed. These products also inherently have used different definitions, source data, and methods. Both the national and sub-national mapping products, however lacked proper assessment of uncertainties introduced during data processing, analysis and reporting. Proper documentation on methodological approach in processing, analysis, reporting and data management is also lacking both at the national and provincial levels. Summary of sub-national level mapping products is presented in Table 4.

Table 4 Summary of land use/land cover and forest types used in previous sub-national works

Land Use/Land Cover Product/Year	Land Use/land Cover Classes	Forest Types
District Wise Forest Cover Assessment – WWF Pakistan (2007-2010)	Forest, Agriculture land, Soil/Rock, Water, Build-up Areas, Shadow (unclassified)	Mixed Broad- leaf/Scrub/ Shrubs, Riverine Forest, Dense Conifer Forest, Mixed Broadleaf, Conifer, Sparse Riverine Forest, Sparse Mixed Broad-leaf/Scrub
Land Cover Atlas of Pakistan – PD, SD, KP and FATA (2014-2016)	Orchard, Crop Irrigated, Crop Marginal and Irrigated Saline, Crop in Flood Plan, Crop Rainfed, Forest-Natural Trees and Mangroves, Natural Vegetation in Wet Areas, Range Lands - Natural Shrubs and Herbs, Built-up, Bare Areas, Bare Areas with Sparse Natural Vegetation, Wet Areas, Snow and Glaciers	Natural Trees and Mangroves
District Wise Natural Resource Database of Khyber Pakhtunkhwa, 2008	Forests, Shrubs & Bushes, Rangelands, Agriculture, Fruit Orchards, River Beds, Water Bodies, Canal, Glacier & Snow, Settlements, Barren Land	Conifer Forest, Broad Leaved Forest, Riverain Forest, Scrub Forest, Mangrove Forest, Plantation
District Wise Land Cover Atlas of Punjab (2012-2013)	Forests, Agriculture Land, Desert, Built-up Area and Water Bodies	Irrigated Plantations, Scrub, Coniferous, Riverain, Rangeland, Mixed
Forest Carbon Inventory of Gilgit Baltistan, 2016	Natural Forest, Farm Forest, Agriculture Land, Pastures/Rangeland, Winter Pastures, Water Bodies, Built-up Area, Snow/Glacier Rocks/Barren Land (Harmonized to IPCC Classes Forest, Cropland, Grassland, Wetlands, Settlements, Other Land)	Forest types: Dense Conifer, Dense Broadleaved, Dense Mix, Sparse Conifer, Sparse Broadleaved, Sparse Mix Farm Forest types: Linear/Block Plantation/Orchard
Forest Cover Mapping of Forests of Khyber Pakhtunkhwa, 2017	Forest	Sub-Alpine, Temperate, Dry Temperate (Oak), Subtropical Pine, Subtropical Broad-Leaved, Dry Tropical Thorn

9

2.1.3. *Institutional Setup and Mandates*

Formal and legal institutional mandates to undertake forest and emission monitoring related activities is mandatory in order to exercise the obligations of national and sub-national authorities and institutions to support national monitoring and reporting to UNFCCC. Formal mandates also necessary so that the authorities can orientated to building their capacities in terms of financial, infrastructural and human resources to conduct the forest monitoring activities.

At the national level, there is not any regular authority for the national forest cover assessment on a regular basis. The institutional arrangements at the federal level for forest monitoring have been limited to the role of coordination and policy advice after the 18th amendment in the constitution of Pakistan in 2012 (Hussain et al. 2014). Only the provincial forest departments are mandated for regular monitoring and assessment of forests within their jurisdictions. At the provincial level, forest circles and divisions within the forest departments are mandated to undertake regular inventory for the sole purpose of preparation and update of the Working Plans.

Several provincial forest departments also carry mandates to map and monitor forest resources and land cover/land use and have established functioning GIS/Remote Sensing Units to undertake the mapping works. However, due to the lack of resources including financial and human resources, necessary hardware and software system, data and materials and consistent methodology, the system of regular monitoring is not uniform in all the provinces and with non-existence in some provinces. Therefore, though those institutional mandates exist, lack of institutional capacities in terms of technical aspects of REDD+ MRV and lack of resources required to implement also do exist.

Academic institutions such as the Pakistan Forest Institute (PFI) and Punjab Forest Research Institute (PFRI) do have certain capacities and institutional setup to implement REDD+ MRV components. However, these institutions are academic institutions and do not necessarily have mandates to undertake MRV components on their own. Though, these institutions have been partnering with the provincial authorities providing advisory and technical support to undertake forest inventory and satellite-based forest monitoring activities, notable in KP and GB.

During 2017-2018, provinces have revised or in process of revising their forest policies and acts/rules to legally incorporate various components of REDD+ MRV including SLMS and NFI as their institutional mandates and have also initiated measures for institutional arrangements to implement SLMS and NFI. KP, in its REDD+ Strategy has proposed to build its own Provincial Forest Monitoring System (PFMS) to meet the requirements of UNFCCC and integrate with the NFMS.

Provincial forest departments have formally established REDD+ Management Units with responsibilities for the implementation and

monitoring of REDD+ activities at the provincial, district and local levels (INDUFOR/ChiP Traning and Consulting 2018). These also serve as the main focal points for operational coordination between the provincial and federal REDD+ institute (National REDD+ Office) and is mandated to draft provincial REDD+ strategy and standards including the development of NFMS in conformity with the national system and standards.

2.2. Capacities and Gaps in SLMS

Satellite Land Monitoring System (SLMS) is one of the core pillars of NFMS MRV functions. This chapter describes the prevailing states of SLMS institutional capacities of the major stakeholders at the national and provincial levels. The detailed capacity assessment checklist is presented in Annex 1 of this report

Consultations and key informant interviews for the assessment of capacities related to the development and implementation of SLMS in the provinces were undertaken during March-August 2017[1]. A synopsis can be drawn on the existing state of the institutional capacities and gaps in SLMS.

Provinces have various levels of institutional capacities to implement and institutionalize SLMS functions within their monitoring workflow. National agencies such as SUPARCO and SOP has well established institutional capacities and resources but are not mandated to undertake regular SLMS based monitoring to report activity data at the national or provincial levels. Academic institutions such as PFI also possess institutional setup and infrastructure to undertake activities related to SLMS but lacks human resources, access to imagery data as well as do not have consistent methodology.

AJK Forest Department has institutional mandate for mapping, field inventory and working plan but no specific mandate for development of SLMS based LULUC activity data or regular monitoring under MRV. Institutional capacity in terms of system infrastructure, human resources, standard operating protocol is also lacking. There is a limited technical capability for undertaking general LULUC mapping and field-based forest inventory.

GB Forest Department has a well-established mandate to undertake SLMS based activity data generation and regular monitoring. The department also has well established Remote Sensing and GIS Section/Unit integrated with inventory unit and manned by an

---

[1] Consultations on SLMS capacities could not be conducted with Sindh and FATA Forest Departments as these department as relevant personnel to response were not available.

academically qualified and trained GIS expert. However, the department do not have supporting GIS/RS Analyst, operators or IT personnel to support mapping and data management works. GB FD has good technical competency in image processing, analysis and production of LULUC data with field inventory/ground truth data, validation and accuracy assessment. However, there is limited technical capacity for reporting in compliance to IPCC reporting. The department also possess good system infrastructure in terms of computer hardware and IT. Licensed commercial GIS and RS software is not available. Field equipment such as GPS is limited in numbers to conduct provincial level field inventory or validation.

