Establishment of a Reference Level (FRL) for forest land and development of a System for Monitoring, Reporting and Verifying (MRV) carbon emission reductions from forests in FIJI

(04.2017 – 02.2019)

D11 Capacity development strategy for MRV, including immediate trainings done in the consultancy implementation, as well as a future development plan

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Summary

An assessment of Fiji's existing capacities for estimating emissions and removals from forests provided the basis for defining the capacity-development needs for an operational National Forest Monitoring System (NFMS) for the country. The capacity-gap assessment is carried out for the three phases of the REDD+ NFMS: (i) planning and design, (ii) monitoring, and (iii) analysis and reporting (GOFC-GOLD, 2016) and its associated components. A 'Capacity Development Plan' is proposed to bridge the capacity gaps and focuses on capacity building for the key action areas.

We found substantial capacity gaps in the existing national forest monitoring system relative to the IPCC 'good practice' requirements of transparency, consistency, completeness, comparability and accuracy. Despite the high political interest in forest, climate change and REDD+ and financial and technical supports (FCPF, UN-REDD, and other targeted supports), limited improvement was observed in forest monitoring capacities in Fiji. Modest improvements were observed in forest inventory capacities. We noticed a low forest inventory capacity exists that could be usefully resuscitated. However, capacities in forest area change monitoring and carbon pool reporting showed no improvements since the recent NFI (2005- 2007). The NFI system needs to be institutionalized to ensure a practical way for proficient monitoring and analysis of forest biomass and carbon. The institution (i.e. MSD) which carries out NFI requires continued institutional support and adequate and predictable finance provided with qualified and committed professionals from relevant disciplines (e.g., forest mensuration/inventory, remote sensing, statistics) for design, monitoring, analysis and reporting.

Though some progress has been made in REDD+ capacity building at central level, it is yet to realize at local level. We observed that Divisional Forest Office (DFO), Forest Beat Office (FBO) and local communities have less involvement in REDD+ readiness activities in Fiji. They are the key actors who play a decisive role for the successful implementation and monitoring of REDD+ activities in the future. There are opportunities to incentivize the key actors (i.e. DFO, FBO and local communities) for the effective implementation of REDD+ whilst increasing the resources available to them to do so. Thus, Fiji should actively put efforts towards capacity building through both national and international sessions, targeting key technical staff (Divisional, Forest Beat), and civil society groups, NGOs, faith based organizations. Enhanced capacity building tends to increase legitimacy and feasibility, i.e., political realism of the REDD+ (Neupane, 2009, 2015).

In most of the REDD+ participant countries, capacity building is mostly underfunded, so is in Fiji. Fiji is supported by the FCPF REDD+ readiness fund and by other regional REDD+ projects. The government has been allocated some funds from its Reforestation of Degraded Forests (RDF) program. To execute the proposed capacity development plan, a large investment is needed. Fiji needs to raise a substantial and predictable finance from new sources and improve effectiveness of spending.

Strengthening national capacity is an inherent component of the development and implementation of the NFMS. Neither the capacity gaps are something that can be fulfilled within a short period of time, nor there a one-size-fits-all-approach to fill the gaps. The models applied by many countries in building a national forest monitoring system adopt the concept of stepwise and continuous improvements (Mora et al., 2012). We recommend Fiji REDD+ to follow a stepwise approach for capacity building and to develop REDD+ elements (i.e., National strategy or action plan, national forest reference level, national forest monitoring system, and safeguard information system).

Capacity building should result in sustainable and robust national forest monitoring systems that are able to report on carbon stocks and changes in compliance with IPCC reporting requirements, including the IPCC good practice concepts of transparency, completeness, consistency, comparability, and accuracy. Once a country acquire those capacities, it needs to keep investing in the national forest monitoring programme in order to maintain and retain its capacities (Romijn et al., 2015). **Only maintained capacities provide the consistent updates. Updated and sustained NFMS can generate the data/information required to meet international quality standards**.

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Acronyms

A/R	Afforestation/Reforestation
AD	Activity Data
AFOLU	Agriculture, Forestry and Other Land Use
AGB	Above Ground Biomass
AWG-LCA	Ad Hoc Working Group on Long-term Cooperative Action
BAU	Business as Usual
BGB	Below Ground Biomass
BUR	Biennial Update Report
C	Carbon
C&I	Criteria and Indicators
CBD	UN Convention on Biological Diversity
CCCPIR	Coping with Climate Change in the Pacific Island Region
CCD	Climate Change Division
CCICD	Climate Change and International Cooperation Division
CCU	Climate Change Unit
CFMF	Carbon Fund Methodological Framework
CfRN	Coalition of Rainforest Nations
CH_4	Methane
CI	Conservation International
CO_2	Carbon Dioxide
COP	Conference of the Parties to the UNFCCC
CSO	Civil Society Organization
D&D	Deforestation and forest Degradation
DBH	Diameter at Breast Height
DEM	Digital Elevation Model
DFO	Divisional Forest Office
DMU	Database management Unit
DoA	Department of Agriculture
DoDD	Drivers of Deforestation and forest Degradation
DoE	Department of Environment
DOM	Dead Organic Matter
EF	Emission Factor
ELE	Extracted Log Emissions
ER Program	Reducing Emissions and Enhancing Livelihoods in Fiji' Program
ERPA	Emission Reduction Payment Agreement
ERPD	Emission Reduction Program Document
ER-PIN	Emission Reductions Program Idea Note
ERs	Emission and Removals
EU	European Union

FAO	Food and Agriculture Organization of the United Nations
FBO	Forest Beat Office
FCPF	Forest Carbon Partnership Facility
FGRM	Feedback, Grievance and Redress Mechanism
FHCL	Fiji Harwood Corporation Limited
FIS	Forest Information Sector
FNU	Fiji National University
FPIC	Free, Prior and Informed Consent
FPL	Fiji Pine Limited
FRA	FAO's Forest Resource Assessment
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
FSA	Fiji Saw millers Associations
FSIS	Forest Sector Information System
FSU	Forest Survey Unit
FTTC	Forest Technician Training Centre
GEF	Global Environment Facility
GEM	Geoscience, Energy and Maritime
GHG	Greenhouse Gas
GHG-I	Greenhouse Gas Inventory
GIS	Global Information System
GIZ	German Development Agency
GOFC-GOLD	Global Observations of Forest and Land Cover Dynamics
GPG	Good Practice Guidance
GPS	Global Positioning System
GSU	Geospatial Science Unit
Ha	Hectare
HAR	Harvested Area Reporting
ICA	international consultation and analysis
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IPs	Indigenous Peoples
LC	Land Cover
LDF	Logging Damage Factor
LEDS	Low Emission Development Strategy
LIF	Logging Infrastructure Factor
LIS	Licensing and Inventory Section
LOI	Letter of Intent
LRD	Land Resource Division
LU	Land Use
LULUCF	Land Use, Land-Use Change and Forestry

MC	Monte Carlo Simulation
MoA	Ministry of Agriculture
MoE	Ministry of Economy
MoFo	Ministry of Forests, Fiji
MoRD&MD	Ministry of Rural and Maritime Development and National Disaster Management
MRV	Measurement, Reporting and Verification
MSD	Management Service Division, Ministry of Forests, Fiji
MTA	Ministry of iTaukei Affairs
N_2O	Nitrous Oxide
NC	National Communication
NDC	Nationally Determined Contribution
NDP	National Development Plan, Fiji
NFI	National Forest Inventory
NFMS	National Forest Monitoring System
NGO	Non- Governmental Organization
Norad	Norwegian Agency for Development Cooperation
NRCC	National REDD+ Coordination Committee
NSS	National Safeguard System
NTFP	Non-timber Forest Products
PA	Paris Agreement
PAMs	Policy and Measures
PIC	Pacific Island Country
PNG	Papua New Guinea
PSP	Permanent Sample Plot Program
QA/AC	Quality Assurance and Quality Control
RBP	Result-Based Payments
RDF	Reforestation of Degraded Forests program, Fiji
REDD+	Reducing Emissions from Deforestation and Forest Degradation, and the Role of Conservation of Forest Carbon Stocks, Sustainable Management of Forests and Enhancement of Carbon Stocks
RIL	Reduced Impact Logging
RL	Reference Level
R-PIN	Readiness Project Idea Note
RPP	Readiness Preparation Proposal
RRR+	Reporting for Results-based REDD+ Project of the CfRN
RS	Remote Sensing
RSIA	Remote Sensing Image Analysis
SBSTA	Subsidiary Body for Scientific and Technological Advice
SC	Steering Committee
SDGs	Sustainable Development Goals

SEPAL	System for earth observation, data access, processing, analysis for land monitoring
SESA	Strategic Environmental and Social Assessment
SFM	Sustainable Forest Management
SIDS	Small Island Developing States
SIS	Safeguards Information System
SLMS	Satellite Land Monitoring System
SNC	Second National Communication
SOC	Soil Organic Carbon
SOM	Soil Organic Matter
SOP	Standard Operating Procedure
SPC	South Pacific Community
TA	Technical Advisor
TLTB	iTaukei Land Trust Board
TM	Thematic Mapper
TNC	Third National Communication
TOF	Trees Outside Forestland
TOR	Terms of Reference
TRS	Timber Revenue System database
UNCCD	United Nations Convention to Combat Desertification
UNCSICH	Convention for the Safeguarding of the Intangible Cultural Heritage
UNDRIP	Declaration on the Rights of Indigenous Peoples
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UN-REDD	United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation
USP	University of South Pacific
WG	Working Group

1 Introduction

1.1 Background

Monitoring forests over time allows countries to observe changes (Romijn et al., 2015). Regular, accurate and consistent information on forest resources and the information on changes in the forest resources over time are needed for developing policies and management practices to sustainably and responsibly manage forests (MacDicken, 2015; Romijn et al., 2015). Forest assessments on national level are of particular interest because countries that wish to engage in the REDD+ initiative and to benefit from results-based payments, need to give quantitative evidence of their progresses in enhancing their forest resources (Tewari and Kleinn, 2015). Thus, REDD+ mechanism requires systematic measuring of forest resources (forest carbon stocks) and monitoring of forest cover change at a national scale. The monitoring systems use a combination of remote sensing (RS) and ground-based forest carbon inventory approaches for estimating anthropogenic forest-related greenhouse gas (GHG) emissions by sources and removals by sinks, forest carbon stocks and forest area changes (Decision 4/CP. 15).

Monitoring of carbon stocks at national level requires a high degree of organizational capacity. National Forest Monitoring System (NFMS), to be functional and to sustain over many years, demands coordinated efforts of a large number of individuals and institutions across a broad range of disciplines (Hardcastle et al., 2008).

Effective capacity building programmes are needed to meet operational needs for REDD+ measurement, reporting, and verification (MRV) and reference level (Goetz et al., 2015). The need for continued capacity development efforts is important for REDD+ countries to maintain their forest monitoring system and update their inventories on a regular basis (Romijn et al., 2015). Only well maintained NFMS can generate the data required to meet international quality standards. Strengthened and continued capacity building further improves accuracy and reliability of data and information on forest resources and will provide countries with the necessary input to refine policies and decisions and to further improve forest conservation, protection and sustainable management of forest resources (ibid.). The continued capacity development efforts (for REDD+ NFMS) might be accompanied and closely connected in tandem with the capacity building initiative for meeting the provisions stipulated in the Transparency Framework (Article 13) of the Paris Agreement (PA).

Decision 1/CP. 21 (Article 13, Paragraph 7) stipulates that each Party of the PA shall regularly provide information on a national inventory report of anthropogenic emissions by sources and removals by sinks of GHGs, prepared using good practice methodologies accepted by the International Panel on Climate Change (IPCC) and agreed upon by the Conference of the Parties (COP) serving as the meeting of Parties (MoP) to the PA. The decision also requires the Parties to provide information necessary to track progress made in implementing and achieving its Nationally Determined Contribution (NDC) under the Article 4 of the same Decision. Such capacity building efforts associated with the REDD+ NFMS and capacity building initiative under the PA's Transparency

Framework establishment are also beneficial for countries to form and implement NDCs and other economic and development policies (Umemiya et al., 2017).

For forest area change monitoring and for carbon stock and carbon stock change estimation for different carbon pools corresponding to Tier 2 and Approach 3 of IPCC guidelines for Land Use, Land-Use Change, and Forestry (LULUCF) and Agriculture, Forestry and Other Land Use (AFOLU) and as required by the Forest Carbon Partnership Facility (FCPF)-Carbon Fund (CF) Methodological Framework (MF) for the Emission Reduction Payment Agreement (ERPA), requires a huge investment in the form of human, technical, institutional and infrastructure resources.

One of the tasks of this consultancy is to assess capacity of REDD+ relevant stakeholders involved in REDD+ readiness and its implementation, and to prepare a capacity development plan for MRV, which includes trainings carried out during the consultancy period.

1.2 Summary of the Terms of Reference

In accordance with the TOR, the consultants perform the capacity assessment for relevant stakeholders involved in each of the tasks assigned to the consultancy and prepares capacity building plan. Meanwhile, the consultant conducts several trainings, workshops and on-the-job trainings during the consultancy period.

1.3 Aim of this report

This report aims to provide an assessment of national capacity and capability of Fiji for measuring and monitoring forests as a requirement to establish an operational MRV and for reporting on REDD+ under the UNFCCC. With much momentum around the NFMS (Satellite Land Monitoring System (SLMS), National Forest Inventory (NFI) and greenhouse gas inventory (GHG-I) systems)), this report analyzes the capacity building needs for an operational MRV, identifies key areas in which national capacity need to be developed, and suggest a Capacity Development Plan for implementation.

The costs for the capacity development activities proposed in the plan are indicative but show the levels of funding that would be required to achieve Tier 2 reporting.

2 Methods

The 'REDD+ readiness' phase is a period of capacity-building prior to full implementation of REDD+ at national level. Comprehensive capacities are required for the data collection, estimation of emissions from deforestation and forest degradation (D&D), monitoring and reporting, and addressing institutional needs of REDD+ implementing countries to estimate and reduce emissions from D&D. The countries need to develop capacities to understand COP decisions, IPCC guidance and guidelines, as adopted or encouraged by the COPs, to prepare required REDD+ elements (Four Cancun elements of REDD+) and to undertake steps that are needed for implementation. Provision and timely capacity building support is one of the main challenges REDD+ process faces today (Maniatis et al., 2013). Without timely and enhanced capacity building, countries might not able to absorb carbon financing provided by multilateral funds (e.g., the World Bank's Forest Carbon Partnership Facility (FCPF) Readiness and Carbon Funds)) and bilateral financial support.

2.1 Capacity gap assessment approach

For the purpose of this task, capacity gap is defined as the difference between what is required for REDD+ NFMS (focusing more on MRV) in accordance with the national circumstances and existing monitoring capacity of Fiji (Figure 1). Consultant team assessed capacity gaps of the stakeholders associated with Forest Reference Level (FRL), NFMS, and database in Fiji. The capacity gap assessment is guided by and responds to the three central questions, and paves the foundation for the capacity development plan. The assessment investigated, in terms of capacities, ***where the country needs to go*** (required capacities)? ***Where is the country*** (existing capacities)? And ***to what extent capacity building is needed*** (gap)? Based on the gap assessment, Capacity Development Plan (***How do we get there***?) is prepared.

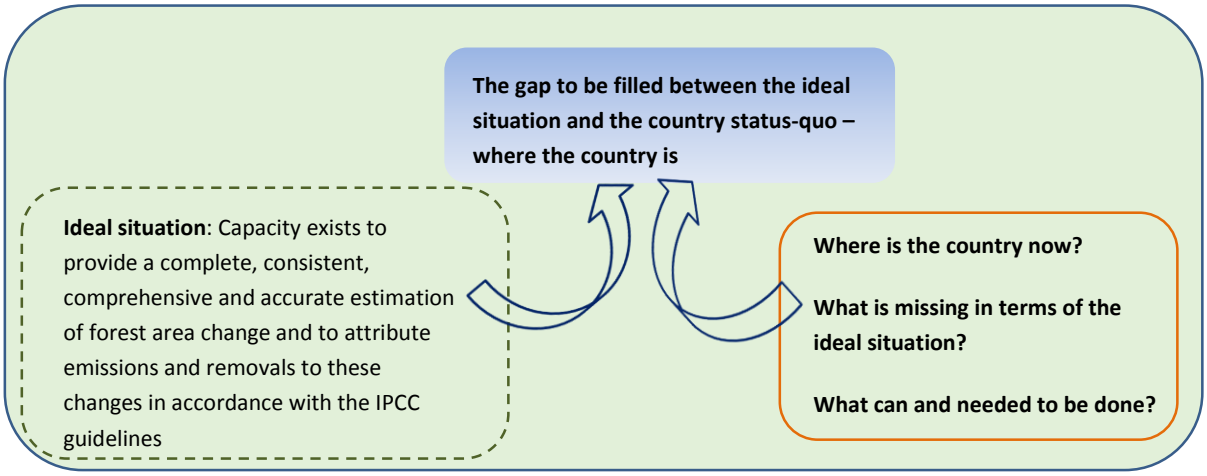

Figure 1: Capacity gap analysis approach

2.2 Major information sources

The main data sources to assess the monitoring capacities were as following:

- Food and Agriculture Organization of the United Nations (FAO) Forest Resource Assessment (FRA) reports
- The National Communications (NCs) submitted to the United Nations Framework Convention on Climate Change (UNFCCC)
- REDD+ readiness documents: Readiness Project Idea Note (R-PIN), Readiness Preparation Proposal (R-PP), Emission Reductions Program Idea Note (ER-PIN)
- REDD+ Mid-term Progress Report (2017) submitted to the FCPF
- Country experts

2.3 Data/information collection tools

- Literature/document and archival review
- Questionnaire survey
- Expert consultations
- Personal observation

2.4 Analysis of the information

We used four selected indicators and a three-phase approach of REDD+ NFMS to assess forest monitoring capacities of Fiji.

The indicator included,

1. Forest area change monitoring and remote sensing capacities,
2. Forest inventory capacities,
3. Green-house gas inventory capacities, and
4. Database management capacities.

The first three indicators were used by Romijn (2012) and Romijn et al. (2015) for the assessment of forest monitoring capacities of Non-Annex 1 tropical countries. Since, NFMS database is a key element of the REDD+ NFMS, we added the fourth indicator.

GOFC-GOLD sourcebook (GOFC-GOLD, 2016) summarizes the main components of NFMS, and capacity building requirements for the different phases: (i) Planning and design, (ii) Monitoring and Analysis, and (iii) Reporting phases (Table 4.2.1, p. 248). Based on the NFMS phases and associated components, this assessment study prepared a cross-walk matrix for each of the phases. The cross-walk matrices include required capacities for each component of the REDD+ NFMS phases, existing capacities, identified capacity gaps and proposed capacity development needs in Fiji.

3 Overview of capacity building in Fiji's REDD+ implementation

Like most of the REDD+ countries, capacity building efforts have been ongoing to strengthen the technical and political skill sets necessary to establish and implement national forest monitoring in Fiji. There are several international and regional initiatives and a number of agencies investing millions of dollars into REDD+ focusing on capacity building and piloting REDD+ at the local level (Please see selective list of activities/events in Table 1). With the supports, Fiji has been strengthening coordination structures to ensure a holistic approach. This included, for example: Quarterly REDD+ Steering Committee (SC) meetings and seminars, participation in international climate change meeting relevant for REDD+, visit of selected SC members to other REDD+ countries, integration of REDD+ activities in the plans and communication procedures in SC members' agencies activities (FCPF, 2017).

The following sections provide an overview of the past and current capacity building initiatives in Fiji. To present a complete/comprehensive list of the initiatives is neither a scope of this document nor it is possible due to very scattered and inconsistent information. Thus, this section only be understood merely an illustrative overview.

3.1 International initiatives to support capacity development with respect to national forest monitoring

3.1.1 FCPF REDD+ country participant

Fiji has been supported by the FCPF since the inception of REDD+. The country is one of the FCPF Readiness Fund recipients and received supports, among other, to establish a FRL and to set-up of MRV systems.

3.1.2 Capacity building through UN- REDD Programme

REDD+ capacity building workshop[1]

Under the auspices of the Secretariat of the Pacific Communities (SPC) located in Fiji, the UN-REDD Programme delivered a three-day capacity building technical workshop in March, 2015 on forest reference emission levels / forest reference levels (FREL/FRL) for Pacific countries. The workshop, led by FAO as a collaborating partner of the UN-REDD Programme, is part of a series of capacity building sessions under the project '*Strengthening Regional Support to National Forest Monitoring Systems for REDD+*' in the Pacific that began in May 2014.

[1]http://www.unredd.net/announcements-and-news/2177-pacific-island-countries-take-part-in-series-of-redd-capacity-building-workshops-on-forest-reference-levels-and-collect-earth-land-use-change-tool.html

Collect Earth land use change monitoring tool[2]

The UN-REDD Programme, through FAO, is supporting Pacific Island Countries (PICs) to use the Collect-Earth tool to gather information on land use and land use change to support reporting of GHG-I under the UNFCCC.

In March 2015, the SPC organized a two-week UN-REDD Programme-supported workshop to customize and develop Collect-Earth based plot establishment. Forest officers from Fiji, Marshall Islands, Papua New Guinea (PNG), Palau, Solomon Islands, Tonga, Tuvalu and Vanuatu participated in the training. Two officers from of PNG Forest Authority assisted the training and contributed with their Pacific experience in establishing Collect-Earth plots which provided a very useful South-South knowledge exchange.

Capacities in REDD+ MRV strengthened in the South pacific: UN-REDD and SPC (23-27 May, 2016)[3]

Since May 2014, the project "*Strengthening Regional Support to National Forest Monitoring Systems for REDD+ in the Pacific*" under the leadership of the SPC with funding support through the UN-REDD, has been addressing the technical and capacity-related barriers faced by the PICs in implementing a NFMS.

Fiji received support on the estimation of emission factors (EFs) from a recent NFI (2005- 2007) and a network of permanent sample plots (PSP). Over five days (23-27 May), twenty South Pacific Community and Forestry Divisions officers increased their capacity to estimate carbon and biomass densities in different forest carbon pools and developed understanding about the uncertainties required for reporting according to the IPCC guidance and guidelines.

Pacific Regional Workshop on Forest monitoring, 5-9 December 2017- hosted by PNG[4]

Experts from PNG, Solomon Islands, Vanuatu, Fiji and Tonga Indonesia and from SPC shared achievements and challenges of forest monitoring in the workshop. The workshop introduced and provided hands-on trainings on FAO forest monitoring tools including Open Foris and System for earth observation, data access, processing, analysis for land monitoring (SEPAL). The workshop was financially supported by the European Union (EU), Global Environment Facility (GEF), UN-REDD Programme and the Norwegian Agency for Development Cooperation (NORAD) regarding the SEPAL component.

[2] http://www.unredd.net/announcements-and-news/2177-pacific-island-countries-take-part-in-series-of-redd-capacity-building-workshops-on-forest-reference-levels-and-collect-earth-land-use-change-tool.html
[3] http://www.unredd.net/announcements-and-news/2514-capacities-in-redd-mrv-strengthened-in-the-south-pacific.html
[4] http://www.unredd.net/announcements-and-news/2744-pacific-regional-workshop-on-forest-monitoring-5-9-december-2017.html

Table 1: List of selected training, workshop conducted to enhance capacity of relevant stakeholders of Fiji REDD+. This list is not comprehensive, but is illustrative.

S. No.	Activity details
1	Training; Forest inventory refresher training- REDD+ monitoring; 6- 8 February 2013; participants: Ministry of Fisheries and Forests, SPC/GIZ, iTaukei landowners
2	Training; GPS (Trimble & Garmin)/GIS training – REDD+ monitoring; 21 February 2013; participants: Ministry of Agriculture (Land Resource Planning Department), Forestry Department, Landowner representative (Emalu REDD+ Pilot Project), SPC/GIZ
3	Regional training; Regional forest inventory training in the Pacific; Labasa, Fiji; 5– 29 August 2014; organised by the SPC with the support of the UN-REDD and FAO through the Regional Forest Monitoring Project; participants: 20 participants representing six PICs- Cook Islands, Fiji, PNG, Solomon Islands, Tonga and Vanuatu
4	Regional workshop; Workshop on National Forest Monitoring System; 27 October 2014; Lami, Fiji; 22 participants from seven PICs- Papua New Guinea, Solomon Islands, Vanuatu, Fiji, Tonga, Cook Islands and the Republic of Marshal Islands
5	Regional workshop; Second Regional National Forest Inventory Workshop; Makira Island, Solomon Islands; 3- 14 November 2014; organized by SPC/UN-REDD Programme; 22 participants from six PICs: PNG, Solomon Islands, Vanuatu, Fiji (5 participants), Tonga and Samoa
6	Training; Forest Inventory Backstopping Data analysis (EFs) training; 17- 19 June 2015; organized by UN-REDD Programme through the SPC
7	Regional workshop; Regional Forest Monitoring Capacity Building Workshop; 18- 19 November 2015; organized by UN-REDD Programme through the SPC, participants: 21
8	Workshop; National Forest Inventory Capacity Building Workshop on Data Analysis for Fiji; 23- 27 May 2016; organized by UN-REDD Programme through the SPC; participants: 13
9	Workshop; REDD+ Forest Reference Emission Level Workshop: Preparing a UNFCCC FREL/FRL Submission; 26-28 September 2016; organized by UN-REDD Programme through the SPC
10	Training; Fiji Forestry Collect Earth tool training, 13- 15 December 2016; organized by Fiji Forestry Department, UN-REDD Programme and Papua New Guinea Forest Authority (PNGFA)
11	International symposium on forest policy; Tenth executive forest policy course: Revisiting the poverty reduction agenda in the context of Sustainable Development Goals (SDGs): opportunities and challenges for Asia- Pacific forestry; 15-25 May 2017; Colombo, Sir Lanka; event organized by FAO, Asia Pacific Forestry Commission, Forest Department Sir Lanka; Fiji participants were funded by SPC/GIZ REDD+ II

S. No.	Activity details
12	Study tour; Nepal: REDD+ (Safeguards, benefit sharing mechanisms), sustainable management of forest, community based forest management; 4-7 September 2017; organized by SPC/GIZ REDD+ II with GIZ Sector Network Asia & Pacific and International Centre for Integrated Mountain Development (ICIMOD) Nepal
13	Regional workshop for expert exchange; Expert exchange on REDD+ and Forest Landscape Restoration (FLR) for Asian-Pacific Countries; 17-19 October 2017; Bangkok, Thailand; SPC/GIZ REDD+ II with GIZ Sector Network Asia & Pacific; participants: More than 30 representatives from Cambodia, Fiji, Indonesia, Lao, Myanmar, Nepal, PNG, the Philippines, Thailand and Viet Nam met and discussed on REDD+ and FLR for Asian Pacific countries
14	Regional workshop; Pacific regional workshop on forest monitoring; Port Moresby, PNG; 5- 9 December 2017; event organized by the government of PNG and UN-REDD Programme by the Pacific Community and SPC-GIZ Regional REDD+ Program; financially supported by the EU, GEF, UN-REDD Programme and Norad; participants: PNG, Solomon Islands, Vanuatu, Fiji, Tonga, Indonesia and SPC
15	Study tour; Germany: Sustainable management of forests, downstream wood processing and climate science in the scope of REDD+; 15- 22 September 2018; ~20 participants from PNG, Solomon Islands, Vanuatu, Fiji, GIZ; event organized and financed by SPC/GIZ REDD+ II

3.2 Other targeted support

The Reporting for Results-Based REDD+ Actions (The RRR+ Project), Coalition for Rainforest Nations

The Coalition of Rainforest Nations (CfRN) has been building capacities at national level through its 'Reporting for Results-based REDD+ (RRR+) Project' in Fiji. The RRR+ project (2016- 2019) seeks to build capacity in up to 21 forest countries including Fiji to (Massai, 2017),

- monitor emissions and removals (ERs) from the land sector, focused on forests and optionally agriculture, including the support of information on expected FRL and actual GHG emissions and removals from REDD+ activities.
- report through national GHG-I on international reports under the UNFCCC (e.g. NC, Biennial Update Report (BUR), NDC)), and
- share knowledge and learning generated with a wider set of practitioners, such that the benefits of the project are beyond the countries directly supported.

The RRR+ project had its first project kick-off meeting on 5 July 2017. The project is planned for supporting the countries in the whole GHG reporting cycle. The GHG-I cycle includes six steps: (i) plan (inventory kick-off meeting, choose methods and identify available data), (ii) collect (collect and quality control (QC) of activity data (AD) and EFs)), (iii) estimate (prepare and QC initial estimates, draft and QC of key category analysis (KCA)), (iv) write (draft report and its' quality assurance), (v)

improve (address errors and comments from the review), and (vi) finalize (finalize the inventory draft and the KCA and prepare archives) (United Nations Climate Change Secretariat, 2014).

Enhancing Fiji's AFOLU Sector in Developing National MRV and Greenhouse Gas Inventory System

The CfRN RRR+ and Mullion Group conducted a workshop from 8 October to 12 October 2018. The objectives of the workshop were:

- Formalize an AFOLU sector working group for Fiji's GHG-I,
- Train members of the AFOLU GHG-I working group on IPCC methods and data requirements,
- Identify options for managing data when compiling an AFOLU sector GHG-I,
- Build understanding of spatial modelling platforms to assist in GHG-I and other MRV requirements, and
- Develop a strategic work plan for improving Fiji's AFOLU GHG-I that is aligned with Fiji's draft FRL submissions and MRV efforts under Fiji's Low Emission Development Strategy (LEDS)[5] and REDD+.

3.3 Institutional capacity

Fiji has been actively engaged in the UNFCCC REDD+ process and advancing in its national REDD+ readiness process since 2009 with the support of the SPC and GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) project "Coping with Climate Change in the Pacific Island Region". Fiji developed a national REDD+ Policy in 2011 and submitted R-PP to the FCPF in 2013. In December 2016, Fiji signed a letter of intent (LoI) with the World Bank to transfer the rights and title associated with greenhouse gas emissions resulting from the '*Reducing Emissions and Enhancing Livelihoods in Fiji*' Program (ER Program). The country is currently developing Emission Reduction Program Document (ERPD) for the ER Program and is expected to submit the document in June 2019.

A three tiered institutional mechanism has been designed at the central level in order to implement REDD+, consisting of National Steering Committee (SC) chaired by the Ministry of Forests (MoFo), National REDD+ Coordination Committee (NRCC) and the REDD+ Unit as the operational entity. The SC was established in 2009, and officially approved by the government in 2011. The NRCC is yet to be established.

A REDD+ Coordinator is recently appointed to coordinate the entire REDD+ readiness activities and their implementation.

The SC is a cross-sectoral committee at policy-making level and includes representatives from government agencies (MoFo, Department of Agriculture (DoA), Department of Lands, Department of Environment (DoE), Ministry of Economy (MoE) and its Climate Change Unit (CCU), Ministry of Rural Development and Maritime Development, Ministry of iTaukei Affairs (MTA), Ministry of Education)),

[5] First draft is ready at the time writing of this document.

I/NGOs (Conservation International (CI), GIZ, Nature Fiji-Mareqeti Viti, Live and Learn)), academia (Fiji National University, USP Herbarium), companies/trusts (iTaukei Land Trust Board (TLTB), Fiji Harwood Corporation Limited (FHCL), Fiji Mahogany Trust, Fiji Pine Limited (FPL), Fiji Pine Trust, Scientific Forestry Fiji Limited)), associations and representatives (Land owner representatives, CSO Platform, Fiji Saw millers Associations (FSA), Naco Chambers)) and Pacific Community Land Resource Division (SPC).

There are five technical working groups (WGs): MRV, safeguards, awareness raising, governance and finance. The MRV WG includes representatives/experts from MoFo (Management Service Division (MSD)), Ministry of lands and Mineral Resources, GIZ and its Regional REDD+ Program, CI, land owners representative, TLTB, FHCL, DoE, University of South Pacific (USP), SPC, FSA, CCU, DoA and Department of Meteorology. The MRV WG members have expertise in their respective field; however, most of the members may not have adequate knowledge on REDD+ MRV and REDD+ implementation. Therefore, the technical capacity not only of the WG MRV members, but also the members of the other relevant departments is very essential (FCPF, 2017).

At the sub-national level, Divisional REDD+ Working Groups (DWGs) are established. The DWGs are crucial to implement REDD+ implementation, Fiji emission reduction program (2020-2024) in particular. However, the DWGs are not functional and active as expected.

A REDD+ Unit has been established under the MoFo and is located at MSD. The unit reports to the Deputy Conservator of Forests and the SC. The unit is the lead entity to carry out readiness activities and also working as REDD+ Secretariat. The staff portfolio of the unit includes a REDD+ technical advisor, two technical experts, one communication officer and an administrative assistant. The MoFo also provided an account officer and an assistant forest officer. The technical advisor (TA) has been providing technical support to the REDD+ readiness activities (consultancies, capacity building at national, decisional and local level).

In the last four years, Fiji REDD+ Unit has carried out various systematic capacity building activities for both personnel and institutions for the successful implementation of REDD+ (FCPF, 2017). Table 2 below presents the selected list of trainings, workshops and awareness-raising activities which were either organized or facilitated by the REDD+ Unit.

Table 2: Selective list of capacity building activities conducted by REDD+ Unit, Fiji. This list is not comprehensive, but is illustrative.

Year	Activity details
2018	
	Workshop; Enhancing Fiji's AFOLU Sector in Developing National MRV and Greenhouse Gas Inventory System; 8- 12 October, Suva; organized by CfRN RRR+ and Mullion Group.
2017	

Year	Activity details
	Awareness; Agricultural show; 21- 23 June 2017; Nausori, Fiji; organizer: Ministry of Agriculture (MoA) and REDD+ Unit, MoFo; participants: approximately 400
	Awareness; World Day to combat Land desertification, 16- 17 June 2017; organizer: MoA and REDD+ Unit, MoFo; 30 participants
	Awareness; Government Road Show; (two days); Cakaudrove, Vanua Levu; participants: approximately 200
	Workshop; Understanding climate change and the principles of REDD+; organizer: Fiji Council of Churches (FCC)- West and REDD+ Unit; 27- 28 June 2017; Western Forest Division, Lautoka; 30 participants
	Awareness; Government Road Show; 3- 5 July; Kadavu Island; participants: approximately 300
	Awareness; School programme; Reforestation of Degraded Forests (RDF) Action Against Desertification; (one day), Early childhood education, Tacirau Kindergarten; Tacirau, Suva; participants: approximately 20
	Workshop; REDD+, Fiji Institute of Valuation and estate Management; (3 days), Suva; participants: approximately 30
	Awareness; Accelerating climate action for a resilient Fiji National Climate Change Week; 23- 29 September 2017; Sukuna Park, Suva; government ministries, NGOs; REDD+ stall- participants: approximately 120
	Workshop; Understanding climate change; (3 days); organizer: MoFo; Central and eastern Division, Suva; 15 participants
	Workshop; Reporting for results-based REDD+ actions; organizer: MoFo
2016	
	Workshop; National Planning Workshop; (2 days); Suva; attendance: MoFo, MoA, Department of Environment (DoE), Fiji Pine Trust, Fiji Sawmillers Association (FSA), WWF Pacific, Naco Chambers, GIZ, Emalu land owner representative
	Workshop; Measuring, Reporting and Verification (MRV) Work plan, TOR, National Forest Stratification; (2 days); Suva; attendance: MoFo, SPC, GIZ, FNU, USP, Conservation International (CI), CSO/NGO; number of participants: 9
	Workshop; Stakeholder Engagement; (2 days); attendance: MoFo, Department of Mineral resources, Soqosoqo Vakamarama (SSVM), Department of Information, Ministry of Rural and Maritime Development and National Disaster Management (MoRD&MD and NDM), MoA, MTA, USP, FSA, Scientific Service Limited; number of participants: 22
	Workshop;

Year	Activity details
	Draft Communication Strategy; (1 day); Suva; attendance: MoFo, Department of Mineral Resources, SSVM, Department of Information, MoRD&MD and NDM, MoA, MTA, USP, FSA, Scientific Forestry Services Limited; number of participants: 15
	Awareness workshop for youth; Climate Change & Forests; REDD+; (2 days); Suva; attendance: MoRD&MD and NDM, Ministry of Youth; number of participants: 40
	Workshop; Understanding REDD+; (2 days); Suva; MoFo, SSVM, Department of Information, MoRD&MD, MoA; number of participants: 15
	Workshop; Stakeholder workshop; (1 day); Loa village, Vanua Levu; attendance: village communities; number of participants: 12
	Workshop; Understanding REDD+; (2 days); Western Division; MoFo, SSVM, Department of Information, MoRD&MD, MoA; number of participants: 15
	Workshop; Understanding REDD+; (2 days); Suva; MoRD&MD, MTA, Ministry of Environment (MoE); number of participants: 25

3.4 Support from other organization for capacity building

SPC/GIZ REDD+ Capacity Building Program Regional Project[6]

German Agency for International Cooperation (GIZ) has been in the Pacific Region for more than 30 years, and been supporting Fiji Forestry sector since 1985. The supports includes development projects; research, demonstration and dissemination; capacity building; and enabling environment (policy, legislation, institutional support) in the area of sustainable management of forests (SFM), plantation management, agroforestry, climate change mitigation and adaptation. The regional programme, "Coping with Climate Change in the Pacific Island Region" (CCCPIR) was funded by the Government of Germany. Besides it focusses on land-based natural resources and the climate change mitigation and adaptation. The scope of the programme also includes fisheries, tourism, energy and education. The German Government allocated to the programme a further €13 million, bringing the total funding package to €17.2 million. The additional funding enabled the programme to expand its scope from Fiji, Tonga and Vanuatu to nine other PICs: the Federal States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, PNG, Samoa, Solomon Islands, and Tuvalu.