Khyber Pakhtunkhwa Forest Department has institutional mandate for SLMS based LULUC/activity data development and regular monitoring including inventory, mapping and reporting. FD has well established operational GIS/RS Lab under the Planning and Monitoring Circle with qualified GIS Expert, GIS Analysts and GIS Operators in required numbers. Computer and IT infrastructure is available but requires upgrading to perform SLMS based workflows. Field equipment such as handheld GPS is also available in adequate numbers to conduct inventory and validation ground truthing. Licensed GIS and RS software are available, though not in adequate quantities. The GIS/RS Lab has good capacity image data acquisitions, processing and classification/analysis, field data collection and validations using sampling method and GPS. FD, however, has limited capacity in SLMS reporting following IPCC Guidelines. KP also has technical support from Pakistan Forest Institute (PFI). PFI has well established GIS/RS Lab with required system hardware and software and technical capacities.

Punjab Forest Department is mandated to undertake SLMS based LULUC and activity data, inventory, reporting and NFMS at provincial level. The department also has well established independent SLMS Section/Unit comprising of combined GIS/RS Lab with required human resources including SLMS expert, RS analyst, GIS analyst, GIS Operators, IT expert, system engineers and trained surveyors. Computer and IT infrastructure are also adequate to undertake provincial level SLMS workflow. FD also possesses high end DGPS survey equipment and has recently acquired mapping grade professional UAV for monitoring the plantations. However, FD lacks licensed newer versions of RS/GIS software. Expertise are available for imagery data acquisition, processing and analysis including field data collection for SLMS based data development. However, the department lacks capacities for reporting under IPCC Guidelines. Additionally, FD has developed web-based forest management information system (MIS) integrating WebGIS application in the MIS platform.

Balochistan Forest Department do not have legal mandate to undertake SLMS based LULUC and activity data development and regular monitoring. FD also do not have institutional setup for implementing SLMS. However, FD has cooperation with IUCN Pakistan to provide them with technical support in project basis. Though the scale of support and cooperation for provincial level SLMS based works is not known. IUCN has its institutional mandate to undertake SLMS based works at project/study area level. IUCN also has well established institutional setup with GIS/RS Lab in their Quetta Office, headed by a qualified and well-trained GIS Coordinator. IUCN GIS/RS Lab is equipped with good capacity hardware and licensed commercial software as well as sufficient number of field equipment such as GPS. Good technical capacity is available for acquisition, processing and analysis of satellite data for producing LULUC data products. Capacity is also available for undertaking field inventory and validation ground truthing works, uncertainty analysis and area estimation.

In Sindh the provincial Forest Department do not have institutional mandate to undertake and implement SLMS based LULUC and activity data monitoring (Hussain et al. 2014). Further, there is no operational GIS/RS Lab in the department to undertake SLMS related works. However, Sindh FD has established working cooperation with WWF-P, IUCN and SUPARCO, capable of providing technical expertise and services on project needs basis. Cooperation with these institutions for continual support and technical assistance for continuous SLMS based data generation and monitoring is not understood.

FATA Forest Department has not had formal mandate or the capacities to undertake SLMS based works.

SUPARCO at the national level, has been supporting provincial FDs and other institutions to access low cost commercial satellite imagery such as SPOT-5 as well as providing post processed imagery products to the users, including FDs. SUPARCO has technical capacities, system infrastructure and outreach to support the provincial FDs to undertake SLMS works continually. Provincial FDs, which do not yet have their capacities may collaborate with SUPARCO to enhance their capacities as well as establish SLMS based workflow as necessary in the future.

2.2.1. *Azad Jammu and Kashmir - Forest Department*

Satellite imagery-based data products, availability and accessibility	Technical Capabilities (Institutional Setup, Human Resources and Capabilities)	Technical Capabilities (Infrastructure, computer system, software, IT)
▪ Forest/land cover mapping being undertaken (in progress) with limited resources and limited technical expertise ▪ Mapping exercise being done for the year 2016-17 covering the province using Spot 5 image of 2009 with limited ground truthing field data and visual interpretation method using toposheets and Google Earth as references ▪ Limited field data related to wood volume and number of trees used as ground truthing ▪ Legal definition under Forest Act used (≥2 ha / 5 Acre area and ≥30% crown cover) ▪ No standardized international land use categories defined. Provincial definitions of land use categories. Forest stratified based on types and density. ▪ No standardized procedural guideline or protocol for LULUC mapping	▪ Institutional mandate for inventory, mapping, reporting and preparation of working and management plan, but no mandate for SLMS based LULUC/activity data ▪ No proper institutional arrangement and setup to undertake SLMS ▪ Very limited qualified/trained human resources - 1 personnel attended short course/workshop related to GIS ▪ No existing technical competencies in any process of SLMS ▪ Some technical competency in field data collection for ground truthing and validations using sampling and GPS ▪ No technical competency in IPCC guidance for SLMS reporting	▪ 2 Pentium 4 desktop computers in working conditions ▪ Plotter and printers in working conditions ▪ 2 units of DGPS and 30 units of handheld GPS ▪ Power backup in the office ▪ GIS software (unlicensed)

▪ Documentation of procedure, accuracies, uncertainties and areas estimates not done for LULUC product ▪ Maps and data products are not available publicly yet but intends to make it open data once ready		

2.2.2. *Gilgit-Baltistan – Forest Department*

Satellite imagery-based data products, availability and accessibility	Technical Capabilities (Institutional Setup, Human Resources and Capabilities)	Technical Capabilities (Infrastructure, computer system, software, IT)
▪ Forest cover, land use /land cover, forest type, forest crown density and biomass have been produced for the year 2015-16 covering the province using Sentinel-2 imagery of 2016 and carbon field inventory data. ▪ Accuracy assessment, uncertainties and area estimation has not been made/no proper procedure available ▪ Forest and land use change have not been produced ▪ FAO's forest definition used (≥0.5 ha area, ≥10% crown cover, ≥2m height)	▪ Institutional mandate for SLMS based LULUC/activity data including inventory, mapping and reporting ▪ Institutional Setup - Combined inventory, remote sensing and GIS section/unit ▪ GIS Expert (1 person) with Masters in GIS and Remote Sensing and trained in INPE, PFI, ICIMOD, SUPARCO ▪ Good technical competency in image data acquisitions, processing and classification/analysis	▪ 2 nos. of Intel Xeon workstations in working conditions ▪ 1 no. of I7 laptops/field computer in working conditions ▪ Printers in working conditions ▪ Good internet connectivity (512 mb) ▪ 2 nos. of external HDD of 1TB each ▪ 2 units of handheld GPS ▪ Power backup in the office ▪ GIS software (unlicensed) ▪ Image processing and analysis software (unlicensed)