GIZ has been actively involved in capacity building since the establishment of REDD+ in the Pacific region including Fiji (see Table 1). The organization is focusing on enhancing human resource capacity, conducting training and workshops related to NFI, GIS-REDD+ monitoring, data analysis and FRL. The following presents some indicative examples related to REDD+ activities:

- Advocate institutional capacity through forest governance in relation to REDD+ in Fiji. This resulted in both financial and technical support in the development of the Fiji REDD+ Policy 2011. The policy supports:[7]
  - socio-economics development of forest resource owners and local communities;
  - relevant domestic legislation and polices and contribute to the implementation of international agreements, conventions and treaties that Fiji has associated itself with, signed or ratified;
  - Fiji's efforts to conserve Fiji natural forests and the valuable ecosystem services they provide and biological diversity and contribute to meeting Fiji's international commitments under the CBD (the Convention on Biological Diversity) and UNCCD (United Nations Convention to Combat Desertification).
- Advocate institutional capacity with relevance of carbon rights to a national REDD+ scheme in Fiji,[8]
- Develop technical capacity through training of forestry staff and local communities on the parameters for the integration of SFM and REDD+,
- Develop technical capacity in relation to activity of carbon emissions from forest degradation caused by selective logging; and estimate the magnitude of emissions from the

[6] http://www.spc.int/lrd/spcgiz-qclimate-protection-through-forest-conservation-in-the-pacific-island
[7] SPC/GIZ (2011), Fiji REDD+ Policy: Reducing emissions from deforestation and forest degradation in Fiji, p2.
[8] SPC/GIZ 2013, C. Trenorden, (2013). REDD+ and Forest Carbon rights in Fiji. Background Legal Analysis, p. 11

selective logging using emission factors and log production data; and assess the carbon benefits of a transition from conventional logging to SFM in a jurisdictional REDD+ context.

3.5 Capacity building by University of Hamburg (April 2017- December 2018)

Based on the findings of the capacity gap assessment during the situational analysis, the following trainings were provided during the consultancy period.

(i) Training on '*Statistical Design of NFI*'

Date:	26-27 April 2017
Venue:	Management Service Division, Colo-I-Suva, Fiji
Trainers:	Prof. Dr. Michael Köhl, Dr Prem R. Neupane, Dr. Narendra Chand
Methods of training:	• Hands-on lectures • One-to-one exercise
Participants:	Ms. Akosita Lewai (MoFo, MSD), Mr. Viliame Tupua (REDD+ Unit, MSD) Mr Timoci Lagataki (MoFO), Mr. Maika Tabukovu (FNU), Mr Anare Nayacakalou (MoFo, MSD)
Major sessions:	• Introduction to statistical designs for NFIs • Key statistical parameters (means, totals, proportions, confidence intervals)
Outcomes:	• Participants were introduced to statistical sampling • Presentation of statistical estimation procedures

(ii) Training on '*Emission factors: data analysis and interpretation*'

Date:	4 July and 7 July 2017
Venue:	Management Service Division, Colo-I-Suva, Fiji
Trainers:	Dr Philip Mundhenk, Dr Prem R. Neupane, Dr. Narendra Chand
Methods of training:	• Hands-on lectures • One-to-one exercise
Participants:	Ms. Akosita Lewai (MoFo, MSD),

	Mr. Viliame Tupua (REDD+ Unit, MSD) Mr Timoci Lagataki (MoFO), Mr. Maika Tabukovu (FNU), Mr Anare Nayacakalou (MoFo, MSD)
Major sessions:	• Introduction to R • PSP data cleansing
Outcomes:	• Participants installed R in their personal computer (PC), and run the software • Loading the data into R workspace and learned basics in R-codes • Learned techniques for data checks and data cleansing • Calculated basic summary statistics (growing stock, biomass, carbon stock) for PSP Round 1 (2010)

(iii) Training on '*Data cleansing: Permanent Sample Plot Programme, Emalu REDD+ Project*'

Date:	24- 25 July 2017
Venue:	Taveuni
Trainers:	Dr Philip Mundhenk, Dr Prem R. Neupane, Dr. Narendra Chand
Methods of training:	• One-to-one exercise
Participants:	Mr. Viliame Tupua (REDD+ Unit, MSD) Mr Timoci Lagataki (MoFO),
Major sessions:	• Introduction to R- advanced • PSP data cleansing • Emalu REDD+ inventory data cleansing
Outcomes:	• Loading the PSP and Emalu data into R workspace • Learned techniques for data checks and data cleansing • Calculated basic summary statistics (Growing stock, biomass, carbon stock) for PSP and Emalu data • Developed height-diameter models using PSP data • Observed the problems and outliers in the datasets

(iv) Workshop/Training on 'Uncertainty assessment of land use change and Quality Assurance (QA) and Quality Control procedures'

Date:	28- 30 August 2017
Venue:	Suva
Trainers:	Mr Peter Navratil, Dr Wolf Forstreuter, Prof. Dr. Michael Köhl
Methods of training:	• Lectures • Practical training sessions
Participants:	13 participants; MoFo, SPC, Ministry of Agriculture (Land Use Division), GIZ, SPC/GIZ, REDD+ Unit
Major training sessions:	• Introduction to the current state of the art of mapping land cover and land use change by remote sensing in the context of REDD+ • Introduction to the context of accuracy and uncertainty assessment of remotely sensed data • Practice of methods for accuracy and uncertainty assessment based on the FCPF training materials • Practical application of uncertainty assessment based on "real" land use change data of Fiji
Outcomes:	• Please see in the 'Proceedings of the training' which is submitted to REDD+ Unit/MoFo.

(v) Training on '*Database instalment and operation of NFMS Database and Setup and configuration of field Surveys*'

Date:	25 September- 9 October 2017
Venue:	Suva
Trainers:	Dr Hans Jörg Schnellbächer, Mr. Armin Bajramovic, Dr Volker Müss, Dr. Prem Raj Neupane

Methods of training:	• Installation and operation of the NFMS database
	  ○ Hands-on lectures
	  ○ One-to-one exercise
	  ○ Practical training sessions
	• Setup and configuration of field surveys
	  ○ Hands-on lectures
	  ○ Practical training sessions

	○ Filed measurements ○ Feedback an reflection discussions ○ FNU
Participants:	• Installation and operation of the NFMS database ○ Database Administrator ○ MSD staff ○ REDD+ Unit • Setup and configuration of field surveys ○ Database Administrator ○ Forest inventory crew (MSD) ○ GIZ ○ Ministry of Agriculture ○ MSD staff ○ REDD+ Unit ○ FNU
Major training sessions:	• Data management (processing, storage): NFMS client desktop setup for data processing • Automatic transfer of collected data from electronic devices into the database, via cloud server, with physical backup on servers at MoFo and its partners; set up and manage ODK Collect for survey clients, collect setup for survey devices (tablets) • Administer ODK Aggregate • Easy extraction of collected data for different purposes (carbon, biomass, merchantable timber, biodiversity, social safeguards information); • Administer NFMS Web application • Link database to other national systems, the USP and SPC. Manage data from other systems • Run the database independently; Maintain NFMS data base • Reinstallation of server software after disaster crash
Outcomes:	• Please see in the 'Proceedings of the training' which is submitted to REDD+ Unit/MoFo.

(vi) Training on '*Forest inventory including designing field data collection protocol and forms*'

Date:	October 2017
Venue:	Suva, Nausori, Lautoka
Trainers:	Dr Volker Müss, Dr. Prem Raj Neupane
Methods of training:	• Design possibilities and usage of ODK forms, amendment of the field data collection protocol and field forms (missing stand level and tree attributes,

	attributes related to missing C- pool, forest disturbance indicators) o Hands-on lectures o Exercises o Practical training sessions • Test inventory including electronic data transfer, introduction of equipment (Vertex IV, Densitometer) o Practical training sessions o Filed measurements • Test inventory- PSP measurements o Filed measurements • Feedback an reflection discussions
Participants:	• Design possibilities and usage of ODK Collect forms, amendment of the field data, test inventory including electronic data transfer o Forest inventory crew (MSD) o Database Administrator o GIZ o Ministry of Agriculture o MSD staff o REDD+ Unit o FNU • Test inventory- PSP measurements o Forest inventory crew (MSD) o Forest technicians from Divisional Forest Offices (DFOs)
Major training sessions:	• Design possibilities and usage of ODK Collect forms. This session is jointly organized with the Database training (see above). (3- 4 October 2017) • Amendment of the field data collection protocol for Fiji PSP program. This session is jointly organized with the Database training. (5 October 2017) • Preparation and working on digital data collection field forms. (9 and 10 October 2017) • Permanent plot assessment (*in-situ*) o 12- 13 October, PSP 48, Suva o 16 October, PSP 49, Nausori o 17 October- Vakawaqa Mataqali, PSP 5, Western Division o 18 October PSP 1; Narewa • ODK data submission and data check process (forms, data submission checks, data submission checks SQL statements) • Data evaluation
Outcomes:	• Please see in the report on 'Fiji MRV test inventory' which is submitted to REDD+ Unit/MoFo.

(vii) Training on *'Database'*

Date:	24-7- 2018
Venue:	Skype conference
Participants:	Mr. Timoci Lagataki, MoFo Mr. Erenatau, MoFo Mr. Armin Bajramovic (UHH consultant, INTEND Germany)
Methods of training:	• Virtual meeting
Outcomes:	• Provided an updated SOP and data for data maintenance to import the tables necessary for the FRL • Cleanup of import errors in the "NFI" – database scheme by executing a provided SQL script. This was necessary, because an error was made by Mr. Bajramovic during the initial setup of the database. • Discussion of the new chapter in the SOP • Import of the FRV data files • Problem with importing some of the files, because the tool (PgAdmin) showed in explicate behavior (tried to import into non existing columns and showed these column in the object browser) • Tried to fix the problem, by updating PgAdmin and resetting the connection. Problem remained, but all except one file (NFI2006_plot_data_fixed.csv) could be imported • Discussion about the next possible appointment

(viii) Training on '*Forest inventory data analysis using R*'

Date:	5- 13 March 2018
Venue:	Suva
Trainers:	Dr Philip Mundhenk
Methods of training:	• Hands-on-lecture • One-to-one exercise
Participants:	~ 20 • MSD staff • REDD+ Unit • MoF- Silviculture and Research • Divisional Forest Offices

	• NGOs
Major sessions:	• Introduction to R • Forest inventory data cleansing • Forest inventory data analysis (basic exercises)
Outcomes:	• Loading NFI data into R workspace • Learned techniques for Data checks and data cleansing • Calculated basic summary statistics (Growing stock, biomass, carbon stock) • Plotting and producing graphics

(ix) Training on '*Database: Installation of R-Packages*'

Date:	30-10- 2018
Venue:	Skype conference
Participants:	Mr. Timoci Lagataki Mr. Armin Bajramovic (UHH consultant, INTEND Germany)
Methods of training:	• Virtual meeting

Outcomes:	• Cleanup of the table PSP.PLOT_INFORMATION
	• Fixed NFI2006_Aggregated (missing "division" column). After the change, the CSV data could be imported without problems (which failed in the last session)
	• **Installation of R-Packages for the script**
	  ○ Failed, because currently no current administrative account on BAKA14 is known to Mr. Lagataki
	  ○ Mr. Lagataki requested the credentials from ITC services
	• **Capacity building**
	  ○ Refresher: the process to convert data from ODK to the MRV-Tables using a function & trigger in PostgreSQL

(x) Training on '*Preparation of the database for the FRL scripts, installation and test of R-Packages for the script and Configuration of the web application to start the FRL script*'

Date:	11-01- 2018
Venue:	Skype conference
Participants:	Mr. Timoci Lagataki Mr. Armin Bajramovic (UHH consultant, INTEND Germany)

Methods of training:

- Virtual meeting

Outcomes:

- **Preparation of the database for the FRL scripts**
  - New tables and their data were imported using SQL scripts.
  - These include tables in the MRV, NFI and FRL schemas.
- **Import of new vector data**
  - The current version of QGIS (3.4) was installed on the computer of Mr. Lagataki
  - The connection to the Database on BAKA14 was configured and the vector data was imported by using the database manager in QGIS
  - (Imported Layers: AA_LUC_0612, AA_LUC_1216, Fiji, FijiREDD, FijiNFI, Logging_polygons, sw_planted)
  - The process is documented in the Data Maintenance SOP.
- **Installation of R-Packages for the script**
  - The R-Packages were installed manually on BAKA14, in order to prepare the machine for the FRL script
- **Test of FRL script**
  - The correct execution of the R script was tested within the R GUI-Application
- **Configuration of the web application to start the FRL script**
  - The web application was configured, so the FRL script can be executed using the web interface.
  - This was successfully tested.

4 Capacity gaps in National Forest Monitoring System (NFMS) in Fiji: assessment using four indicators

It is imperative to understand forest tenure and forest use systems in Fiji before discussing on the existing government capacities related to forestry sector. Much of the land ownership rests on customary land ownership units known as Mataqali (Leslie and Tuinivanua, 2010). Ownership of native lands is not transferable through land sales, but user rights can be transferred via land leases. Nearly 88% of the total land in Fiji is iTaukei (indigenous or customary) land, and the state owns only 4% of the total land. Forests cover 56% (~1.014 million ha.) of the total land area of Fiji, and 90% of the forests are owned by iTaukei people (Trenorden, 2013).

The intensity of native forest harvesting has declined gradually as large-scale harvesting operations began in the Pine plantations from the late- 1980s and from hardwood plantations in early 2000. Native forest harvesting fluctuated between 100,000-200,000 m^3 per year from the early 1970s peaking in 1987 at 220,000 m^3, and at a declining trend, falling to 100,000 m^3 in 2004 and 61,000 m^3 in 2007 (Leslie and Tuinivanua, 2010). For 2006- 2016, average annual commercial logging in natural forests is 50731 m^3 (50,731±10,111) from an annual average area of 1767 ha (1767±1190)[9]. However, conventional logging is the major driver of forest degradation. In 2015, the MoFo had a total staff of 227 out of which 118 are tenured and 68 are wage-based (Forestry Department, 2015). Major responsibilities of the forestry staff are monitoring of timber harvesting, providing training, extension services and coordination with key stakeholders. The facts indicate a lesser involvement of the government in the forest management.

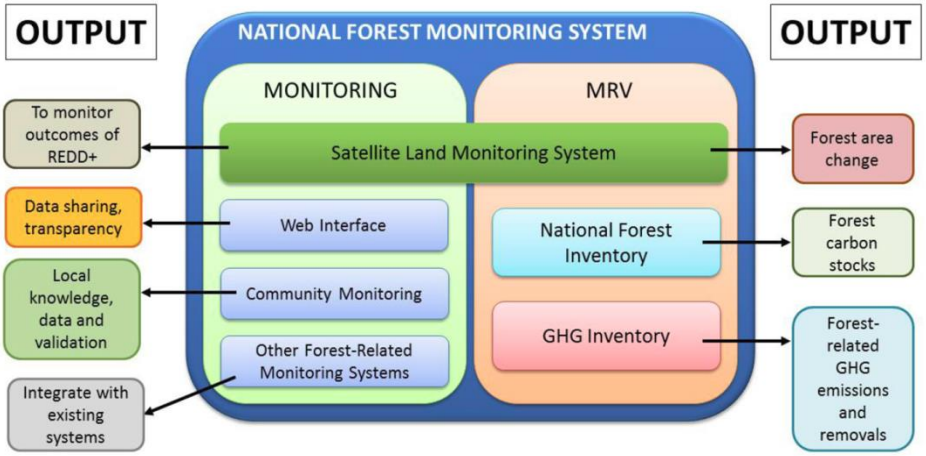

Figure 2: Schematic representation of the elements of a National Forest Monitoring Systems for REDD+ (UNEP, 2017).

NFMS is one of the four Cancun Elements that the country Parties should have in place to obtain and receive result-based payments. The information that becomes available through the NFMS/MRV can

[9] Fiji's Forest Reference Level 2006- 2016, draft report prepared by University of Hamburg, and submitted to Fiji Ministry of Forests, November 2018

be used to develop the National Strategy or Action Plan. The NFMS serves two simultaneous functions: 'Monitoring' function, and 'Measurement, Reporting and Verification (MRV)' function (Figure 2). A 'monitoring' function is primarily a domestic tool to assess the impacts and outcomes of REDD+ demonstration activities, and national policies and measures (PAMs) for REDD+. The MRV function refers to the estimation and international reporting of national-scale forest related emissions by sources and removals by sinks (ERs). The MRV is based on three 'pillars'- i) SLMS, ii) NFI, and iii) the GHG-I.

To establish robust and transparent national forest monitoring system, Decision 4/CP.15 requests the developing country Parties to '*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*'. The decision also requests the Parties '*to use the most recent Intergovernmental Panel on Climate Change (IPCC) guidance and guidelines, as adopted or encouraged by the Conference of the Parties, as appropriate, as a basis for estimating anthropogenic forest-related greenhouse gas emissions by sources and removals by sinks, forest carbon stocks and forest area changes*'.

The 'ground-based forest carbon inventory approaches' indicated in the UNFCCC Decisions (Decision 4/CP.15 and 1/CP.16) generally refers to a NFI which is a systematic collection of data and forest information for assessment or analysis (Hewson et al., 2014; Köhl, 1993; Köhl et al., 2006). NFIs concentrate on a quantitative and qualitative description of forest resources by means of *in-situ* assessments. As an integral component of the REDD+ MRV, the NFI provides country-specific biomass and carbon density estimates. NFI data is used to estimate emissions for various land use types then combined with activity data (AD) to produce emission factors (EFs).

Emission Reductions (ERs) programs shall demonstrate the conformity with the FCPF Carbon Fund's Methodological Framework (FCPF CF MF) and its' criteria and indicators (C&I). Indicator 5.1 of the framework reads that the ER program identifies the IPCC methods used to estimate emissions and removals for setting the FRL and Measurement, Monitoring and Reporting (MMR).

Capacity gap in forest assessments on national level and REDD+ implementation have long been identified in Fiji (Herold, 2009, Romijn et al., 2012, Romijn et al., 2015). Romijn et al., (2012) assessed capacities of 99 tropical non-annex countries for national monitoring in the context of REDD+ using four assessment categories: (i) national engagement, (ii) monitoring capacities, (iii) REDD+ challenges, and (iv) RS technical challenges. Several indicators were developed assess the current capacities and specific challenges with respect to REDD+ monitoring.

Since the inception of REDD+ in Fiji, the country is in the process of developing capacities and still in its early stage. According to Romijn et al. (2012), Fiji is as one of the tropical non-Annex I countries with low existing capabilities to continuously measure forest area changes, conduct forest inventory, and report forest carbon stock changes on the IPCC Tier 2 level (Table 3). The country faces high

remote sensing technical challenges to adopt IPCC Approach 3. Trines (Trines, 2012) also indicated that Fiji's capacity to design and implement a robust inventory system is rudimentary.

Fiji has been actively engaged in the UNFCCC REDD+ process in later years (Romijn et al., 2012) compared to its' low engagement in the process before 2010 (Herold, 2009). However, a large capacity gap exists to measure and verify the success of REDD+ implementation using the IPCC GPG and FCPF-CFMF. Like most of the developing countries, Fiji needs considerable capacity improvements at technical, political and institutional levels to provide complete, consistent, comprehensive and accurate estimates of forest area/change and carbon stock change; and to attribute anthropogenic forest-related GHG emissions and removals to these changes.

Table 3: Indicators for Fiji for NFMS capacity assessment categories suggested by Romijn et al., 2012

Engagement in UNFCCC REDD+ Process	Completeness of GHG Inventory	Forest Area Change Monitoring Capacity	Forest Inventory Capacity	Carbon Pool Reporting Capacity	Forest Area affected by Fire	Proportion of Forest Area with high soil carbon content	RS Technical Challenges (Summarized)
Medium	Low	Low	Low	Low	Low	Low	High

Following section presents the country capacity assessment examining three indicators as follows:

1. Forest area change monitoring and remote sensing capacities,
2. Forest inventory capacities,
3. Greenhouse gas inventory capacities, and
4. Database management capacities.

4.1 Forest area change monitoring and remote sensing capacities

Fiji is currently developing its' Emissions Reduction Program Document (ERPD). The ER Program, under the leadership of MoFo, implements REDD+ activities in the three major islands of the country- Viti Levu, Vanua Levu and Taveuni between 2020 and 2024. For the period, activity data are determined periodically, at least twice using IPCC Approach 3.

Significant capacity is needed for activity data (AD) and pre-processing and processing methods. Sources of uncertainties associated with the AD need to be systematically and consistently identified and assessed, and managed and minimized to the extent feasible in a cost effective way. Remaining uncertainties need to be quantified using accepted international standards (accuracy, confidence interval, distribution of error and propagation of error) which allows for comparability between periodic assessments. Finally, the uncertainties shall be reported. Fiji has significant capacity gaps related to the different aspects of the uncertainty as discussed above.

4.1.1 Data availability and accessibility

Land cover (LC) change information provides a basis for estimating ERs from human activity (activity data). In the past, satellite data, mostly Landsat, was used to create land/forest cover map. Land cover maps based on Landsat imagery are available for 2006, constructed by external consultants

(SPC, then SOPAC). The images were classified by visual interpretation rather than using automated methods. As a land-use classification is available only for one point in time, no change estimates can be derived. A forest change analysis between 2007 and 2012 was done. For the 2007 assessment, no uncertainty analysis (e.g., confusion matrix) was conducted. The recently conducted Collect-Earth Assessment on 10,000 points for estimating land use and land use change was not successful. It was suggested that the team forgot to assess some points for earlier years.

To estimate accurate and consistent AD, a forest area change assessment and an accuracy assessment were carried out. During the construction of FRL, net historical forest-ERs for the period 2006 to 2016, i.e. the reference period was estimated. Activity data used for FRL construction was obtained from a LC change assessment conducted between the years 2006-2012 and 2012-2016. The focus of change assessment was primarily on changes between the land-use category “Forests” (including two forest strata, Lowland and Upland forest) and non-forests (including land-use categories grassland, cropland, wetlands, settlements and other land). Landsat Thematic Mapper (TM) data downloaded from the United States Geological Survey (USGS) Global Visualization Viewer (GloVis) were used to obtain LC data. In addition, geospatial information of the Fiji Ministry of Lands and Mineral Resources, Lands Department, river system and Shuttle Radar Topographic Mission (SRTM) Digital Elevation Model (DEM) with 30 m and 90 m resolutions were used as supplementary data. Land cover data for 2006, 2012 and 2016 as well as the change detection map have been prepared by the SPC, Geoscience Division with the assistance of MSD, Ministry of Forests. Information and maps related to the plantation area were provided by the FHCL and FPL.

Forest change detection conducted by the SPC/MSD team includes seven LC classes: natural forest, mangrove, pine plantation, hardwood plantation, coconut plantation, water bodies and non-forest. The land cover classification is not consistent with the IPCC land use categories. The summary of the results of the forest cover change detection are interpreted for entire country (wall-to-wall) and also on island level. The team attempted data cleaning to some extent as possible. A 20 x 20 km grid was overlaid over Viti Levu and 10 x 10 km grid over Vanua Levu and all grid intersections were numbered. For each grid intersection, LC class of the map was stored in one field and the interpretation of the image data in a different field of a database. This was performed separately for the years 2006, 2012 and 2016. All of the maps, all map sheets and the change detection matrix are available. However, manual digitizing and visual interpretation by multiple experts working at a time might have introduced several errors in terms of accuracy, consistency and completeness.

Accuracy assessment of the land cover change (2006-2012-2016) was performed by Remote Sensing Solution GmbH (RSS), Germany. A sampling approach was applied that implemented an independent second image interpretation of Landsat TM data (i.e., assessing the accuracy of a map using independent reference data). The accuracy assessment report is available. Please see the report on ‘Uncertainty analysis of the landuse change assessment’ prepared by RSS- Remote Sensing Solutions GmbH, Germany.

Fiji Pine Limited (FPL) and Fiji Hardwood Corporation (FHCL) holds data on plantation lease areas and plantation harvesting areas (vectors and raster products). However, the FPL and FHCL are highly inaccessible in terms of the data availability.

Vector maps of several Mataqali's were available at the MSD including logging polygons. The maps were prepared as a component of forest harvesting plan of the respective Mataqalis.

To enhance the accessibility, currently available data, spatial and activity data in future, SOPs and reports on QA/QC will be saved to the REDD+ NFMS database at Ministry of Forests. Besides, a backup copy of such data shall be saved at MSD Colo-I-Suva.

Table 4: Existing capacities and identified gaps regarding data availability and accessibility for the operational REDD+ NFMS

Existing capacity	**Gaps identified**
• LC maps based on Landsat imagery for 2006 are available. • Forest cover maps 2006, 2012 and 2016 are available. • Forest cover change detection maps 2006-2012-2016 are available. • Topographic sheets are available. • Harvesting polygons (natural forest) are available at DFOs and at MSD. • Most of the above data are now accessible within the MoFo (MSD, REDD+ Unit) • 30 m resolution images of Landsat and other high resolution images are available with SPC-GSD. • Leased plantation area polygons are available with FPL and FHCL.	• All of the RS based data are produced with medium resolution satellite data. • Satellite images not available for all of the years. • Forest cover maps 2006-2012-2016 prepared using visual interpretation and on screen digitization method. • Most of the data is produced by external experts (e.g., SOPAC, and now SPC-GSD) • Except forest cover change detection maps 2006-2012-2016, uncertainties are not addressed and ground truthing has not been done for other vector or raster data. • IPCC land categories are not followed. • Most of the data is not owned by MoFo and is less accessible with other organizations.

4.1.2 Technical capacity

Regular satellite based forest cover monitoring was not the priority of the MoFo in the past. Apparently, the technical capabilities which include both technical equipment and logistics are not well developed. After the inception of REDD+, a range of capacity building activities and cooperative efforts are being undertaken by the MoFo (See Chapter 3). Several capacity building measures have been taken both at national and divisional level during the REDD+ readiness.

Currently, MoFo and REDD+ Unit are establishing a basic computer section/GIS workstation at the MSD. There are already some desktop computers currently being used for GIS work, particularly for

preparing harvesting base maps and delineation of forest boundaries. However, the technical potential of remote sensing and the availability of operational tools is almost none.

Some of the urgent technical equipment needs include high definition (HD) desktop computers (dual monitors, multi-core processing), high accuracy handled GPS system (differential GPS) and field equipment for ground truthing. Logistics such as high speed internet connection, licensed software, web hosting service, and web domain are needed. Latest software and equipment are available with SPC-GSD who has been supported the MoFo for many years. But most of the efforts between the MoFo and the SPC-GSD are project based. Other organizations, for example, GIZ support SPC-GSD to assist MoFo for particular tasks.

Table 5: Existing capacities and identified gaps regarding technical capacities for the operational REDD+ NFMS

Existing capacity	**Gaps identified**
• A small GIS workstation at the MSD currently functional (but still is rudimentary). • Single frequency GPS machines are available at the MSD and DFOs. • A GIS/RS lab is functional at the SPC-GEM. The lab contains HD desktops with duel monitors and multi-core processing, high data storage capacity, high-speed internet connection and licensed software. The SPC-GSD provides the high resolution satellite images with charge. • GIZ supports MoFo to develop technical capacities.	• Technical capacities for satellite based AD monitoring virtually do not exist at MSD, but could be obtained from SPC-GEM • Procurement procedure for equipment is chaotic. • There have been forest cover mapping and similar assignments, but the products are not archived in a system. • Existing computers are almost outdated.

4.1.3 Human capacity

Expertise in accessing, processing, and interpretation of multi-date RS imagery for forest cover /area changes are at the core of the capacities required for forest area change assessment. Unfortunately, no remote sensing/GIS analyst is available within the MoFo. Several assignments and projects related to the forest and forest land cover mapping have been accomplished with support of various regional and international organizations. An expert is urgently needed to review and consolidate the existing data and information.

A specific problem for the South Pacific region is the limited availability of historical satellite data, which is partly due to persistent cloud cover, non-regular recording of satellite imagery due to the lack of receiving stations and inadequate data access infrastructure in the region. Expertise and approaches for dealing with the technical challenges (i.e. cloud cover, missing data) neither exist with MoFo nor with other organizations.

Table 6: Existing capacities and identified gaps regarding human capacities for the operational REDD+ NFMS

Existing capacity	Gaps identified
• At MSD and DFOs, there are some employees who are able to perform rudimentary GIS. • The MSD team was involved to assess the forest cover change 2006-2012-2016. However, the expertise in image interpretation is limited on screen digitization. • Expertise exists to use GPS system in the field for ground truthing. • SPC-GSD and University of South Pacific (USP) are the few institutions that have relevant capacities. • SPC-GSD and the USP lend their services to the MoFo on project basis.	• Knowledge and understanding of IPCC guidance is very limited. • No single RS/GIS analyst • Expertise and aapproaches for dealing with the technical challenges (i.e. cloud cover, missing data) do not exist. • No expertise on the application of statistical methods • No expertise with an understanding of error sources and uncertainties in the AD and EFs assessment process • No expertise on the application of statistical methods to quantify, report and analyze uncertainties for land use cover change including forest area change • No expertise in accounting and reporting procedures for LULUCF using the IPCC GPG

4.1.4 Capacity building facilities

There are opportunities available for the capacity enhancements of the professionals working in the field of GIS, RS and geospatial information systems in Suva. The School of Geography, Earth Science and Environment (SGESE) at the USP hosts Geospatial Science Unit (GSU). The GSU unit offers a number of courses relevant to RS/GIS including geography techniques and methods, geospatial information systems, GIS and RS. The GIS courses include both foundation course and an advanced course. The GSU provides students and staff with licenses of ESRI and ArcGIS Desktop. RS course provides students with a foundation in the basic principles of RS of the environment. This course covers a range of multi-scale remotely sensed imagery, traditional supervised and unsupervised image classification, enhancement indices and multivariate statistical analysis of multiband imagery using principal components analysis.

College of Agriculture, Fisheries and Forestry (CAFF) at the Fiji National University (FNU) offers a three-year full time Bachelor of Science (B Sc) in Forestry program. The program offers courses, among others, statistics in forestry, climate change and REDD+, forest ecology, forest survey and mapping, forest fire, forest economics, non-timber forest products, plantation forestry, agroforestry, forest biometry, sustainable forestry, silvicultural systems, environmental forestry, forest administration, forest harvesting and ergonomics and remote sensing and GIS in forestry. The college also offers Trade Diploma in Forestry (2 years full-time course) which includes the same courses as in the B Sc in Forestry (except RS/GIS).

Forest Technician Training Centre (FTTC) within the MoFo provides trainings on forestry. The FTTC is focused on timber harvesting and utilization and produces graduates with forest technician certificates. Many of the graduates are recruited into the Fiji Civil Service as Forest Guards (Dranibaka, 2011). In addition, the SPC-GEM provides internship on GIS/RS for the Fijian and international students and professionals.

Table 7: Existing capacities and identified gaps regarding training facilities for the operational REDD+ NFMS

Existing capacity	**Gaps identified**
• Local experts are available for GIS/RS trainings (USP, FNU, SPC-GSD) • Training venues are available at MoFo, MSD, Fiji Revenue and Custom Services, Nasase, but without the availability of GIS/RS infrastructure.	• Government forestry training institutions do not provide the training on GIS/RS. • Lack of budget allocations for staff training • Training equipment and logistics are not available • Training to the right persons is an issue. • Not many opportunities to participate on training and seminars (in country and outside the country) available to the foresters working at DFOs.

4.2 Forest inventory capacities

This indicator assesses capacities to conduct national forest assessment which is defined as a systematic process of gathering, collecting, analysing and using information from diverse sources to assess the value, quality or importance of forests at national level, taking into account all their functions; and NFMS (FAO, 2017).

To estimate overall GHG emissions for the forest sector, UNFCCC Decisions (Decision 4/CP.15 and 1/CP.16) suggest countries, using the most recent IPCC guidance and guidelines, to combine information about how land use patterns are changing through, for example, deforestation or afforestation, with information from a ground-based national forest inventory (i.e., NFI). A NFI is the systematic collection of data and forest information for assessment or analysis (Hewson et al., 2014). NFIs concentrate on a quantitative and qualitative description of forest resources by means of in-situ assessments. The NFI provides country-specific estimates of biomass and carbon densities for various forest types. The estimates are combined with AD to produce EFs. Without a decent ground-based data collection system, attempts to apply state-of-art RS techniques would be a complete waste of money and a missed opportunity (Hardcastle et al., 2008).

In Fiji, forest inventories have been carried out since 1966. The first NFI was carried out between **1966 and 1969** by the Land Resource Division (LRD) of the Overseas Development Administration, England (Berry and Howard, 1973). The inventory covered the major part of the natural forests

including most of Vanua Levu, the forested eastern part of Viti Levu and the Island of Kadavu. The NFI used aerial photographs and the river catchments (16 catchment groups) were the units of survey. The study described 41 forest types. Three forest management categories were identified: non-commercial, production and protection. After the permission of Fiji Government 1971, the LRD published the inventory report in three volumes.

The second **NFI of 1991-1992** classified Fiji's natural forest resources into three forest management categories as Production (549393 ha; 64%), protection (251264 ha; 29%) and Preserved forests (56876; 7%) (Leslie and Tuinivanua, 2010). The management categories were reduced to two categories, as production and protection forests in the recent NFI 2006 (2005- 2007), the third NFI of Fiji.

The **NFI 2006** is the primary source of data to derive biomass and carbon stock estimates for natural forest. Data collection started in 2006 and was finalized in late 2007. A stratified simple random sampling design was employed, where the strata were closed and open forest. The map that was used for stratification was derived by visual interpretation of Landsat imagery that was acquired between 2000 and 2002.

In 2010, the **Permanent Sample Plot (PSP) Program** designed 100 PSPs throughout Vanua Levu, Viti Levu and Taveuni islands including forest areas (n= 86), grass lands (n= 8) and mangroves (n= 6) (Figure 5). In grassland and mangroves, the plots are yet to be established. The plot measurement has been provided biannual data on stand structure, tree species, height and diameter at breast height (DBH).

Existing PSP Program and the last three NFIs were not designed for carbon stock assessments and have limited use for the forest inventory purpose. There is little national capacity for forest inventory although basic capacity related to field measurement exists. This is mainly due to under-staffing and financial problems. There is almost null capacity for designing of forest inventory.