▪ IPCC's Good Practice Guideline used for the definitions of other land use categories ▪ IPCC's Good Practice Guideline used as standard procedural guideline for forest cover/LULUC mapping ▪ MMU of 0.5 ha used, image enhancement process, segmentation and OBIA and post classification procedures followed using commercial software ▪ Stratified random sampling method adopted for carbon inventory and ground truthing field data (with circular plots of 17.84 radius). ▪ 2.5m Spot-5 (2012-14) and Google Earth image used as reference ▪ Reports and maps are in progress to be published (digital available during the CNA) ▪ Data and maps will be available publicly (digital and analog) through Data Usage MoU ▪ Satellite data available: sharable Sentinel-2, 2016 and SPOT5, 2012-14 single license non-sharable	▪ Good technical competency in field data collection for ground truthing and validations using sampling and GPS ▪ Limited technical capacity of IPCC guidance for SLMS reporting	

2.2.3. *Khyber Pakhtunkhwa – Forest Department and PFI*

Satellite imagery-based data products, availability and accessibility	Technical Capabilities (Institutional Setup, Human Resources and Capabilities)	Technical Capabilities (Infrastructure, computer system, software, IT)
- Forest cover for the year 2016 covering the province have been produced using Spot-5 of 2012 and carbon field inventory data. - Land use/land cover and district natural resources management (NRM) database 2007 - Land cover (1996-2008) using Landsat image - Forest and land use change have not been produced - Province specific forest definition used (≥0.05 ha area, ≥10% crown cover, ≥2m height) - Provincial/organizational guideline for forest/land use/land cover map - Forest stratification based on climatic conditions and floristic composition (using DEM) and sub-stratification based on crown cover (CC) - Forest crown cover classified as dense (>50% CC) and remaining as sparse (10-50% CC) through visual	- Institutional mandate for SLMS based LULUC/activity data including inventory, mapping and reporting - Institutional Setup – operational GIS/RS Lab in the Planning and Monitoring Circle of KP Forest Dept. and PFI - GIS Expert (1 person) with Masters in GIS and Remote Sensing Lab - GIS Analyst (5 persons) in GIS and Remote Sensing Lab - GIS Operators (8 persons) in GIS and Remote Sensing Lab - GIS Expert (2 persons) with Masters in GIS and Remote Sensing in PFI GIS Lab - Good technical capacity in image data acquisitions, processing and classification/analysis - Good technical capacity in field data collection for ground truthing	**GIS/RS Lab at KP Forest Dept.** 1 nos. of server 1 nos. of high end workstation (needs upgrading) 13 nos. of desktops in working conditions 3 nos. of laptop/field computers 2 nos. of large format printers/plotters in working conditions - LAN and Wi-Fi - Internet connectivity (shared) 18 units of handheld GPS - Power backup in the office - GIS software (2 License) Image processing and analysis software (Licensed) **GIS/RS Lab at PFI** 20+ nos. of desktops in working conditions - Printers in working conditions

interpretation of reference 100x100m grids	and validations using sampling and GPS	Good internet connectivity
IPCC's Good Practice Guideline used for the definitions of other land use categories	Limited capacity of IPCC guidance for SLMS reporting	2 units of handheld GPS
IPCC's Good Practice Guideline used as standard procedural guideline for forest cover/LULUC mapping		Power backup in the office
MMU of 0.05 ha used, image enhancement process, segmentation and OBIA and post classification procedures followed using commercial software		GIS software (Licensed)
Stratified random cluster sampling (1 PSU and 4 SSUs in a cluster@200 x 200m) method adopted for carbon inventory and ground truthing field data (with cluster sample circular plots of 17.84m radius)		Image processing and analysis software (Licensed)
2.5m Spot (2012-14) and Google Earth image used as reference		
Reports and maps are in progress to be published (digital available during the CNA)		
Data and maps will be available publicly (digital and analog) through Data Usage MoU		

2.2.4. *Punjab – Forest Department*

Satellite imagery-based data products, availability and accessibility	Technical Capabilities (Institutional Setup, Human Resources and Capabilities)	Technical Capabilities (Infrastructure, computer system, software, IT)
▪ Forest cover, forest type, forest crown density, forest change maps for the year 2017 covering the province is being produced using Pleaides and Spot-5 of 2015. ▪ Forest cover change of Changa Manga Irrigated Plantation (2005,2010,2015) in progress using Pleaides/Spot-5 and land cover change (1960-2011) using aerial photographs, Landsat and Spot images have been produced (2012-13) ▪ No standard definition of forest and other land uses ▪ No standard procedural guideline for forest cover/LULUC mapping ▪ MMU not defined, but mapping done at compartment level ▪ Pre-processed imagery acquired through SUPARCO. Visual interpretation and supervised classification using commercial software. Change analysis using NDVI and crown density change analysis.	▪ Institutional mandate for SLMS based LULUC/activity data including inventory, mapping, reporting and NFMS also including planning, monitoring and evaluation ▪ Institutional Setup – independent SLMS Section/Unit consisting of combined GIS/Remote Sensing Lab ▪ SLMS Expert (1 person) with MPhil in GIS and training in GIS/RS ▪ Remote Sensing Analyst (1 person) with MPhil in Geomatics with training in GIS/RS ▪ GIS Analyst (3 persons) with MPhil in GIS/RS ▪ GIS Operators (3 persons) with MPhil in GIS ▪ IT/MIS Expert (1 person) with MSc. in IT	**GIS/RS Lab at Punjab Forest Dept.** ▪ 2 nos. of Server in operational condition ▪ 7 nos. of I7 desktops in working conditions ▪ 2 nos. of laptops/field computers ▪ Large format printer/plotter in working conditions ▪ No LAN connectivity ▪ Good internet connectivity (512 mb) ▪ Power backup in the office ▪ 1 unit of DGPS in operational condition ▪ GIS software (unlicensed) ▪ Image processing and analysis software (Unlicensed) ▪ Web-GIS and spatial database in development using open source platforms

Post processing using commercial software. Error matrix and accuracy assessment using random sampling ground truthing data. ▪ Reports and documentation of procedure are in progress ▪ Data, maps and reports will be available publicly free and online ▪ Satellite data available: SPOT-5 and Pleaides, Organizational license and non-sharable	▪ System Developer (3 persons) with MSc in GIS ▪ System Engineer/Administrator (1 person) ▪ Surveyors (4 person) DAE Surveying ▪ Good technical capacity in imagery data acquisition (open data or commercial) ▪ Good technical capacity in image processing and analysis using commercial software ▪ Good technical capacity in field data collection for ground truthing and validations using sampling and GPS ▪ No required capacities of IPCC Guidance and SLMS reporting	

2.2.5. Balochistan – IUCN Pakistan

Satellite imagery-based data products, availability and accessibility	Technical Capabilities (Institutional Setup, Human Resources and Capabilities)	Technical Capabilities (Infrastructure, computer system, software, IT)
▪ Forest cover, land use/land cover, forest crown density, forest change, land use/land cover change maps covering study area in Ziarat (2005-2010 using Spot-5 and 2016 using Sentinel-2) and Gwadar (1989-2010 using Landsat) and ground truthing. ▪ No standard definition of forest and other land uses ▪ No standard procedural guideline for forest cover/LULUC mapping ▪ MMU not defined ▪ Pre-processed imagery acquired through SUPARCO and ER Solutions. Visual interpretation and supervised and OBIA classification using commercial software. Change analysis using commercial software. Post processing using commercial software. Error matrix and accuracy assessment using existing ancillary survey maps and field GPS data	▪ Institutional mandate for SLMS based LULUC (at project/study area level) ▪ Institutional Setup – Combined GIS/Remote Sensing Section/Unit ▪ GIS Coordinator (1 person) with Masters in IT and trainings in RS and GIS from various organizations (WWF, Peshawar University, IST, ESRI/NASA) ▪ Good technical capacity in imagery data acquisition (open data or commercial) ▪ Good technical capacity in image processing and analysis using commercial software ▪ Good technical capacity in field data collection for ground truthing and validations using sampling and GPS ▪ Good technical capacity in LULUC data production,	**GIS/RS Lab at IUCN, Quetta Office** ▪ 3 nos. of Xeon Workstations in operational conditions ▪ Large format printer/plotter in working conditions ▪ LAN connectivity ▪ Internet connectivity ▪ Power backup in the office ▪ 1 nos. of external HDD (1 TB) ▪ 5 unit of handheld GPS in operational condition ▪ Arc GIS software (Single Licensed) ▪ Image processing and analysis software Erdas Imagine (Single Licensed)

21

▪ No reports and documentation of procedure and accuracy assessment ▪ Data, maps and reports will be available publicly through purchase or open data license ▪ Satellite data available: SPOT-5 Organizational license and non-sharable	validation, uncertainty analysis and areas estimate ▪ No required competencies of IPCC Guidance and SLMS reporting	

2.2.6. Capacity Gaps in SLMS Operationalization

The assessment of existing capacities of the provincial forest departments and other relevant institutions shows capacity gaps in several areas. Though few FDs have required capabilities in terms of infrastructure, human resources and have gained relevant working experiences, there are still several common areas where the capacity gap is visibly evident, these areas can be generalized as:

- Gaps in understanding of IPCC Guidance and requirements for SLMS based LULUC/activity data for consistency, completeness, comparability, transparent and accurate reporting.

- Inconsistent definitions used for forest and other land use categories, harmonization of definitions with national/international definitions not existent.

- Non-availability or usage of temporally consistent imagery data.

- Non-uniformity and inconsistency of procedural steps used for sampling, inventory, image processing, classification and analysis of LULUC data.

- Gaps in documentation of processes and steps implemented to demonstrate transparency and comparability.

- Gaps in robust process for accuracy, error and uncertainty assessment and area estimation and lack in technical capacity do the assessment.

- Gaps in IT, hardware infrastructure and software system with GIS/RS Units/Labs in the provincial FDs.

- Gaps in capacities to report in compliance to IPCC Guidance and REDD+ MRV requirements.

2.3. Capacities and Gaps in NFI

National Forest Inventory (NFI) is the other core pillar of NFMS-MRV functions. Provincial Forest Departments have been conducting forest inventories for the preparation of Management Plans/Working Plans though the inventory processes have not been consistent and standardized among all the district or provinces. Heterogeneity in forest types, ranging from the alpine in the Northern Himalayas, arid scrubs in the deserts and mangroves in the coastal region have attributed to the design and applications of various methods. Available institutional capacities and human resources in the provinces have also contributed in adoption of various methods.

In general, institutional capacities for systematic NFI required for IPCC reporting compliances is found to be limited. Only few provinces and associated institutions have developed capacities to undertake independent NFI in compliance to the requirements of IPCC's forest carbon emission reporting. Due to the decentralisation of forestry sector to the provincial level (after 18th amendment of the Constitution), there has not been institutional framework to undertake the NFI at the national level until now.

Academic institutions, notably PFI and PFRI possess institutional setup to undertake activities related to NFI, including research and development of methodology, biometrics model and undertake the inventory, but still lacks trained human resources. The following assessment of capacities done during the first phase of the assignment demonstrates prevailing states of NFI institutional capacities of the focal organizations at the provincial levels.

A detailed capacity assessment checklist is presented in Annex 2 of this report. This assessment is based on the consultations and interviews with key informants for the assessment of capacities related to the development and implementation of NFI in the provinces. The consultations were undertaken during March-August 2017[1]. Following synopsis can be drawn on the existing state of the institutional capacities and gaps in NFI:

▪ Only KP, GB, Punjab and AJK Forest Departments have certain capacities to undertake forest inventory following their own methodology.

▪ AJK Forest Department has mandate to undertake forest inventory and mapping works to prepare working plans of the forests. The department has been conducting inventories at the forest block levels to estimate the commercial timber volume. Such inventories are conducted in an interval of 10-15 years covering 1 plot per acre area at the sampling intensity of 1 percent. Inventory measurements are done establishing randomly sampled Temporary Sample Plots (TSPs) and quality control measurements. The standard procedure of the inventory is documented, with the latest in the Working Plan of June 2017.

▪ GB Forest Department is mandated to undertake inventory, mapping, reporting and preparation of working and management plan. The department is undertaking biomass inventory and sub-national level along with capacity enhancements with the support of PFI and ICIMOD. Stratified random sampling has been adopted to establish Temporary Sample Plots. Field inventory measurements also included measurements of parameters using been GPS for plot locations and vertex for heights. FD has trained human resources but are in limited numbers. Enhancements of human capacities are required in planning and designing, inventory data collections, QA/QC, data analysis and reporting as well as to generate data related of the drivers of deforestation and degradation. Computer hardware, software licenses and establishment of soil lab is also deemed necessary for operationalization of provincial level NFI.

▪ KP Forest Department is mandated to conduct forest inventory for above ground biomass, biodiversity and commercial timber volumes. FD with the technical support from PFI has conducted the carbon stock assessment of the province in compliance to the sub-national level reporting requirements for IPCC. The sampling design adopted stratified random sampling to

---

[1] Consultations on NFI capacities were conducted with KP, AJK, Punjab and GB Forest Departments only as other Forest Departments did not have established inventory units that could respond to the technical assessment.

establish cluster sample plots and measurements using GPS, hypsometer, relascope and other modern equipment. The provincial FD has limited number of trained human resources at planning and operational levels of NFI. Enhancements of capacities in planning and sampling design, forest inventory measurements, data management, calculations and analysis, QA/QC is required to operationalize NFI as a regular activity for provincial level MRV. Further upgrading of computer hardware and necessary software is also required for fully operational NFI in the FD.

▪ Punjab Forest Department is mandated to undertake forest inventories for timber management, fuel wood and plantations activities for both commercial and non-commercial purposes. Forest inventories are undertaken in irrigated and non-irrigated plantations (including linear plantations) to prepare management plans. The FD has adequate number of qualified and trained human resources including a separate GIS Lab capable to support the sub-national level NFI. The FD also has sufficient quantity of field and measurement equipment, though modern equipment such as relascope, vertex transponders is not available. For the full operationalization of sub-national NFI following a consistent methodology, capacity enhancements in planning and designing of sampling, inventory measurements, carbon and GHG inventory, QA/QC, analysis and reporting is deemed necessary. Upgrading of computer hardware and licensed software is also required.