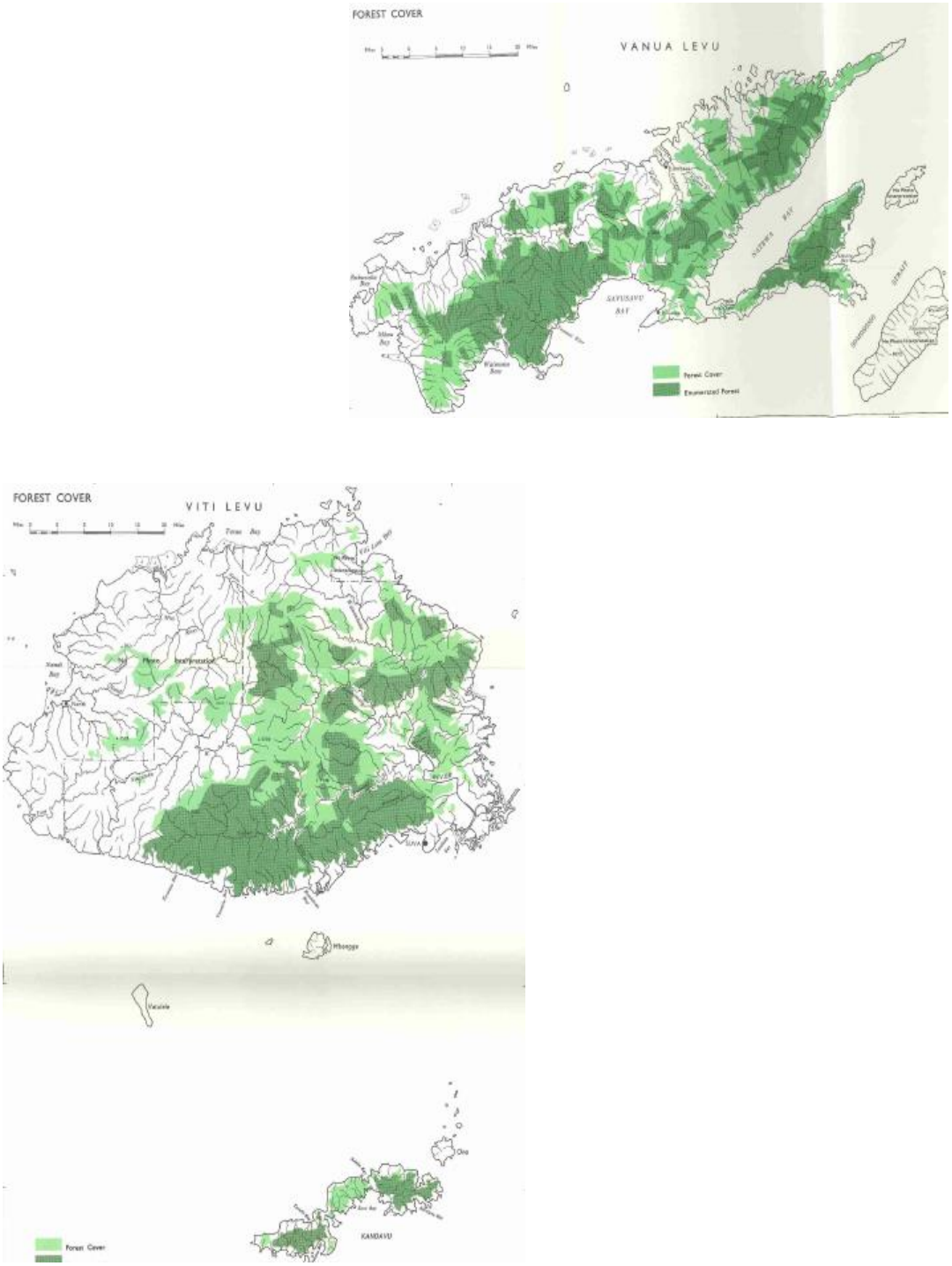

Figure 3: Forest cover (light green) and enumerated forest (dark green) in Vanua Levu, Viti Levu, Kadavu (top to down) Islands estimated in the first Fiji NFI (1966- 1969) (Berry and Howard, 1973).

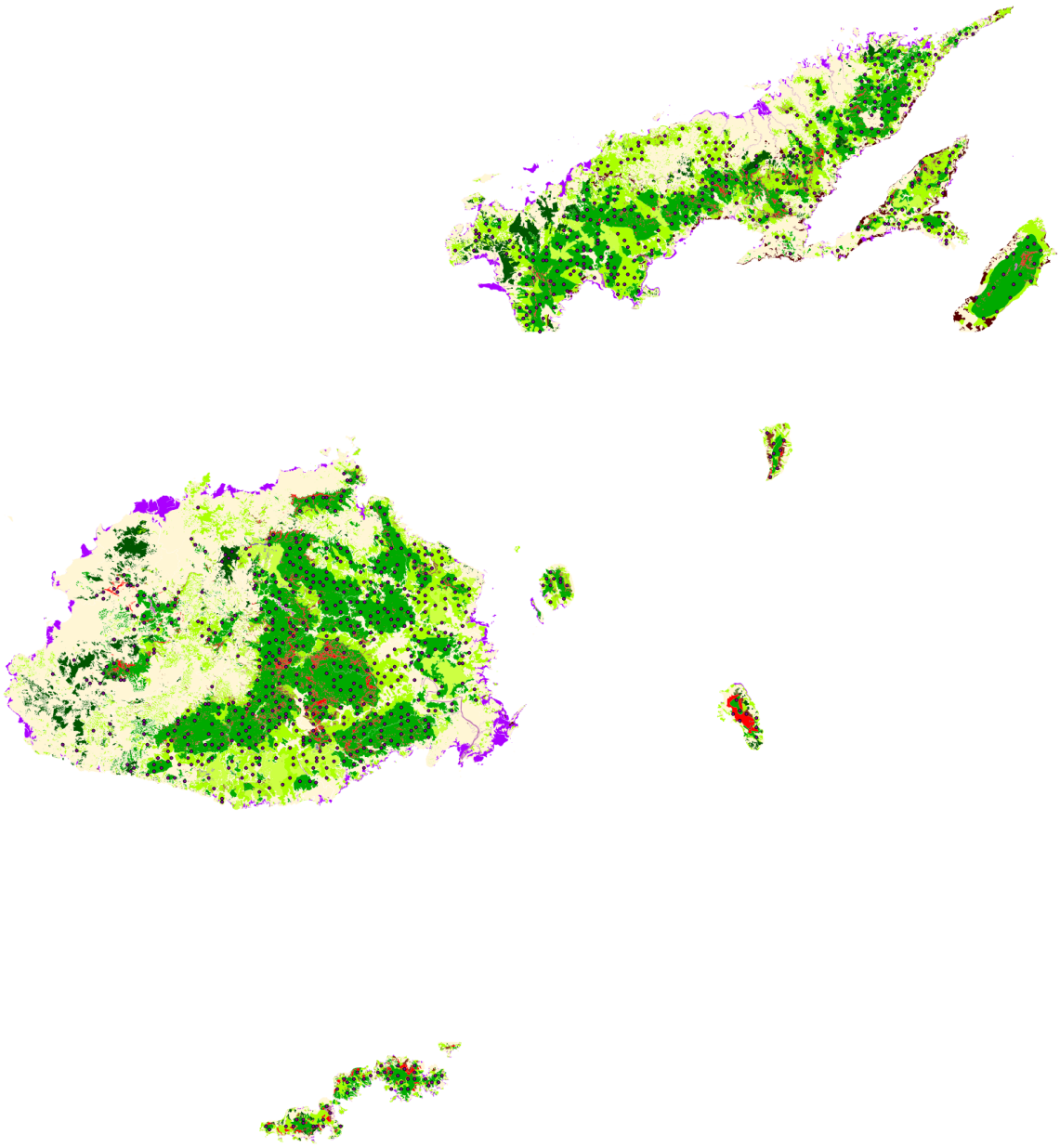

Figure 4: Fiji third National Forest Inventory NFI 2006 (2005 – 2007) plot distribution

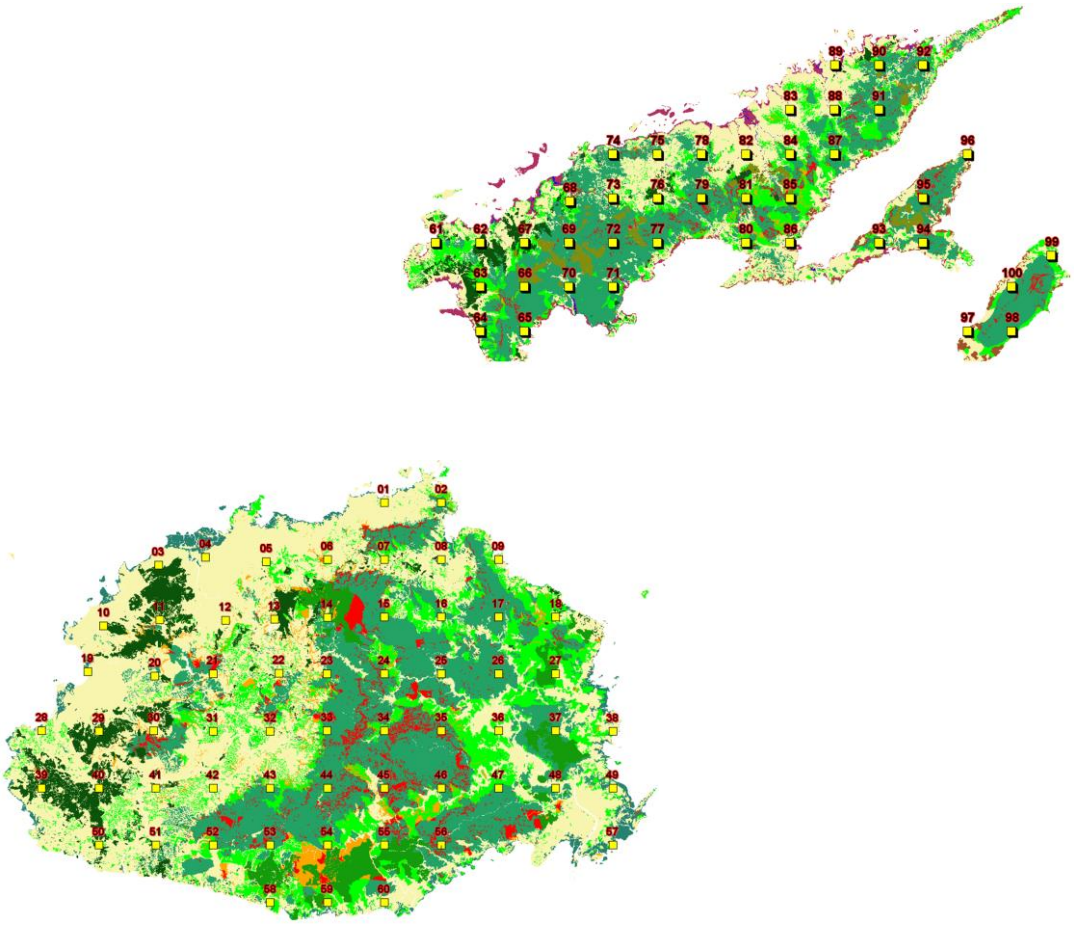

Figure 5: Fiji Permanent Sample Plot Program 2010 plot distribution

4.2.1 Data availability and accessibility

Forest inventory data are currently the most common data source for the estimation of changes in forest carbon stocks (GOFC-GOLD, 2016). NFI for REDD+ will have to measure the five carbon pools (IPCC, 2003, 2006) as identified by the IPCC (Maniatis and Mollicone, 2010). The NFIs (1966- 1969, 1991-1992 and 2005 – 2007) were aimed at estimation of growing stock in the existing forests and the PSP Program aims at long term monitoring of growth and yield of natural forests. The forest inventories, in accordance with their objectives, adopted their own sampling designs, field plot configurations and information from the plots. Attributes from the inventories are mostly limited to species name, DBH and tree height. Data on deadwood and litter have been collected during PSP Program, but they are not yet available for analysis. Currently, information about only above-ground and below-ground carbon pools is available.

Few forest inventories were conducted on project basis in the past. In Vanuatu, a forest inventory was done 1989 funded by the Australian Aid. In 2014, UN-REDD regional REDD+ project ("Strengthening Regional Support to National Forest Monitoring Systems for REDD+ in the Pacific") conducted a forest inventory in trialling out a methodology to carry out the NFI. At different points of time, different consultancies have been carried out inventories of specific forest areas mostly with purpose of commercial and sustainable management of forest resources. Neither the data nor the results of forest inventories were found in the database functional at the MSD Colo-I-Suva. With the support from GIZ, few studies on forest carbon assessment have been carried out, and the reports of the studies/assessments are available. Table 8 below summarizes the data availability and accessibility related to the forest inventories, and Table 9 indicates the capacities and identified gaps regarding forest inventory data availability and accessibility.

Table 8: Availability of data relevant to forest inventory and emission factors and their accessibility

Data	**Accessibility**
1st NFI: National Forest Inventory 1966- 1969 • Timber volume (commercial species, dbh≥40 cm over bark) for 49 forest types, • Forest area and r. m.e. of timber volume for each forest management categories (3) • Growing stock, forest area- Vanua Levu, Viti Levu and Kadavu • Volume equations, volume tables • Bio-physical environment of the three islands • Forest management prescriptions • 1:50,000 maps of forest types	Book, M. J. Berry and W. J. Howard, 1973. Fiji Forest Inventory Volume 1, Volume 2 and Volume 3, LRD, England.
2nd NFI: National Forest Inventory 1991-1992	Data not available
3rd NFI: National Forest Inventory 2006 (2005 – 2007)	MSD database, MoFo
Permanent Sample Plot (PSP) system (2010, 2012, 2014)	MSD database, MoFo

Data	Accessibility
Forest inventory data of Emalu REDD+ pilot site	GIZ
Forest inventory data of Vunivia REDD+ pilot site	Project developer
Logging statistics • Natural forests (2006- 2016): wood volumes removed, area logged, location (vector data; shape file)	MoFo, DFOs, FRL document
Pine plantations (2006- 2016) • Areas leased by Fiji Pine (vector data; shapefiles) • Areas of harvested and planted pine (including year of harvest and planting) • Volumes extracted in the areas • Average growing stock stratified by age	Fiji Pine Limited, MSD, FRL document
Mahogany plantations (2006- 2016) • Similar data as of Pine plantations	Fiji Hardwood Corporation Limited, MSD, FRL document
Data on average annual volume increments in Pine and Mahogany plantations; i.e., age vs volume functions	Reports, FRL document, publications/reports
Carbon stocks	FRL document, MoFo, REDD+ Unit
Carbon density stratification	FRL document, MoFo, REDD+ Unit
Change estimates of C stock due to LU change	FRL document, MoFo, REDD+ Unit
Change estimates of C stock in forest areas remaining forest	FRL document, MOF, REDD+ Unit

Table 9: Existing capacities and identified gaps regarding forest inventory data availability and accessibility

Existing capacity	Gaps identified
• NFI 1966- 1969 report is available in the form of published report. • NFI 2006 data (n =1023 fixed area cluster plots) are available in the form of digital form within the MoFo (at MSD) • Data on forest plantations • Time series (2010, 2012, 2014 and 2016) data from PSP Program are available in the MSD database system and in the form of	• The NFIs/PSPs do not provide necessary data to estimate carbon stock in all of the five forest carbon pools identified by IPCC (IPCC, 2003, 2006). • Currently available data can be used for above- and below ground (root) biomass estimates. Because of lack of necessary data, deadwood, litter and soil carbon pools cannot be assessed. • The existing data of the NFI 1966- 1969 included only commercial tree species and limited to specific diameter classes. • NFI 2006 data collection was lesser comprehensive

hardcopies. • An 'adjusted' allometric model to predict above-ground tree biomass exists, which was developed by adjusting Chave et al.'s (2014) model using locally available data (Tier 2) • A robust diameter-height model based on a large sample size (n = 5000 trees) • Forest inventory statistics appear in Annual Reports of MoFo and other country reports (e.g. FAO, 2015). Those statistics are referred to NFI 2006 and PSP Program. However, the statistics are not presented in a specified National Forest Assessment Report. Accuracy assessment is not done for the statistics. • Carbon stocks are estimated for 2006- 2012, based no accuracy assessment is applied.	than the 1991 NFI. Information on upper bole diameters and top end diameters including branch sizes were not collected. Thus there is insufficient data to calculate growing stock, biomass, and carbon stock (FAO, 2015).). No statistical estimation procedures were provided for the NFI 2006. • No country-specific allometric model for biomass estimation is available. • Data collection protocol (SOP) of PSP Program is not developed. • The PSP Program is not consistent with the NFI 2006 in terms of sampling and response design. Therefore, both assessments should be treated as independent assessments. • No statistical analysis was employed to estimate the number of PSP needed to obtain results with a desired precision/ accuracy. • Forest inventory data collected by other (than state) initiatives or consultancies are not available at MoFo/MSD. • Forest stratification in the FRL differs from the one given in Fiji's Country Report to FAO FRA (FAO, 2015). Stratification provided in the FRA is based on forest cover maps produced by the SPC-GSD. To differentiate between closed and open natural forest, unsupervised classification techniques were used. No accuracy assessment (Olofsson et al., 2014) has been conducted on these maps, and their quality remains unknown. For the FRL, the available remotely-sensed data did not allow to reliably distinguish between e.g., closed and open forest.

4.2.2 Technical capabilities (Equipment and logistics) for National Forest Inventory (NFI)

Ministry of Forests mandated the MSD as a regular authority for the national forest assessment. But provided with limited capacities, the MSD assess only the PSPs biannually. An experienced and dedicated forest inventory team has been employed at the MSD. When the assessment takes place in the PSPs under a jurisdiction of a DFO, the MSD team is accompanied by the foresters from the respective DFOs. MoFo has established a database at the MSD based on PostgreSQL which is a

powerful, open source object-relational database system. The system host many features that safely store and scale the most complicated data workloads. In the system, the administrator can define own data types and write codes from different programming languages (e.g., R) without recompiling the database. The NFI 2006 data, timer series data of PSP Program and logging statistics are stored in the database. Built upon the existing database system, University of Hamburg developed a NFMS database system and provided seven Standard Operating Procedures (SOPs) (manuals) to maintain and run the database (see section 4.4 for detail).

There are Tablets with ODK Collect (an open source Anroid application) installation and digital forest inventory field data collection forms. Forest inventory crew can collect required stand level attributes and plot measurements, images from plots (damages or disturbances) and can record audio clips (explaining remarkable things found/noticed on the forest inventory plots/forest stands) in the Tablets and automatically transfer into the database at MoFo/MSD via internet. Moreover, the ODK Collect system applies 'hot checks' during the plot measurements, tree attributes in particular. If a data recorder entered a dbh or height value above or below of certain thresholds and misses to enter an attributes, the system immediately informs the recorder.

Table 10: Existing capacities and identified gaps regarding technical (equipment and logistics) capacities for the operational REDD+ NFMS

Existing capacity	**Gaps identified**
• MoFo mandated MSD for national forest assessment. • Well-developed PSP assessment planning • Regular budget within the MoF to assess the PSPs • The same team has been working for the entire PSPs since many years, and thus, consistency in PSP data • Forest Information Sector (FIS) database based on PostgreSQL is functional. • A NFMS database built upon the FIS database • REDD+ Unit supports forest monitoring equipment and logistics • Forest inventory team has recently been equipped with relevant equipment such as tablets with ODK Collect, vertex IV, laser rangefinder, spherical crown densitometer, D-tapes and Garmin GPSMAP • DFOs received some pairs of the equipment • Enough vehicles available • An inventory work station at MSD with computers, desks, internet facility and storage facilities • SPC-GSD, CAFF at FNU and GIZ are the other	• Field equipment for forest inventory and PSP assessment were not adequate. However, recently the MoFo purchased forest inventory instruments and stored it in the MSD. • The PSPs are mostly assessed by the forest technicians (Forest Guards). The field supervision of the forest inventory work by the respective Divisional Forest Officer and senior officers at MSD is generally lacking. • The building which hosts the forest inventory work station is old and has a problem of water leaching through wall. Hardcopies of the inventory data might get damages quickly. • No QA/QC methods are applied for

institutions with relevant technical capabilities except the MSD and DFOs.	the PSP

4.2.3 Human capacity

Fiji had benefited from support to develop forest inventory expertise (See Chapter 3). However, the capacity building efforts were mostly event based and without a concrete capacity development plan. The capacity building activities were mostly carried out by certain projects and without the assessment of capacity needs and gaps. For example, there is no capacity to analyse the data of the forest inventories conducted in the past and report them. National forest assessment reports for the last two NFIs were not prepared (see Table 11). This indicates that expertise for processing, analysing and reporting forest inventory data is missing. This suggests that an approach along traditional lines with capacity building (event-based, project-based) and only provision of equipment might not result in sustainable and enhanced capacity (Hardcastle et al., 2008).