2.3.1. *Azad Jammu and Kashmir Forest Department*

Forest Inventory Protocols, Data, Models and Tools	Technical Capabilities (Institutional Setup, Human Resources and Capabilities)	Capacity Needs
- Periodic forest inventory being undertaken to prepare Working Plans with limited resources and limited technical tools - Procedural guideline exists (in some form including standard data collection sheet) for forest stratification, sampling design, measurements, calculations and Q/A to prepare/update Working Plans for commercial timber harvesting, however not for forest resources or carbon inventory - Random sampling to establish 1 sample plot per 1-acre area (1% intensity) Temporary Sample Plots to estimate timber volume - Sampling design is done manually using available topographic sheets (generally outdated) and no software tools have been used - Standard forest inventory protocol in compliance to the reporting requirements of IPCC yet to be prepared	- Institutional mandate for inventory, mapping and preparation/update of Working Plan. Inventory being undertaken for commercial timber volume estimation - Institutional arrangement and setup to undertake forest inventory for timber volume estimation - Qualified/trained human resources available but limited in numbers - 4 personnel with MSc in Forestry (DFOs) with training in forest inventory - Lack of trainings in carbon stock, biomass and GHG inventory - Limited availability of measurement equipment including handheld GPS, diameter/linear tapes, compass, clinometer, camera and others - Non-availability of height measurement equipment such as	- Human capacity enhancement for forest inventory planning and design - Human capacity enhancement for forest inventory measurements - Human capacity enhancement for calculations, analysis and uncertainty assessment - Human capacity enhancement for QA/QC processes and reporting - Upgrading of computer hardware and availability of licensed software - Requirement of inventory equipment

Documentation of recent/current inventory not done yet (but planned after the completion of the works)	relascope, hypsometer or vertex and densitometer • Non-availability of soil sampling kits and laboratory facilities	

2.3.2. *Gilgit-Baltistan – Forest Department*

Forest Inventory Protocols, Data, Models and Tools	Technical Capabilities (Institutional Setup, Human Resources and Capabilities)	Capacity Needs
▪ Forest inventory for aboveground biomass being undertaken to measure DBH, height, slope, aspect of terrain, crown cover of different forest types (coniferous and broadleaved) ▪ Forest inventory design using stratified random sampling to establish circular Temporary Sample Plots for forest carbon undertaken during (2015-2016) including quality control measurements supported by PFI and ICIMOD ▪ Procedural guideline for forest stratification, sampling design, measurements, calculations and Q/A being prepared and documented ▪ Forest stratification based on remote sensing data, LULUC maps and secondary GIS data using GIS software ▪ Field inventory and measurements undertaken using digital calliper, hypsometer, GNSS, vertex and recorded in paper/digital form	▪ Institutional mandate for inventory, mapping, reporting and preparation of working and management plan ▪ Ongoing biomass inventory at sub-national level, piloting projects for REDD+ strategies, capacity enhancements of forest personnel, coordination with national and international organizations for REDD+ related activities ▪ Institutional Setup - Combined inventory, remote sensing and GIS section/unit ▪ REDD+ Coordinator (1 person) with MSc in Forestry and trained in Forest Inventory in PFI and ICIMOD ▪ GIS Expert (1 person) with Masters in GIS and Remote Sensing and trained in INPE, PFI, ICIMOD, SUPARCO ▪ Good technical competency in image data acquisitions, processing and classification/analysis ▪ Good technical competency in field data collection for ground truthing and validations using sampling and GPS	▪ Upgrading and capacity enhancement of human resources in inventory planning and design ▪ Human resources and capacity enhancement in forest inventory measurements ▪ Capacity enhancements in Carbon accounting and GHG Inventory and uncertainty assessment capacity needed ▪ Capacity enhancements in QC/QA, analysis, reporting ▪ Capacity enhancement to generate data on drivers (forest fire, fuel wood, natural hazards etc.) ▪ Computer hardware and software need to be updated/licensed ▪ Soil analysis capacities and laboratory infrastructure

▪ Allometric models, wood densities, volume tables, conversion and expansion factors developed using MS excel, R scripts etc. ▪ Independent plot measurements for QA	▪ Limited technical capacity for FREL/FRL, NFMS, carbon accounting and GHG inventory ▪ Availability of handheld GPS, relascope, measurement tapes, soil sample kits, camera and vertex in limited quantities	

2.3.3. *Khyber Pakhtunkhwa – Forest Department*

Forest Inventory Protocols, Data, Models and Tools	Technical Capabilities (Institutional Setup, Human Resources and Capabilities)	Capacity Needs
▪ Forest inventory for above ground biomass, biodiversity and commercial timber for working plans ▪ Forest inventory design using systematic sampling/line transit and random checking ▪ Procedural guideline for forest stratification, sampling design, measurements, calculations and Q/A documented in the working plan code and forest manual ▪ Forest stratification based topographical map sheets ▪ Field inventory and measurements undertaken using calliper, hypsometer, and recorded in paper form ▪ Allometric models, wood densities, volume tables, conversion and expansion factors available ▪ Forest inventory calculations done in MS Excel	▪ Institutional mandate for inventory for above ground biomass, biodiversity and commercial timber at division/ sub-division level ▪ Limited number of trained human resources DFO, range officers (18, only 4 are working), foresters (9) and forest guards ▪ Limited availability of handheld GPS, relascope, measurement tapes, hypsometer, clinometer, compass ▪ Lab facilities available in PFI	▪ Upgrading and capacity enhancement of human resources in inventory planning and design ▪ Human resources and capacity enhancement in forest inventory measurements ▪ Capacity enhancements in Carbon accounting and GHG Inventory and uncertainty assessment capacity needed ▪ Capacity enhancements in QC/QA, analysis, reporting ▪ Computer hardware and software need to be updated/licensed

2.3.4. *Punjab – Forest Department*

Forest Inventory Protocols, Data, Models and Tools	Technical Capabilities (Institutional Setup, Human Resources and Capabilities)	Capacity Needs
▪ Forest inventory for biodiversity and commercial timber for working/management plans and subdivision and range levels conducted every 5 years ▪ Temporary Sample Plots of 1km rectangular size established and 2-3 plots measured in a range to cover all the species for plantations ▪ Forest inventory design using systematic sampling/line transit and random checking ▪ Procedural guideline for forest stratification, sampling design, measurements, calculations documented in the management plan ▪ QA/QC measurements not implemented	▪ Institutional mandate for inventory for forest management plans required for timber management, fuel wood, plantations activities (for both commercial and non-commercial purposes) ▪ Separate GIS Lab is well established to support ▪ PFRI Faisalabad also capable to support ▪ Adequate number of qualified human resources with 5 personnel with MSc in Forestry, 1 personnel with MSc In Environmental Science and 1 personnel with BSc in Forestry with various trainings in GIS/RS, Forest management, biomass estimation ▪ Availability of handheld GPS, calliper. Diameter tapes, hypsometer, liner tapes, compass, clinometer, soil sample kit, camera and others ▪ Soil laboratory facilities not-available	▪ Capacity enhancements of human resources in inventory planning and design ▪ Capacity enhancement in forest inventory measurements ▪ Capacity enhancements in Carbon accounting and GHG Inventory and uncertainty assessment capacity needed ▪ Capacity enhancements in QC/QA, analysis, reporting ▪ Computer hardware and software need to be updated/licensed ▪ Infrastructure development is needed in PFRI, Faisalabad to support inventory

2.3.5. Capacity Gaps in NFI Operationalization

The assessment of existing capacities relevant to the NFI of the provincial forest departments shows capacity gaps in several areas. Few FDs have required capabilities in terms of infrastructure, human resources and have gained exposure to the NFI requirements, there are common areas with capacity gaps. These areas can be generalized as:

▪ Non-availability of standardized protocol defining the methodology for NFI at the sub-national level.

▪ Different methods of sample design used by different forest departments and inconsistency in variables/parameters collected in the inventory across the provinces for different forest types.

▪ Lack of adequate numbers of trained human resources for the planning and design of inventory.

▪ Lack of adequate numbers of trained human resources for inventory measurement, data management, analysis and reporting.

▪ Non-availability or proper modern equipment for inventory measurements and data collection.

▪ Non-availability of software tools and hardware for designing, planning, data management, analysis and reporting.

▪ Gaps in documentation of processes and steps implemented to demonstrate transparency and comparability.

▪ Gaps in capacities to report in compliance to IPCC Guidance and REDD+ MRV requirements.

2.4. Capacities and Gaps in GHG-I

Green House Gas Inventory (GHG-I) is being undertaken at the national level by the Global Change Impact Studies Centre (GCISC) to report greenhouse gas emissions from agriculture, forestry and other land uses (AFOLU) at national level to UNFCCC. GCISC is the mandated national entity (through GCISC Act 2013) responsible for the study on the impact of climate change (CC) and AFOLU, devise plausible adaptation to counter the negative effects of CC, recommending climate smart practices in AFOLU, preparation of GHG-I and mitigation potential assessment, policy advice to the Ministry of Climate Change. The earlier Ministry of Environment with the support of GCISC has submitted the Initial National Communication (INC) to UNFCCC in 2003. The Second National Communication (SNC) was under preparation during the consultation in August 2017.

▪ GCISC has used 1996 Revised IPCC Guideline for National Greenhouse Gas Inventories (96GL) and Greenhouse Gas Inventory Software for non-Annex I Parties (NAIIS) by the UNFCCC for the INC submission. For the SNC

submission, GCISC is following 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006GL).

▪ The reporting adopted definitions of land use land use changes following 2006 IPPC Guidelines, Vol.4: Agriculture, Forestry and Other Land Use (AFOLU). GHG accounting adopted Approach 1 (net areas associated with land use) for deforestation, degradation, sustainable forest management assessment. Plantations (both linear and riverine) were accounted for carbon stock enhancement.

▪ Terrestrial carbon pools included only Above Ground for Tier 1 reporting. GHGs included CO_2, CH_4 and N_2O for Tier 1 reporting. Default Emission factors (EF) as per IPCC guidelines are used.

▪ GHG-I was compiled using existing data from the National Forestry Resource Assessment (NFRA), Maanics International study, Food & Agriculture Organization (FAO).

▪ In terms of institutional capacities, GCISC has human resources with technical competencies in GHG-I using UNFCCC software and reporting following IPCC Guideline.

▪ GCISC also has good infrastructural setup in terms of computer system hardware and other filed equipment. However, there is a gap in data availability including remote sensing data.

▪ Gaps are also identified in institutional coordination amongst the stakeholders, lack of comprehensive National Inventory Management System, data sharing mechanism, definition of institutional roles at the provincial and central levels, QA/QC mechanism, and lack of sector specific emissions factors.

▪ Capacity enhancements are required in NFI preparation, advance level GHG forest inventory analysis linking with remote sensing data and GIS, QA/QC procedures and reporting.

▪ The 7th Meeting of Steering Committee on REDD+ held on 9th April 2018 at the MOCC has made a decision to include GCISC as a member of the National REDD+ Steering Committee. The meeting also made decision to the data and GHG-I registry to be hosted (housed) at the GCISC. These decisions have mandated GCISC to host the NFMS portal and associated data.

3. NATIONAL FOREST MONITORING SYSTEM AND INSTITUTIONAL FRAMEWORK

A National Forest Monitoring System (NFMS) is one of the elements to be developed by the Parties implementing REDD+ activities as recommended in paragraph 71 of Decision 1/CP.16 (UNFCCC 2015b). NFMS is consisted of methodological and institutional arrangement frameworks to monitor forests for REDD+ and other needs in accordance with guidance by the UNFCCC COP decisions.

REDD+ Measuring, Reporting and Verification (MRV) forms a core function of the NFMS. A robust NFMS should provide data and information that are transparent, consistent over time, and are suitable for measuring, reporting and verifying anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks and forest-area changes resulting from the implementation of the activities. The effectiveness of the REDD+ strategies and interventions can be measured and prioritized among the most significant emission sources reported and verified independently. The NFMS-MRV systems are to be consistent with guidance on measuring, reporting and verifying nationally appropriate mitigation actions by developing country Parties agreed by the Conference of the Parties, taking into account methodological guidance in accordance with Decision 4/CP.15.

The NFMS institutionalization process involves defining institutions and their mandates, developing and formalizing processes and methodologies in the context of the national and sub-national NFMS activities:

1. Institutions: Defining which institutions are involved in national and sub-national NFMS activities and what their respective roles and responsibilities are and how they should interact, how to intervene in case of challenges and who bears overall responsibility
2. Processes: Defining the overall process of collecting, processing, reporting and verifying data. This includes determining which role individual institutions play in this process.
3. Methodologies and tools: Identifying and developing standardized methodologies and tools required to collect, process and store data. The methodologies and tools are needed for NFI, SLMS, Multiple benefits, Impacts, Governance and Safeguards (MBIGS) monitoring and GHG-I.

Additionally, the resulting institutional arrangements should comply with the following criteria:

a. A solid, sustainable network of institutions with the required variety of expertise;
b. Clearly documented roles and responsibilities with a single body assigned for overall coordination;
c. Good coordination and clear lines of communication;
d. Continuity of staff and succession planning;
e. High level of ownership by the participating stakeholders; and
f. Efficient use of existing institutions and frameworks to minimize establishment and operational costs.

The main NFMS institutional roles can be classified as following:

a. National Focal Point with the overall responsibility for coordinating the REDD+ MRV function and liaising with the UNFCCC (Decision 10/CP.19);
b. Institutional Body to manage the work of institutions and organizations; and have overall responsibility for the coordination of administrative and technical arrangements, and the overall quality of reported estimates;
c. Mandated Institutions to perform specific tasks and provide data.

The institutional arrangements should establish frameworks for:

a. Formalizing mandates for data acquisition, processing and sharing amongst relevant institutions to avoid duplication of efforts;
b. Maintaining documented processes for quality assurance and quality control, to ensure the quality datasets (e.g. for spatial data and carbon pool measurements);
c. Continuous improvement including documentation of opportunities for improvement and process for the inclusion of such improvements;
d. Retaining skilled staff through appropriate and ongoing training and environments to encourage staff retention;
e. Securing adequate budgets to support the initial development of the MRV function as well as the ongoing operation and development

Each involved institution is recommended to have their clear roles and responsibilities, which are expected to evolve over time. Table 5 indicates the responsible, partner and co-learner institutions for each NFMS function in Pakistan. The proposal was drawn after assessing the mandates, capacities and interests for the named institutions during the provincial consultations and technical working group meetings held. The international and national organizations include WWF, IUCN, ICIMOD among other international entities. The National Steering Committee has endorsed the institutional roles including GCISC being the NFMS database and web portal host in its 7th session.