Expertise and resources exists for in-situ assessments for the PSP program and conventional forest inventory (see Table 11). Existing PSP Program and the last three NFIs were not designed for carbon stock assessments. The NFI which provides the data for the REDD+ NFMS shall include all the (five) carbon pools identified by the IPCC (2003, 2006) and use the IPCC guidance and guidelines. The NFI must include the data on biodiversity and forest disturbances to provide information related to Cancun safeguards. Understanding of deforestation and forest degradation drivers and processes influencing terrestrial carbon is essential. Very limited knowledge and understanding of IPCC guidance, REDD+ relevant national and international negotiations and decisions and understanding of processes influencing terrestrial carbon stocks exist at the central level, but completely missing among forestry technicians working at MSD, DFOs and Forest Beat Offices (FBOs).

Each year, MoFo publishes annual reports which describe the current status of Fiji's forest resources. Forest statistics are published in forest statistic booklets. The MoFo also publishes annual business plan and forestry business guides. This demonstrates some professional report writing skills exist within the MoFo. However, expertise in accounting and reporting procedures for LULUCF using the IPCC GPG (IPCC, 2003) is missing. Expertise in reporting on REDD+ results through annexes to the BUR need to develop thoroughly and straight away.

Current ODK Collect data collection applies hot checks in the field. Central database system (Server) also sends information to data sender about missing data (missing field) once the filed forms are received through internet. But this is not adequate to ensure data quality of the inventory. A mechanism for the internal verification (Quality Control) of the forest inventory data should be established. DFOs can supervise the forest inventory and apply random cross-check of field assessment. Respective mataqualis can provide feedback. The human capacity for the supervision and verification mechanism within the MoFo is very limited. This needs expertise for accuracy assessment and error analysis and knowledge on approaches to handle and reduce uncertainties.

Table 11: Existing capacities and identified gaps regarding human capacities for the operational REDD+ NFMS

Existing capacity	Gaps identified
• In-house capacity for in-situ data collection: an experienced forest inventory team has been working at the MSD and has been assessing the PSPs biannually. • Database Officers are available in the MoFo. • The inventory crew and other professional forestry staff at the MSD are trained in ODK Collect, in-situ plot assessment using relevant equipment (vertex IV, laser rangefinder, spherical crown densitometer, D-tapes and GPS) and electronic data transfer. • Experienced forest technicians available at DFOs and BFOs.	• Knowledge and understanding of IPCC guidance, REDD+ relevant national and international negotiations and UNFCCC decisions is very limited at (policy or) national level, but missing at divisional/provincial level. • The inventory crew does not have knowledge on REDD+ implementation, accuracy assessment and forest assessment reporting. • Knowledge about carbon pools and understanding of processes influencing terrestrial carbon stocks is very limited. • Expertise on forest carbon stock assessment is limited. • Expertise on verification procedures is missing • All three NFIs in the past were designed and carried out by external consultants; PSP Program was designed by external consultants with a minimal involvement of national expert. There was a little institutional memory with the MoFo about the designs and the NFI assessments. • Expertise dealing with technical challenges of sample design and plot configuration is inadequate. • Capacity for reporting is limited.

4.2.4 Capacity building facilities

There was an International Tropical Timber Organization Diagnostic Mission to Fiji in 2004. The mission concluded that SFM was nowhere being achieved in Fiji. The reason is not a lack of knowledge of what SFM is, but an inability to apply that knowledge (ITTO, 2004). Once a country acquire capacities, it needs to keep investing in the national forest monitoring programme in order to maintain and retain its capacities (Romijn et al., 2015). The country had conducted two consecutive NFIs between 1991 and 2007. Establishment and assessment of 86 PSPs in 2010, and three consecutive repeated measurements of the PSPs (2012, 2014, 2016) were achieved. This

indicate that the country has capacities, but the country is not updating its' NFI and inadequately investing in its' forest monitoring system.

Table 12: Existing capacities and identified gaps regarding training facilities for the operational REDD+ NFMS

Existing capacity	Gaps identified
• REDD+ Unit established within the MoFo and is being equipped with required equipment for forest inventory. • Training venues are available (MoFo, MSD, Fiji Revenue and Custom Services, Nasase) • Local experts are available for conventional forest inventory trainings (FNU, SPC-GSD).	• Government forestry training institutions do not provide training on forest inventory; and are much focused on timber harvesting. • Lack of budget allocations for staff training • Lack of motivation among staff for trainings • Training to the right persons is an issue. • Not many opportunities to participate on training and seminars (in country and outside the country) available to the foresters working at DFOs and FBOs. • Limited number of staff at the MSD, and thus overburdening the limited number of staff at MSD

Besides the carbon pools, the operational national forest monitoring system should also consider the ecological potential for wide variety of natural forest types from Lowland Rain Forest, Cloud Forest to Dry Forest (Mueller-Dombois and Fosberg, 1998) as well as increasing disturbances on forest stands. Considerable capacity improvements are needed to enable MoFo and its divisions to carry out regular NFIs. As suggested by Hardcastle (2008) that traditional approach of capacity building and provision of equipment might not ensure sustainably enhanced capacity, an innovative capacity building approach is needed. The approach should consider data needs, IPCC guidelines and guidance, multiple national and international reporting requirements, and most importantly, country circumstances (bio-physical, socio-economic conditions).

4.3 Greenhouse gas inventory (GHG-I) capacities

4.3.1 Context of REDD+ reporting and Fiji National Communications and greenhouse gas inventory

Fiji intends to achieve 'sustainable management and development of forestry resources' which is a the policy goal of Fiji's 5- Year and 20- Year National Development Plan (NDP) through a course of strengthened sustainable management of its forest resources (Policy objective). To achieve the objective, Fiji will employ several strategies: strengthen efforts on forest conservation, sustainable

forest harvesting practices, climate change mitigation and adaptation and long-term leasing mechanism(s) to support forest conservation, forest concessions and plantation leases. Developing New Forest Act, National Planation Policy, and Fire Management Strategic Plan, managing more than 5% of total forest area under long-term conservation and regular monitoring of PSPs (50 plots per annum) by 2021 are some highlighted programs within the portfolio of multiple projects (Government of Fiji, 2017a).

Fiji has been submitting near-term targets to address GHG emissions, called NDCs. Fiji NDC is specific to the national energy sector, where it aims to achieve a 30% reduction in carbon dioxide (CO_2) emissions compared to a business-as-usual (BAU) scenario by 2030 (Government of Fiji, 2015). Furthermore, in accordance with Article 4, paragraph 19 of the Paris Agreement, Fiji will strive to formulate and communicate long-term GHG emission development strategies. By 2020, the country will develop mid-century long-term low GHG emission development strategies, laying out a plan to deeply decarbonize the Fijian economy by 2050 (Government of Fiji, 2017a).

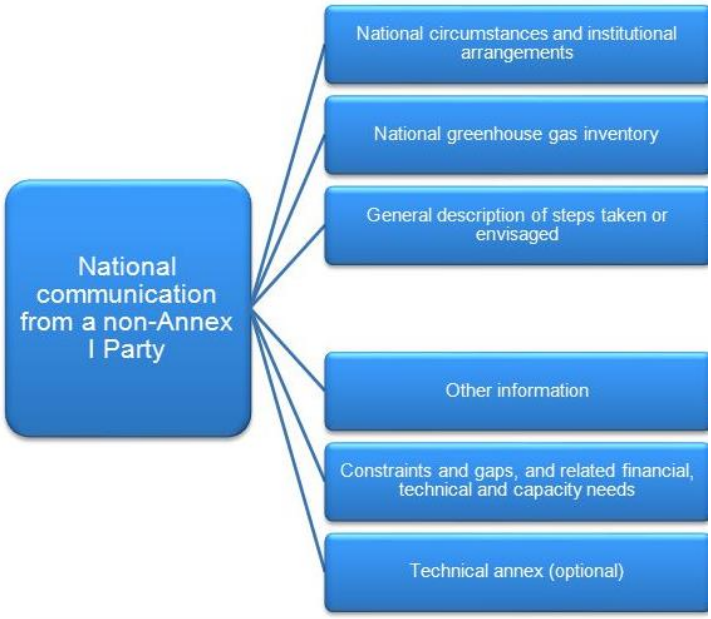

Figure 6: Figure Key elements of national communications

NC constitutes an element for the existing framework for MRV under the UNFCCC for developing country parties. The NC is at the core of reporting on the progress in the implementation of the Convention. This is a reporting document to be submitted periodically by all Parties to the Convention containing information on their emissions of all GHGs not controlled by the Montreal Protocol, and on the steps taken or envisaged to implement the Convention (United Nations Climate Change Secretariat, 2014). The developing Parties need to submit the NC every four years and a BUR every two years. However, the least develop countries (LDCs) and Small Island Developing States (SIDS) may submit BURs at their own discretion.

A national GHG-I is a key element of the NC (United Nations Climate Change Secretariat, 2004) (Figure 6) and contains the information on GHG emissions and removal. Non-Annex I Parties are required to prepare and submit a national inventory report as part of their BUR. Moreover, the Parties need to describe the constraints and gaps, and related financial, technical and capacity needs in the NCs.

Fiji's first GHG-I was reported in the Initial National Communication (2005) (INC) based on the data of 1994. The second GHG-I was reported in its' Second National Communication (SNC) to the UNFCCC in 2014. The annual GHG emissions for Fiji were -6310 and -5278 Gg CO_2e in 1994 and 2014 respectively. Fiji reported GHG ERs from Land Use, Land Use Change and Forestry (LULUCF) in the SNC. However, estimated GHG ERs from the LUCF were for the year 2004. The calculation of ERs has closely followed the IPCC Revised 1996 Guidelines utilizing Tier 1 default values where applicable and available (Government of Fiji, 2014).

Fiji is currently preparing its Third National Communication (TNC) using the GHG data from 2006 to 2011. The country has estimated its GHG emissions to be approximately 2,700 Gg CO_2e in 2011, of which 59% comes from the energy sector, 22% from agriculture, 15% from forestry and 4% from waste (as cited in Government of Fiji, 2017b).

REDD+ supports Fiji's commitment to reduce carbon emissions. Fiji's NDP envisaged REDD+ as a long-term conservation initiative which protects the forest and generates financial benefits under carbon-trading mechanism. To take the opportunity of a results-based payment, REDD+ activities for which payments are being sought, need to undergo to an international MRV. The country needs to report REDD+ results in a technical annex to the BUR. The BURs may undergo an international consultation and analysis (ICA) process for technical analysis. The technical analysis in decision 2/CP.17, annex IV, paragraph 4 referred to a technical team of experts (TTE). As a part of the technical analysis of the BUR, the TTE shall analyse the extent to which:

- There is consistency in methodologies, definitions, comprehensiveness and the information provided between the assessed reference level and the results of the implementation of the activities referred to in decision 1/CP.16, paragraph 70
- The data and information provided in the technical annex is transparent, consistent, complete and accurate, and is consistent with the methodological guidelines on REDD+,
- The results are accurate, to the extent possible.

GHG-I covers ERs of direct GHGs (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs), sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3)) from five sectors (energy; industrial processes and product use; agriculture; land use, LULUCF and waste). Fiji includes national inventory reports (NIR) on GHG in its TNC. In its TNC, Fiji (must) describe any constraints and gaps, and related financial, technical and capacity-building needs associated with not only with the NIR, but also the preparation and improvement of the NCs as a separate section. Therefore, to assess the existing capacity, capacity gaps and to suggest the capacity development strategy for the GHG-I is not the scope of the present document. However, following section deals with the capacity assessment related to forest sector of the GHG-I.

4.3.2 Data availability and accessibility

Preparation of NCs is executed by the Ministry of Economy. The NC requires data for the five different sectors and the sectors are under the custodian of various ministries, departments and authorities. Gonelevu et al. (2016) provides Fiji climate change/information custodian map which presents a schematic overview of national ministries and departments and regional and international organizations who holds and shares the data (Figure 7). They also provide Fiji climate change/information registry which includes a comprehensive list of national entities, title of resources, brief description of the data, owner or publisher, resource type, data format, location of the resource, contact person and accessibility of the data. The document is available in Pacific Climate Change Portal[10].

For the forest sector data, MoFo and its divisions and REDD+ Unit, Colo-I-Suva are the major sources. Ministry of Lands and Mineral Resources, SPC-GSD and Ministry of Agriculture are the sources for geospatial information of Fiji. The USP and FNU have considerable research-based information. Table 11 presents availability of data to prepare the GHG-I of the forest sector.

Table 13: Data needs and availability of data relevant to greenhouse gas inventory-forestry sector

Data needs	**Availability**
Activity data: Forest land converted to cropland, grassland, wetlands, settlements and other land use categories; and vice-versa	• Partially available • Approach 3 • Fiji REDD+ FRL does not distinguish between different land-use categories (e.g., Cropland, Grassland, Settlements, etc.)
Forest harvesting statistics (Forest degradation- Forest Land remaining Forest Land)	• Available, Fiji REDD+ FRL
Emission factors: Carbon stock changes, emissions and removals	• Available, Fiji REDD+ FRL • Tier 2
GHGs	• Partially available • CO_2, CH_4, N_2O • Emission from fires – not assessed!
Carbon pools	• Partially available • Soil organic carbon (SOC), litter, deadwood and harvested wood products – not assessed!
Quantitative assessment of uncertainties (Activity data, EF data)	• Available, Fiji REDD+ FRL • Sources of uncertainties systematically and consistently identified, assessed, managed and minimized to the extent feasible.

[10] Available at: https://www.pacificclimatechange.net/document/pacific-iclim-climate-change-data-and-information-stocktake-fiji-tonga-and-vanuatu-june

	• Remaining uncertainties are quantified using accepted international standards including Monte Carlo simulations • Uncertainty of ERs associated with deforestation, forest degradation and enhancements are reported separately

4.3.3 Current capacity, capacity building and gaps

The GEF through the United Nations Environment Programme (UNEP) provided funding to prepare the GHG-I report as a key component of the TNC. The capacity of the country has been strengthened through several global initiatives (GEF, the Coalition of Rainforest Nations) and regional projects, for example, Strategic Programme for Climate Resilience (SPCR) for the Pacific Region (supported by Climate Investment Fund).

A technical training and hand-holding workshop on development of GHG-I was organized for relevant stakeholders on 21-22 June 2016 as a part of the TNC project activities. The training was conducted at the ICT Center of the USP. The overall objective is to empower the stakeholders in Fiji to achieve the necessary level of expertise to develop GHG-I through data collection, analysis, monitoring and reporting procedures as required by the UNFCCC.

As mentioned before, the TNC presents a capacity assessment as a separate section. Therefore, to assess the Fiji capacity of the GHG-I is neither the scope of this document nor a ToR of this consultancy. This document presents the assessment of forest area change monitoring and RS capacity (Chapter 4.1) and forest inventory capacity (Chapter 4.2) in relevance with the operational NFMS. The assessments are equally relevant to the Fiji capacity assessment of the GHG-I of the forest sector. The data sources and the responsible national stakeholders for the both processes are the same government ministries, departments and divisions. Moreover, the present document highlights the some of the existing capacities and major gaps in the following section.

Climate Change Division (CCD), and Climate Change and International Cooperation Division (CCICD) are rigorously involved in the TNC preparation and coordination. However, coordination with other data points, for example, joint work and sharing between the GHG-I team and forest inventory experts of the MoFo needs to be strengthened. This will bring a higher synergy for the both processes, GHG-I for NC and NFI for FAO FRA and REDD+ NFMS.

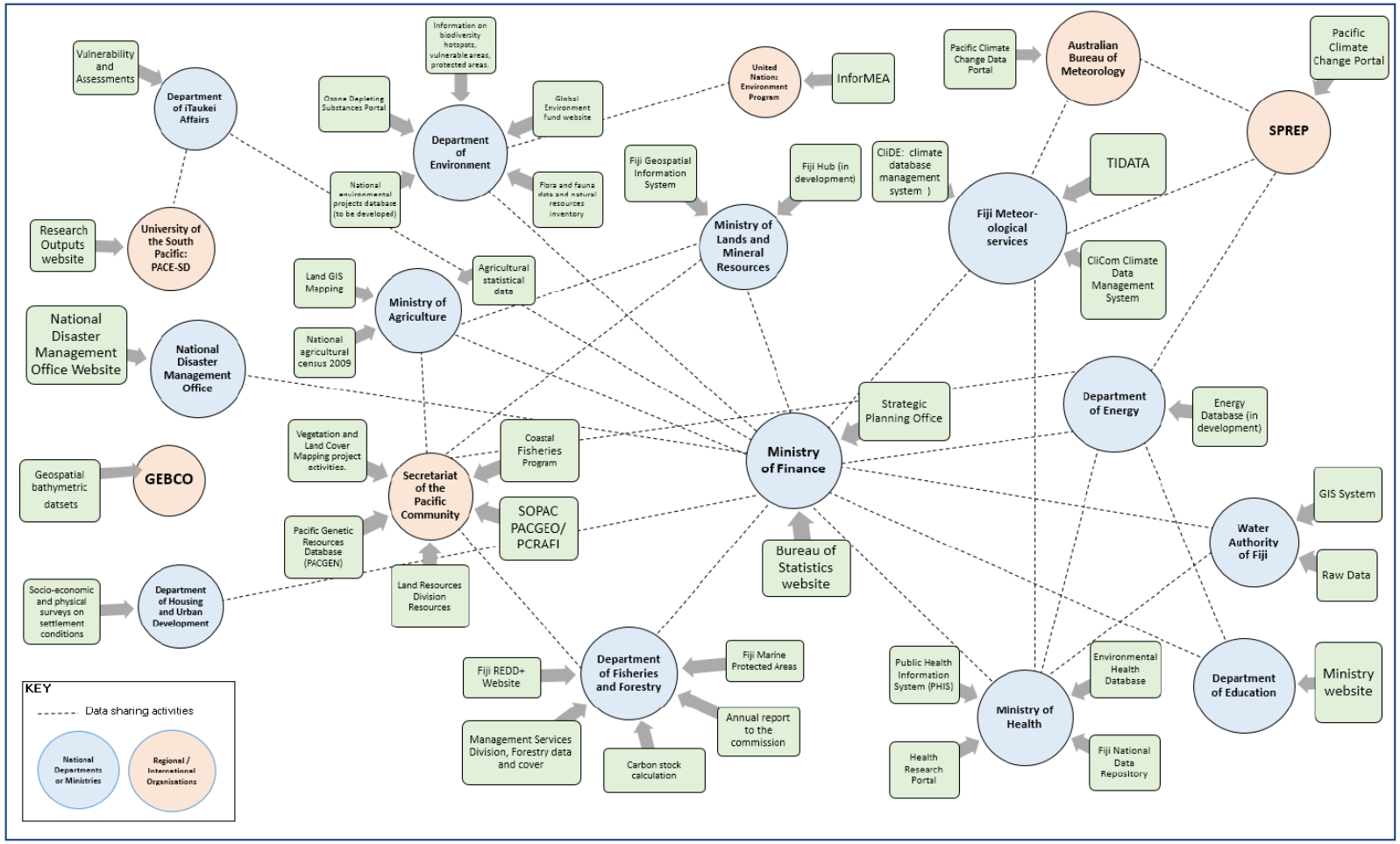

Figure 7: A schematic overview of Fiji climate change data/information custodian map (Gonelevu et al., 2016)

Fiji is working on the TNC, implies that a strong capacity exist for data collection, compilation and archiving. The staffs at CCD and CCICD are good on handling web-based software tool developed by UNFCCC Secretariat, training materials provided by CGE, and IPCC Inventory Software based on the 2006 IPCC Guidelines for national GHG-I.