Table 5 NFMS functions and institutional roles.

Function	Responsible institution	Partner and co-learning institutions
Preparation, approval and national level monitoring of finances related to REDD+ interventions	MoCC /Pakistan Climate Change Authority/ National Steering Committee on REDD+	Provincial representatives for NCCA/ NRO
NFMS/MRV Coordination	MOCC/OIGF/National REDD+ office[1]	Provincial (or State) Forest Departments
NFI data production	Provincial (or State) Forest Departments	PFI
SLMS data production	Provincial (or State) Forest Departments	PFI, SUPARCO
GHG-I	GCISC	National REDD+ Office (forest sector data)
MBIGS	National REDD+ office	Provincial REDD+ Management Units
Independent verification, QA/QC	National REDD+ office	PFI, SUPARCO, SOP, International and National Organizations
NFMS Database and Web Portal Hosting	GCISC	MOCC
Data Ownership (primary data)	Provincial Governments	Provincial (or State) Forest Departments
Data Custodianship	GCISC	MOCC
Training and capacity-building	PFI (NFI) SUPARCO (SLMS)	Institute of Space Technology, Universities, International and National Organizations
Methodology and System Development	REDD+ technical working group	International and National Organizations[2]

---

[1] The functions of the NRO will be taken over by the Pakistan Climate Change Authority established under Section of the Climate Change Act, 2017.

[2] The referred international and national organizations include WWF, IUCN, and ICIMOD among other international commercial or non-commercial entities.

4.   CAPACITY BUILDING TRAINING

Capacity building in scope of the NFMS/MRV and FREL/FREL development assignment focused on enhancing the institutional capacities of provincial FDs and other relevant stakeholders through developing and institutionalizing standardized procedure for generating SLMS based activity data and emission/removal factors. The integrated SLMS and NFI processes were designed, piloted and implemented to fulfil the requirements of emission reporting in compliance to IPCC guidance. SLMS and NFI methodology was designed considering the existing capacities and built upon the approaches already implemented in the country. Methodologies for SLMS and NFI were expected to be developed using freely available imagery data and Free and Open Source Software for inventory design, sampling, data management, remote sensing, GIS and data analysis.

Standard Operating Procedure (SOP) documents and manuals have been developed to ensure systematic and consistent implementation of the processes. Since several trainings have been conducted following the SOP documents for SLMS and NFI for the National REDD+ Office and provinces on calculation of carbon stock, GIS, remote sensing, field verification of emissions/removals at various stages of the works. Further training lectures have been conducted for GHG-I the process and NFMS operation/administration. Institutional capacity building trainings conducted were:

1. National Forest Inventory Training Organized by Arbonaut Ltd, 21-25 August 2017 in Joensuu Finland
2. Satellite Land Monitoring System Training Organized by Arbonaut Ltd, 4-8 September 2017 in Joensuu Finland
3. National Forest Inventory Training Organized by the National REDD+ Office, 16-19 October 2017 in Islamabad, Pakistan
4. Satellite Land Monitoring System Training Organized by the National REDD+ Office and PFI, 20-23 November 2017 in Peshawar, Pakistan
5. Forest Reference Level training session by Arbonaut Ltd. in scope of the Technical Working Group Meeting in 12 June in Islamabad, Pakistan
6. Green House Gas Inventory Training by Arbonaut Ltd and WWF, 11 June 2018 in Islamabad, Pakistan
7. National Forest Monitoring System User's Training by Arbonaut Ltd and WWF-P, 11 June 2018 in Islamabad, Pakistan

Based on the organised training events the topics and general contents recommended for the future short courses to support the NFMS institutional development are presented in the following sections.

4.1. Training in SLMS

Satellite Land Monitoring System (SLMS) trainings cover contents on the following topics:

1. Satellite Imagery Acquisition and Processing

- Searching/exploring and downloading imagery online (for temporal Landsat)
- Atmospheric and Bidirectional Reflectance Distribution Function (BRDF) Corrections of imagery
- Image mosaic and subsets

2. Sampling Design and Visual Interpretation of Samples for Land Use/Forest Stratification

- Designing of a two-phase systematic sampling scheme
- Visual Interpretation and Stratification of Phase I Sample Points using Open Foris Collect Earth for LULUC Classes and forest parameters (crown density, disturbances, changes etc.)

3. Sample Set for Image Training and Validation

- Region of Interest for image classification
- Generating training and validation subsets

4. Image Classification

- Image classification using Random Forests Machine Learning Algorithm

5. Post Classification Processing

- Post classification processing

6. Accuracy Assessment, Uncertainty Analysis and Area Estimation

- Accuracy assessment sampling
- Construction of area proportionate error matrix
- Calculating User's, Producer's, Overall Accuracies, Variances and Confidence Interval
- Calculating Standard Error
- Calculating Area Estimation and Confidence Interval
- Summary Result

7. Change Analysis for LULUC

- Pixel to pixel matching using Multi-Alteration Detection Algorithm
- Post classification LULUC analysis
- LULUC analysis and activity data calculations

4.2. Trainings in NFI

National Forest Inventory capacity building training cover the following contents:

1. Identification of the inventory objectives and constraints

- Purpose
- Scale
- Variables under interest
- Accuracy requirement
- Availability of skillful human, financial resources and time
- Preparing the sampling and estimation design
- Stratification
- Plot shape and size
- Sample size
- Plot allocation

2. Inventory protocol

- Personnel and training
  - Team member qualifications and roles
  - Team management
  - Training
- Planning of logistics
  - Equipment
  - Transport
  - Accommodation
  - Safety
  - Communication
- Field measurements
  - Field form design
  - Sample plot positioning
  - Biomass measurements
  - Biodiversity measurements
  - Quality assurance and control
- Data cleansing and database entry
  - Excel
  - Open Foris Collect

3. Inventory calculation and reporting

- Handling the incomplete observations

- Software tools (Excel, R)

- Tree-level data

  - Diameter-height model
  - Allometric volume and biomass models

  - Carbon modelling

- Post-stratification of the plots
- Plot level results aggregation by the strata
- Error and uncertainty estimation

4. Wall-to-wall inventory map products

- Combination of remote sensing and field measurement data

4.3.   Training in GHG-I

Green House Gas Inventory (GHG-I) capacity building training includes:

1. Introduction of IPCC GHG-I Inventory Software

- Orientation of IPCC GHG-I Inventory Software
- Installation of IPCC GHG-I Inventory Software

2. Data Entry of Reference Year (2016)
- Creation of new inventory for reference year 2016
- Creation of forest with sub-categories and other land use categories and theory coefficients from the NFI and secondary sources
- Entry of land area data for each classes and changes (Forest Land Remaining Forest Land for base year 2006) and Other Land Uses Converted to Forest Land
- Average wood density for each forest stratum based on NFI and secondary data

3. Analysis of LULUC

- Summary analysis of land use conversion matrix
- Calculation of annual increase in carbon stocks in biomass (AGB and BGB carbon stock due to biomass growth)
- Calculation of Loss of carbon from wood removals
- Calculation of Loss of carbon from disturbance
- Calculation of estimated fraction of biomass lost in disturbance

4. Presentation and Visualization of Results

- Generation of time-series view of historical presentation of the emissions from forest sector
- Generation of worksheet for emissions

4.4. Training in NFMS Webportal Operation

National Forest Monitoring System (NFMS) users' capacity building training includes:

1. User Privileges and Accounts

- Account registration and user access control (UAC) grants
- Managing profiles for updating and viewing account information

2. Document and Datatypes

- Types of documents and datasets: Layers, Maps and Documents
- Exploring Data Layers
- Creating customized Maps using NFMS data Layers and other WMS layers
- Publish text and tabular data, documents, manage metadata

3. Searching

- Searching layers, documents and maps using texts, keywords, date, region or extent

4. Managing Layers

- Uploading Layers
- Downloading Layer Information and details
- Sharing Layers anonymously or via social media
- Adding external layers
- Creating empty layers

5. Editing Layers Styles

- Style editing for custom maps

6. Managing Maps

- Creating a custom Map
- Styling Layers
- Sharing your map

7. Using NFMS with Other Applications

- OGC WMS, WFS and WCS
- Integrating with ArcGIS, QGIS, Google Earth etc.

8. Selecting and Generating Reports

- OGC WMS, WFS and WCS
- Integrating with ArcGIS, QGIS, Google Earth etc.

9. GeoNode DJANGO Administration Panel Management

5. STRATEGY AND ACTION PLAN FOR TECHNICAL CAPACITY ENHANCEMENT

A capacity-building strategy and plan is needed to enable long-term capacity and continuous evolvement of the National Forest Monitoring System (NFMS). The provincial FDs are expected to take an active role in sub-national data collection, analysis and reporting tasks to make the National Forest Monitoring system operational. The REDD+ office should follow-up production and updating methodological standards and guidelines. The methodological guidelines are to be reviewed by the REDD+ technical working group meetings and other sessions.

In the core ministries, departments private sector, training and research bodies, NGOs and CBOs, there are people who have not been involved in REDD+ readiness work but have still some in-depth knowledge of many technical aspects and fields relevant to NFMS. Besides forestry departments there are other sectors such as agriculture, livestock, forestry and energy stakeholders to be considered in the capacity-building strategy. The REDD+ technical capacity building should eventually reach down to the REDD+ project area level, so that all the line civil servants understand REDD+ process and implementation issues.

Table 6 NFMS training programme objectives and means recommended for each stakeholder category.There should be implemented a standard set of training materials and guidelines so that all the trainers throughout Pakistan would have the same standard training package on the NFMS topics. When it comes to local capacity building needs some differentiation is required on training materials. **Table 6** presents the recommendations for capacity building training programme objectives and means by stakeholder categories.

Table 6 NFMS training programme objectives and means recommended for each stakeholder category.

Stakeholder category	Training objective	Means
Government officials	▪The responsible federal and provincial government departments have capacity to manage and conduct the processes associated to them as NFMS functions including NFI, SLMS, FREL/FRL, MBIGS and data inputs for the GHG-I process.	▪ The officers in charge of the NFMS functions have relevant background preferable from academic training institutions and the skills are evaluated during the recruitment process. ▪ Short-courses for upgrading technical skills organised by the universities and/or other training institutions. ▪ Active organisational roles and participation in the REDD+ TWG development activities with participation of the national and international

		expert/research institutions. ▪ Field visits facilitated by the provincial departments and collecting the lessons learnt from the REDD+ project sites. ▪ International study tours and exchange visits to learn about the best practices adopted in other countries. ▪ Forest guards participating on-job-training for measurement, monitoring verification and reporting of the emission and removals activities at the compartment level (i.e. forest inventory measurements; monitoring timber, fuel wood removals and disturbances)
Decision-makers	▪Understanding of the basic concepts and requirements of carbon stock assessment, greenhouse gas inventories and reporting, GIS and remote sensing	▪ National and provincial REDD+ management committee meetings. ▪ Audio-visual materials. ▪ Presentations by the REDD+ office, provincial coordination units in the national and sub-national decision-maker events, with possible facilitation from the universities and/or other training institutions.
Private sector -Forest land management and industry	▪Capacity to manage their forest land sustainably with help of systematically collected forestry data.	▪ Hiring the forest technicians with good understanding about forest inventories and GIS information management. ▪ Training and development consultancies from forest information system companies.
Training institution staffs / Researchers	▪Having the up-to-date knowledge of the technical best practices and R&D topics, and capacity for active	▪ Academic and technical short-courses. ▪ Publications, academic conferences and seminars

	participation in national and international fora.	enabling interactions with the other trainers and researchers from the respective fields.
Students in environmental sciences	▪Theoretical understanding of the key concepts and practical applications (relevant to the studied subject) for ▪Office software and spreadsheet calculations ▪statistics/biometry; sampling theory, statistical analysis and modelling, statistical software ▪GIS data collection, management, analysis, scripting and software skills ▪Database development and management ▪Remote sensing ▪Forest inventory applications (design and model based)	▪ At least for one basic course for all the students. ▪ More advanced courses for specialised applications and software ▪ Internships and practical training opportunities offered in the government offices, research institutions, private companies and NGOs.
NGOs	▪Capacity to monitor forest resource and safeguard information	▪ Recruitment of the staff member with relevant technical background. ▪ Organisation of the internal capacity building and events for the government and civils society
CBOs and community members	▪The community members have basic skills to support forest departments and support MRV of the in REDD+ project areas	▪ CBOs trained by forest departments and guards.

6. REFERENCES

Government of Pakistan, 2015. *Action Plan for the Implementation of the National Forest Monitoring System of Pakistan*. Ministry of Climate Change, Government of Pakistan.

Hussain, K.; Khan, M.I.; Afrasiyab, M. 2014. *Capacity Based Need Assessment: National Forest Monitoring System (NFMS) for REDD+ in Pakistan*. Ministry of Climate Change/WWF Pakistan/UN-REDD.

INDUFOR/ChiP Traning and Consulting 2018. *National REDD+ Strategy and its Implementation Framework - Draft*. MOCC/National REDD+ Office. Unpublished.

Jehangir, S.; Khan, M.I.; Afrasiyab, M.; Hussain, K.; Ali, A. 2015. *Action Plan for the implementation of the National Forest Monitoring System of Pakistan*. Office of the Inspector General of Forests, Ministry of Climate Change, Government of Pakistan.

Qamer, F.; Shehzad, K.; Abbas, S.; Murthy, M.; Xi, C.; Gilani, H.; Bajracharya, B., 2016. *Mapping Deforestation and Forest Degradation Patterns in Western Himalaya, Pakistan*. *Remote Sensing, 8*, 385

UNFCCC (2015a). "*Capacity-building.*" http://redd.unfccc.int/fact-sheets/capacity-building.html. Accessed 15 March 2018.

UNFCCC (2015b). "*National forest monitoring system.*" *REDD+ Web Platform*. UNFCCC http://redd.unfccc.int/fact-sheets/national-forest-monitoring-system.html. Accessed 1 May 2018.

UNFCCC (2015c). *"What is Capacity-building?"* https://unfccc.int/topics/capacity-building/the-big-picture/what-is-capacity-building. Accessed 15 April 2018.

7.   ANNEXES

(attached separately)