However, outsourcing foreign experts to prepare the NCs including GHG-I is the major capacity limitation in Fiji. Majority of developing countries have limitations in providing a complete and accurate estimation of GHG ERS from forest land (GOFC-GOLD, 2016), so is the case in Fiji. Using IPCC guidance and guidelines and demonstrating 'good practices' are still persistent issues in the international reporting. There is a significant capacity gaps to be fulfilled on quality control (QC), quality assurance (QA) and uncertainty quantification, reduction, management and reporting for the development of the GHG-I.

4.4 NFMS database management capacities

4.4.1 NFMS database management system

In Fiji, a Forest Sector Information System (FSIS) is operational. However, the FSIS is rudimentary and includes only few sectors of the NFMS. There are three database systems, they include:

(1) **National Forest Inventory (NFI) Database**: NFI database stores data of NFI 2006 and the PSP Program (PSP plot assessment: 2010, 2012, 2014, and 2016). No statistically sound evaluation procedures are available. The database is hosted at MSD.
(2) **Timber Revenue System Database (TRS)**: Information contained in TRS includes concession number, timber volume logged and year of logging. Area of the concession license is not available. TRS is hosted at MoFo and linked with DFOs.
(3) **Harvested Area Reporting (HAR)**: HAR contains GPS measurements of logged forest areas. The measurements are provided by FBO foresters. Areas are available as shape files. HAR is hosted at MoFo and linked with DFOs.

NFMS Database, a key element of REDD+ NFMS, builds upon those existing FSIS or databases. Information or data collection for the database are accomplished either by the DFO/FBO foresters (for TRS and HAR) or by forest inventory technicians at MSD, and/or DFOs (for PSPs). NFMS database is operated and maintained by the database administrators at MoFo. Thus, NFMS database of Fiji is entirely country driven (Decision 12/CP. 17).

NFMS database is established at MoFo and is linked with the TRS and HAR at DFOs. Decision on database access and integration of the database with other databases operational in different ministries and departments will be decided by the Fiji government. A NFMS database protocol needs to be prepared.

Along with establishment of the functional database that complies with national (e.g. FSIS) and international requirements (REDD+ results reporting as a technical annex to BURs), the consultant produced seven sets of SOPs which cover a complete NFMS database establishment and maintenance. The SOPs provides design decisions and explanations of the decisions along with database establishment process, and future work on the database.

The SOPs were as following:

1. Fiji NFMS database: Actors, Business processes, Use cases, data/account management activities, and NFMS design,
2. NFMS client desktop set-up,
3. NFMS database maintenance,
4. ODK Aggregate maintenance,
5. ODK collect setup for survey devices,
6. NFMS server installation, and
7. NFMS web application maintenance.

4.4.2 Capacity gaps and capacity building regarding the database establishment and execution

University of Hamburg and INTEND Geoinformatik GmbH, Germany jointly conducted a technical training on 'Capacity building for NFMS database' on 25 September- 09 October 2017, as a part of the current consultancy. The training was conducted at MSD meeting hall. Field work was conducted in the Colo-I-Suva Forest Park. Primary objective of the event was to impart necessary knowledge for installation and operation of the NFMS database. The event consisted of a sequence of short theoretical explanations followed by a practical demonstration of relevant activities. To deepen the acquired knowledge, the activities were subsequently carried out independently. All activities have been documented. Participants were Mr. Timoci Lagataki, responsible for system administration, forest inventory crew (MSD, MoFo) and representative from relevant organizations (e.g., GIZ, Ministry of Economy) for the part of the field survey.

During the training, the following skills for the execution of the tasks of the NFMS database were taught.

- Data management (processing, storage);
    - NFMS client desktop setup for data processing (see technical documentation NFMS client desktop setup- SOP submitted to MoFo)
        - Setup MS Access
        - Setup QGIS
- Automatic transfer of collected data from electronic devices into the database at MSD, via cloud server, with physical backup on servers at MoFo and its partners;
    - Setup and manage ODK Collect for survey clients (see technical documentation ODK Collect setup for survey devices (tablets)- SOP submitted to MoFo)
        - Install and configure ODK collect

        - Download surveys
    - Administer ODK Aggregate (see technical documentation NFMS ODK Aggregate maintenance- SOP submitted to MoFo)
        - Create a survey
        - Alter an existing survey
        - Administer survey data
        - Update data migration for surveys
- Easy extraction of collected data for different purposes (carbon, biomass, merchantable timber, biodiversity, social safeguards information, etc.);
    - Administer NFMS Web application (see technical documentation NFMS Web application maintenance- SOP submitted to MoFo)
        - Manage users
        - Manage monitoring documents
        - Configure data extraction
        - Link Geo data
        - Configure analysis scripts
- Link database to other national systems (Ministry of Lands, Department of Environment, Ministry of Agriculture, etc.) and USP and SPC;
    - Manage data form other systems (see technical documentation NFMS data maintenance- SOP submitted to MoFo)
        - Manage activity data
        - Manage logging data
        - Manage plantation data
        - Add GIS data to the NFMS PostGIS database
        - Publish GIS data in GeoServer
- Run the database independently after consultancy ends;
    - Maintain NFMS data base (see technical documentation NFMS data base maintenance- SOP submitted to MoFo)
        - Account management
        - Backup and Restore
    - Reinstallation of server software after disaster crash (see technical documentation NFMS server installation- SOP submitted to MoFo)
        - Database PostgreSQL
        - Application server timcat
        - Survey Server ODK Aggregate
        - Statistics Software R
        - NFMS Web application
        - GeoServer

The SOPs facilitated the training. The training was divided into two areas of expertise:

(i) Instalment and operation of the NFMS database

The capacity building was carried out accompanying the construction of the NFMS database. All activities were carried out together with Mr. Lagataki, the person responsible for the database and the operation of the system. The conditions and background were explained. The steps to be performed were demonstrated and documented at the setup of the test environment. Questions from the administrator were immediately discussed and answered. In order to consolidate the skills learned and to identify any further specializations, the administrator carried out the development of the productive environment under supervision independently. The identified gaps were closed directly.

(ii) Set up and configuration of field surveys

A second part of the capacity building dealt with the knowledge of configuring and using the ODK Collect software to carry out field surveys for the field crew. In a 2-day workshop, a prototype of a PSP survey was developed together with the field crew. The workshop consisted of live presentations of the software via projector to impart the necessary knowledge through INTEND and subsequent independent work in two teams to apply the knowledge to configure a survey. The experiences of the teams were exchanged at regular intervals. At the end of the workshop, a field test with the survey prototype was carried out.

After the training, a continuous support is being provided through virtual meetings and discussions, and document exchanges.

4.4.3 Capacity assessment for the NFMS database system

Fiji NFMS database builds upon the existing FSIS or databases (section 4.4.1). A significant capacity gap exists for database management. During the consultancy period, several capacity building activities were carried out (See Chapter 3 and previous section) to address the capacity gaps. A database (NFI, TRS and HAR) administrator Mr Lagataki (from MoFo) was put for the on-the-job training particularly for the national database design, establishment, maintenance and administration. However, the capacity building activities related to database was interrupted for few months due an absence of the principal database administrator Mr. Lagataki[11]. Once Mr Lagataki resumed his office, the capacity building activities related to database continued.

Table 14 below presents the capacity assessment of the Fiji REDD+ database establishment and smooth implementation and maintenance.

[11] Mr. Lagataki was not able to join the MoFo for few months. Efforts were paid by the MRV consultancy to train another staff from the MoFo, but were not successful as expected.

Table 14: Capacity required, existing capacities and identified gaps regarding database for the operational REDD+ NFMS

Capacities required	Existing capacity	Capacity gap
Hardware		
Productive PostgreSQL database server	Exists	
Staging PostgreSQL database server	Exists	
Productive web application server	Exists	
Staging web application server	Exists	
Client Desktop for administration	Exists	
• Mobile devices for field survey • Rugged tablets with Android OS	Exists Exists	
Software		
PostgreSQL Server	Exists	
GeoServer	Exists	
ODK Aggregate	Exists- open source	
ODK Client	Exists	
MS Access	Exists	
QGIS	Exists	
R-Software	Exists- open source	
Logistics		
Access to Server system from Client (VPN)	Exists	
Web Access for Field Survey Upload	Exists at regional offices	
Domain for Web Server	Exists	
Remote control sessions	Exists	
Human resources		
System administrator with all technical skills	Exists	
Backup system administrator with all technical skills	Missing	Missing
PostgreSQL Database administration skill	Exists	
Web server administration	Exists	
GeoServer Administration	Initial capacity	Practical knowledge
R-Script administration	Exists	
MS Access use and customization	Exists	
QGIS use	Initial capacity	Practical knowledge
ODK Aggregate Administration	Exists	
ODK Collect configuration	Exists	

5 Capacity gaps assessment based on three phases of NFMS: Planning and Design, Monitoring and Analysis and Reporting

The GOFCGOLD REDD+ Sourcebook (GOFC-GOLD, 2016) presents a summary of key components and required capacities for establishing a national monitoring system for estimating emissions and removals from forests. The components are assigned for three different phase of the development of NFMS, (i) Planning and design phase, (ii) Monitoring phase, and (iii) Analysis and reporting phase.

Existing capacities and capacity gaps were assessed for each of the required capacity (indicators) as suggested in the Sourcebook (GOFC-GOLD, 2016, p. 248, Table 4.2.1). Key components, required capacity (indicators), existing capacity and capacity gap are summarised in a Table 15, 16 and 17 below.

Table 15: Components and required capacities for establishing a national monitoring system for estimating emissions and removals from forests: **Planning and design phase**

Component	Capacity required	Existing capacity	Capacity gap/ Capacity development needs
1. Need for establishing a forest monitoring system as part of a national REDD+ implementation activity	1. Knowledge on international UNFCCC decisions and SBSTA guidance for monitoring and implementation	• National engagement to and understanding of UNFCCC negotiations and REDD+ processes is high. • Regular participation in SBSTA meetings • Two NCs submitted to the UNFCCC. TNC is under preparation. • R-PIN, RPP and ER-PIN are available. • ERPD will be submitted by June 2019.	• Knowledge on UNFCCC decisions and SBSTA decision/guidance for monitoring and implementation is medium; and limited to and concentrated with policy-level officials. • NCs are prepared by foreign consultants, and funded by GEF through UNEP. • Estimates in ER-PIN are mainly ad-hoc. • ER-PIN and ERPD are mostly consultant driven, national stakeholders are feedback providers, but are not contributors. • Training and awareness needed on decision making and most importantly planning and design elements, implementation plans, and monitoring and reporting requirements. • Involve government staff and recruit local staff for REDD+ processes as much as possible. • Orientation trainings/seminars on international UNFCCC decisions at national and divisional level. • Raise fund to participate in or organize dedicated national or regional workshop.
	2. Knowledge of national REDD+ implementation strategy and objectives	• Fiji REDD-Plus Policy 2011 defines REDD+ objectives. • General knowledge exists with MoFo, mostly at policy level.	• REDD+ strategy has not disseminated to implementation level yet. Non- forestry sectors also have fair knowledge of REDD+ implementation strategy. For example Land Department, Agriculture and Mineral have fair knowledge of REDD+ strategy. • Knowledge of REDD+ implementation strategy at village and Mataqali level is low. • Discussion and collaboration with other relevant government departments and stakeholders is essential.

Component	Capacity required	Existing capacity	Capacity gap/ Capacity development needs
			• BFO and Villagers are main implementers of REDD+, hence FBO and villagers should be fully informed. • Develop REDD+ Implementation Framework • Build knowledge across line ministries to address cross sectoral issues of REDD+ and to streamline REDD+ into national development plans and climate actions. • Knowledge transfer from nucleus of the MoFo (policy level) to DFO and FBO level
2. Assessment of existing national forest carbon monitoring framework and capacities, and identification of gaps in the existing data sources	1. Understanding of IPCC LULUCF estimation and reporting requirements	• Fiji reported GHG ERs from Land Use Change and Forestry (LUCF) in SNC (2014). Calculation of ERs has closely followed the IPCC Revised 1996 Guidelines utilizing Tier 1 default values where applicable and available. • TNC is under preparation. • Capacity exists in CCICD of MoE.	• Fiji has fair understanding of IPCC LULUCF estimation and reporting requirement. Mostly foreign experts are engaged for preparing the reports. • GHG ERs estimates from LULUCF should be reported at least on Tier 2 level. • Due to lack of activity data, estimates produced in the REDD+ FRL do not comply with the IPCC land use categories. • Subdivide forest land according to forest management practices and forest types to operationalize and implement NFI for REDD+. • Capacity building on estimation and reporting of the GHGs is needed for forestry technicians that are involved on the field. • More trainings and awareness needed to understand applicability of estimation and reporting requirements. • Training on IPCC guidelines and guidance • Training on reporting: GHG-I, BUR and REDD+ Annex
	2. Synthesis of previous national and international reporting (e.g. National Communications to	• Fiji submitted INC and SNC to UNFCCC; TNC is under preparation. • Fiji reported GHG ERs from LUCF in its SNC and TNC.	• See above. • No resource assessment report prepared for the last two NFIs • Enhance information sharing across sectors. Effectively communicate and disseminate (synthesized) information on

Component	Capacity required	Existing capacity	Capacity gap/ Capacity development needs
	UNFCCC, and FAO Forest Resources Assessment)	• Capacity exists with CCICD of MoE. • Capacity in MoFo is limited.	GHG-I and forest information across sectors and relevant stakeholders. • Engage country experts continuously with foreign expert- **country experts as contributors, not as feedback providers**- to develop a capacity of synthesising previous communication report and developing new reports. • Build capacity of MoFo/MSD on data cleansing, analysis, interpretation of results and derivation of required information and reporting in standard formats (e.g. FAO FRA).
	3. Expertise in estimating terrestrial carbon dynamics, related human-induced changes and monitoring approaches	• Limited capacity within MoFo, MoA, Ministry of Lands and Mineral Resources (MoLMR) • Capacity exist with the CCICD (e.g. report to UNFCCC on NCs and NDC, preparation of LEDS) • So far Fiji estimated carbon dynamics is with support of SPC-GSD. • USP retains that capacity to some extent.	• Estimation of terrestrial carbon dynamics is carried out with support of foreign experts. • Fiji government has limited capacity using RS approach to estimate carbon dynamics. • Collaboration with national and international universities is desirable to enhance national capacity. • Active engagement of government staff with foreign experts during planning and design phase is essential. • Establish a database system/data hub/data lake, that is accessible and provide updated information • Capacity development for the database system • Advance data collection tools and monitoring methods
	4. Expertise to assess usefulness and reliability of existing capacities, data sources and information	• Fiji has done some analysis of data and information with support from foreign experts. Example includes Payton and Weaver (2011) who carried out Fiji National Forest Carbon Stock Assessment. Likewise Haas (2015) studied Carbon Emissions from Forest Degradation caused by Selective Logging in Fiji.	• MSD is responsible for the forest monitoring activities and data analysis. However MSD lacks such capacity. • Create positions for forest biometrician, statistician and GIS/RS graduates and deploy them for analysis of data and information. • Alternatively, MoFo can send the existing government staff for higher study at USP and abroad for training and academic

Component	Capacity required	Existing capacity	Capacity gap/ Capacity development needs
			courses. • This document presents a comprehensive overview of the capacity needs and existing capacities. • Create an archive repository to store data and documents. • Assess reliability of data sources and information collected.
3. Design of forest monitoring system driven by UNFCCC reporting requirements with objectives for historical data and future monitoring	1. Detailed knowledge in application of IPCC LULUCF good practice guidance	• Fiji is regularly participating in UNFCCC technical meetings. • Knowledge exists primarily with focal points and Divisions/Sections within government such as MoFo, MoA, CCICD of MoE. • Most of tasks of NCs, LEDS, NFIs are led by foreign consultants. Thus, systematic institutional knowledge and institutional memory are missing.	• Lack of experience in application of the most recent IPCC guidance and guidelines • Much has improved over the years but there is still a need for more effective collaboration within line ministries across Agriculture, Forestry and Other Land Use (AFOLU) sector • Trainings and engagement of country experts with **proper and qualified foreign experts** is essential. • Design and introduce course on climate change and IPCC good practices guidance and guideline at National Universities such as FNU to produce human resource for long term. • A study is needed on: continuity and sustainability of existing knowledge, maintaining institutional memory • Trainings on application of IPCC LULUCF good practice guidance at central and divisional level
	2. Agreement on definitions, reference units, and monitoring variables and framework	• A NFMS including MRV of carbon ERs • A FRL for forest land, integrating all REDD+ activities, for the period of 2006-2016, fully documented and satisfying UNFCCC and FCPF standards • NFMS and FRL development methodologies are available	• Contested debate persists whether Mangrove is included with forest land or a separate LU category. • Quality of historical data (QA/QC- never applied) • Significant capacity development needed to design: ○ National Forest Inventory ○ Safeguard Information System (SIS) ○ REDD+ reporting
	3. Institutional framework specifying roles and	• MSD under MoFo is responsible for forest measurement, monitoring and developing	• Current MSD's institutional arrangement doesn't match fully with experts required for UNFCCC monitoring and reporting

Component	Capacity required	Existing capacity	Capacity gap/ Capacity development needs
	responsibilities	a report of the carbon change. • Under current institutional framework roles and responsibilities are clearly specified. • Forest officers deputed at DFOs and FBOs are important for execution of monitoring system in the future. Their roles and responsibilities are clearly specified but not for monitoring of carbon under REDD+. Their roles could be crucial for future REDD+ monitoring system. • The NFMS mentions the institutions and individuals with key roles and responsibilities in implementing the NFMS.	framework. It lacks human resources such as forest biometrician and RS experts. • Restructure the institutional arrangement of MSD and DFO considering the UNFCCC monitoring and reporting requirement. There should be positions of a forest biometrician/statistician and a RS officer at MSD. • Train MSD, DFO and FBO forest officers on forest inventory and forest assessment and UNFCCC reporting requirements. • DFO and BFO do not have much stake in REDD+ program. Involve them as much as possible. • There are overlapping functional mandates and jurisdictions between ministries. The cooperation between MoE and MoFo should be enhanced. If managed properly, this improves inter-ministerial and/or interdepartmental coordination and overall coherence. • Lengthy bureaucratic procedures often delay progress. Shorten it.
	4. Capacity development and long-term improvement planning	• MoFo is developing long term improvement planning and capacity development plan. • Recently, MoFo developed Forestry Sector Strategic Plan for 2017-2030 which include capacity building activities and long term plan. • This document presents: Capacity development strategy for MRV, including immediate trainings done in the consultancy implementation, and a future development plan	• Commitment at ministry level to implement the capacity development plans • Funding source and resource persons for capacity building

Component	Capacity required	Existing capacity	Capacity gap/ Capacity development needs
	5. Cost estimation for establishing and strengthening institutional framework, capacity development and actual operations and budget planning	• There is no specific information about the cost estimation yet. However, R-PP, Mid-term Progress Report submitted to FCPF (October, 2017), ERPD (e.g., summary of the 10-year financial plan for ERP period and beyond) and World Bank – Grant Reporting and Monitoring (GRM) Report provide some idea. • This document presents estimates (indicative only) for selected capacity development activities.	• No detailed cost estimation for establishing and strengthening institutional framework, capacity development and actual operations and budget planning. • Estimate cost for different REDD+ elements after finalization and approval of the elements.

Table 16: Components and required capacities for establishing a national monitoring system for estimating emissions and removals from forests: **Monitoring phase**

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
1. Forest area change assessment (activity data)	1. Review, consolidate and integrate the existing data and information	• MSD and Fiji REDD+ unit have three GIS professionals who are equipped with laptop or desktop workstations, and use primarily open source GIS software such as QGIS. • However, they are dedicated to other duties. • No RS analyst in the MSD, MoFo	• Technical infrastructure at MSD is partly outdated, and the restriction to open source software limits spatial data analysis in some respects. • Human and technical capacities are inadequate to support use and consolidation of existing data in an efficient way. • Appoint a RS analyst
	2. Understanding of deforestation drivers and factors	• Study on "Analysis of Drivers of Deforestation and Forest Degradation and Identification of Response Strategies" (DoDD) accomplished (by external consultants). • The GIS analysts have a reasonable understanding of the deforestation drivers and factors. • Knowledge available at MoFo, SPC' Geoscience, Energy and Maritime (GEM) Division, MSD, CI, USP and other organizations (CSOs, I/NGOs)	• No institutional and personnel regulation of responsibility
	3. If historical data record insufficient – use of remote sensing:		
	• Expertise and human resources in accessing, processing, and interpretation of multi-date remote sensing imagery for	• The GIS analysts have a basic training in image interpretation which allows them to use RS for mapping forest cover and change. • Experienced staffs are available at SPC-GEM Division; several land-use and forest area change assessments have been carried out	• Interpretation skills are heterogeneous as the analysts have different backgrounds. • A common interpretation key and a comprehensive training using a protocol could further improve the capability. • Set-up of an interpretation key for LC assessment and training • Application of innovative approaches to image analysis capable of

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
	forest changes	for Fiji and other Pacific Islands.	improvement; most of the expert knowledge lies with the head of the Geoscience working group of SPC-GEM; uncertain future after age-related retirement of the head of the Geoscience working group • Lack of sufficient knowledge in the field of accuracy assessments • Ensuring working capacity of the SPC-GEM for SLMS tasks • Securing of personnel capacities and training in the field of innovative methods for image analysis including Radar imagery • Training in the field of accuracy assessment
	• Technical resources (Hard/Software, Internet, image database)	• MSD- Mostly open source software such as QGIS • Hardware and software for image processing of data from passive satellite sensors are currently state of the art at SPC-GEM	• Technical infrastructure is partly outdated, and restriction to open source software limits spatial data analysis in some respects. • Procurement of at least one ArcGIS license would bridge technical gap • Capacities for the analysis of active sensors (e.g . RADAR) are not available • Capacity building for the analysis of active sensors (RADAR)
	• Approaches for dealing with technical challenges (i.e. cloud cover, missing data)	• The MSD receives image data already pre-processed from SPC-GEM. So there is no capacity in processing additional data if there is cloud cover. • With SPC-GEM, limited expertise available	• Sufficient data are not available due to frequent cloud cover. • Poor detectability of degradation due to passive RS data • Possibilities to use more passive RADAR data (e.g. TerraSar-X) have to be investigated. If the methods proof successful, staff has to be recruited and software be purchased • Expertise for implementing new approaches is limited e.g. for increasing availability of data • Capacity for image data procurement, storage, and pre-processing should be established. • Training on data procurement and pre-processing.

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
	1. Consolidation and integration of existing observations and information, i.e. NFI or PSPs		
2. Changes in carbon stocks	• National coverage and carbon density stratification	• Recent NFI (2005-2007) covered entire country. The NFI (1023 plots) provides (almost) wall-to-wall data over forested areas (but limited attributes/variables). • PSP program contains 100 PSPs, of which 84 are regularly assessed every two years. • Forest area change assessment based on Landsat satellite imagery for period 2006-2016. • Field measurements used to estimate individual tree biomass and C-content via biomass models and C-conversion factors • Limited capacity to use robust technology carbon density stratification • The land use categories are limited to forest land and non-forest land only (non-forest land is not an IPCC land category!).	• A country should able to classify entire land into six broad IPCC land use categories. However, Fiji classified land into Forest Land and non-forest land. This is largely because of limited trained human resources and availability of undistorted satellite images. • Increase coverage to 100% of Fiji's forests • Improve existing biomass models • Train experts on RS and GIS. Use new image analysis techniques such spectral unmixing to identify different LU classes. • A country should be able to cover entire forest types and to stratify forest based on forest characteristics to investigate differentiation in C-contents. Stratify forests based on forest (vegetation) characteristics to reduce uncertainty in carbon stock estimates. Identify possible strata, for example, open forest, closed forest, native forest, woodlot • Limited capacity to stratify carbon density in terms of forest types, crown coverage, forest development stage (mature, immature). • Limited availability of remote sensing data. • Cloud cover and seasonality are other factors hindering availability of RS data.
	• Conversion to carbon stocks and change estimates	• Not all stratifications are associated with carbon stock difference. Only stratification into Pine plantation, Mahogany planation, Upland forests and Low land forests are	• See above. • A time series data of NFIs is needed to identify and quantify changes in forest covers and related C-stocks with desired accuracy.

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
		identified showing significant differences in C-stocks. • Limited capacity to estimate changes in above-ground biomass, below-ground biomass and litter.	• Little or no capacity to estimate changes in carbon stocks for deadwood and soil organic carbon (SOC)
	2. Technical expertise and resources to monitor carbon stock changes:		
	• *In-situ* data collection of all the required parameters and data processing	• In NFI 2006 and PSPs, assessments are restricted to individual trees. Not all parameters essential for C-estimation and IPCC reporting are identified and collected. • Mostly, parameters related to a single tree such as species name, DBH, height, crown coverage and crown diameter are collected. • Algorithms for analysis of data partially available (full set available for GHG-I). • Limited capacity exists for *in-situ* data collection of all required parameters, and data processing. • Excel is being used for data processing.	• Implement data assessment for C-pools: dead wood, litter and SOC. Measurement of PSPs does not include litter, deadwood, and SOC. Missing *in-situ* parameters are required to estimate accurate and precise amount of carbon. • Adjustment of data base for entire set of attributes to be assessed. • Quantify C-stocks of croplands, grasslands, wetlands, settlements and other lands to estimate of ERs due to LU conversion. • Include assessment of tree history code in field manual in order to assess forest degradation. • No expert available to use robust statistical tools such as R. • Training and regular use of R tool is essential. At least one officer of MSD and one officer of MoFo must have skills on use of R.
	• Human resources and equipment to carry out field work (vehicles, maps of appropriate scale, GPS, measurements units)	• Number of forestry technicians for PSP assessment is sufficient; however the inventory crew has limited knowledge on inventory methods and equipment. • Enough vehicles, GPS, inventory equipment at MSD which manage and oversee entire measurements.	• REDD+ activities will be implemented at divisional level and at Mataqali level in the future. Train forest officers deputed at the DFOs and FBOs on forest/carbon assessments and equipment use. • Provide sufficient inventory equipment, mobile data recording and logistics to the inventory crew at the MSD and forestry technicians deputed at the DFOs/FBOs.

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
		• Most of the technicians, equipment and logistics are centrally located. DFO level staff has very limited knowledge and skills on ground inventory.	• Training for existing field crews with respect to GHG-I issues • Develop field manuals • Forest officers deputed at DFOs have limited knowledge on forest management. They are basically trained according current forest management system of Fiji which is largely focussed on conventional logging of the natural forest. Training on Reduced Impact Logging (RIL) and sustainable/adaptive management of forests is required for DFO and FBO level forestry technicians. • Many types of forest maps were produced in the past but documentation of maps and methods of mapping is lacking. Moreover, no accuracy assessment was carried out for the maps. • Enhance GIS/RS skill of DFO staff • Improve RS/GIS facilities at MSD/DFOs
	• National inventory/permanent sampling (sample design, plot configuration)	• NFI 2006 collects data from forests across 7 major forested islands; provides data on forest resources available for multiple uses, protection or conservation. However, result of the NFI is not published yet. • PSP program contains 100 PSPs, of which only 84 have been measured regularly. • Mangrove is not covered by the PSPs. • Field guidance for PSP is available.	• Inadequate capacity to conduct next NFI, No capacity for sampling and response design, and statistical analysis of data • No capacity for sampling and response design for assessment of Mangrove, and statistical data analysis • Conduct data need assessment for next NFI and Mangrove assessment • Develop statistically sound and cost efficient sampling and plot designs for next NFI and mangrove assessment • Develop estimation and monitoring design for NFI at successive occasions • Select models to use (e.g. tree volume, biomass, stratification) • Develop methods for error assessment and QA/QC • Inventory planning • Supervision of field work • Develop human resources through long term and short term trainings and academic courses.

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
			• FNU has no forest inventory/ biometric course. Therefore, government should take initiative to introduce the courses into university curricula. • Fiji should make arrangement to sending its existing staff for forest inventory and statistical analysis trainings abroad • Fiji should initiate expert-exchange programs

	• Detailed inventory in areas of forest change or "REDD+ action"	• REDD+ is not implemented in the country yet. PSPs are established to monitor the forest but do not cover the entire country.	• A cost-efficient inventory concept needs to be adapted to the specific conditions of the inventory area for REDD+. Hence an estimation of an optimal number of sample plots is essential taking into account accuracy of carbon estimation.
			• Develop area frame sampling (or alternative) for inclusion of small islands
			• Implementation of a sample based NFI with PSPs allowing assessments at successive occasions
			• Implement approach to assess additionality for "conservation of carbon stocks"
			• Modify NFI estimation algorithms for estimation of CO_2 emissions of C-pools considering each sink/source category
			• Lab analyses for C-content of SOC and DOM (incl. field manual for sample collection, lab analysis manual, provision of lab capacities7facilities)
			• Implement algorithms in programming code for estimation of
			  ○ Forest degradation
			  ○ C-pools by sources and sinks
			  ○ Emissions from forestland fire

	• Use of remote sensing (RS) (stratification, biomass estimation)	• Discussed in depth in Component 4 of this table. • Forest area change assessment based on	• See Component 4 • Availability of RS data is a limiting factor because of absence of receiving station in the south pacific regions. Entire set of images

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
		Landsat imagery for period 2006 to 2016 • Capacities for remote sensing image analysis available at SPC-GEM	are not available for a year. Cloud cover and seasonality are other limitations for monitoring of forest change. • Establish a cooperation agreement between SPC and participating forest institutions, regulating tasks and responsibilities • Cost analysis of RS imagery and decision on satellite imagery to be used • Development of a work flow for satellite image interpretation • Development of interpretation guidelines • Securing the financial resources to procure RS data • Definition of responsibilities for satellite data analysis • Decision of use of high resolution image data for the assessment of drivers and development of guidelines for interpretation • Guidelines for classification of non-forest land-use categories (cropland, grassland etc.) • Guidelines on intersection satellite image classification with other spatially explicit data (e.g. PAN area, plantation area, digital elevation maps) • Cost and procurement planning for technical infrastructure (computers, storage media, image analysis software, etc.) • Purchasing data (RS imagery, digital elevation model, other georeferenced data) • Setting up/ enhancing RS analysis lab • Satellite image analysis including all LU categories • Intersection of GIS data and satellite image classification for further stratification • If necessary, procurement and interpretation of high resolutions and/ or RADAR imagery • Verification and implementation of results in database • Storage of all raw data sets for later access

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
			• Improve current stratification by integrating PAN as individual stratum in order to assess "conservation of carbon stocks" • USP and FNU offer introductory GIS courses and a few support activities are under development. The MoFo should collaborate with universities to produce human resources in RS/GIS.
	3. Estimation at sufficient IPCC Tier level for:		
	• Estimation of carbon stock changes due to land use change	• Estimation of C-stock due to deforestation used Tier 2. The EFs are estimated using existing NFI data. • Pantropical allometric equations for biomass estimation are adjusted using local parameters. • Wood densities are used being estimated locally. • It is assumed that once forest land converts into grassland in order to avoid over estimation of emission. • Procedures for estimation of emissions from conversion of forest land to non-forest land available.	• Develop allometric equations (biomass models) for selected native forest tree species, native forest types and mangrove to move to Tier 3. • Land use information after deforestation is essential - whether forest land converted into grassland, cropland or settlement. • Carbon density of the post land use after is essential. • Develop information on post land use (grasslands, croplands, wetlands, settlements and other land) after forest conversion • Quantify C-stock in grasslands, croplands, wetlands, settlements and other land • Link emissions from deforestation (forest land conversion) to C-stock remaining in grasslands, croplands, wetlands, settlements and other land, and vice versa
	• Estimation of changes in forest areas remaining forests	• Methodology for estimation ERs to sinks/sources, deforestation, forest degradation, enhancement of carbon stocks, sustainable management of forests and conservation of carbon stocks are available. • FRL used a proxy approach at Tier 2 level to estimate emissions from forest degradation.	• Emissions from fuel wood collection, subsistence logging, forest fire and SOC emissions due to logging were not included due to lack of information. • Include these emissions to assure comprehensiveness and completeness • Estimated growth in native forest under different logging intensities is not available. Therefore, Fiji used default value for

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
		• Selective logging is used as proxy of forest degradation. Logging data are collected from logging sites and taken from TRS and HAR database. • Estimates of Extracted Log Emissions (ELE), Logging Damage Factor (LDF) and Logging Infrastructure Factor (LIF) (Pearson et al., 2014, Haas, 2015) are available. • An adjusted allometric model is developed to infer oven-dry aboveground biomass of trees from the 2005 NFI data. Chave et al's (2014) model was adjusted using NFI data to enhance reliability of the adjusted model. • Demonstration plots are established at Nakabu village to estimate growth in natural forest under different logging intensities.	the growth. • Develop growth models for natural forests under different logging intensities based on the data from the demonstration plots established at Nakabu village. • The use of the locally developed growth model to estimate removals could be considered as Tier 3 level.
	• Consideration of impact on five different carbon pools	• FRL includes above and below ground biomass only. • Methods for assessment of C-pools aboveground and belowground biomass are available.	• No information available for other three C pools: litter, deadwood and SOC pools. • Include the assessment of missing C-pools (litter, deadwood and SOC) in next NFI and PSP assessments. • Consider understorey carbon
3. Emissions from biomass burning	1. Understanding of national fire regime and fire ecology, and related emission for different GHGs	• FRL does not take into account emissions from the forestland fire.	• No record available on forestland fire: frequency of occurrence, intensity, size, pattern, season and severity • Conduct research on GHG emissions associated with forestland fire • Develop and implement estimation procedures for NH_4 and CO_2 emissions from forestland fires. • Develop a cost effective RS based fire monitoring system using moderate resolution RS images such as Landsat TM/ETM and

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
			Sentinel-3 is appropriate.
	2. Understanding of slash and burn cultivation practice and knowledge of the areas where being practiced	• No information available about slash and burn cultivation practice	• Conduct research on slash and burn cultivation practice
	3. Fire monitoring capabilities to estimate fire affected area and emission factors (EFs):		
	• Use of satellite data and products for active fire and burned area	• Fiji has not used satellite data and product to identify active fire and burned area yet. • Due to lack of information, FRL excluded forestland fire from current forest carbon accounting. • Burned area resulting from the fire is too small to detect by coarse resolution images. • MODIS Active Fire data are available • MODIS Burned Area product does not cover Fiji.	• No capacity to use satellite technology to identify active fire and to estimate burned area. • Burned area can be estimated using a satellite image. Fiji does not have country specific estimates on fuel loading per unit area, combustion factor and emission factors (the amount of gas released or each gaseous per unit of biomass load consumed by the fire). • Area damaged by fire is relatively small. Thus, coarse resolution images cannot detect those areas while moderate resolution images (e. g. Landsat) have low temporal resolution to detect active forestland fire in Fiji. • Identify methods to estimate area of forestland fire • Develop estimates of fuel densities and combustion factors, and EFs associated with forestland fire. • Train MoFo staff on methods for assessment of burned area and active fire detection
	• Continuous *in-situ* measurements	• No such measurement to estimate EFs associated with forestland fire.	• Develop method and process to estimate EFs associated with forestland fire. Estimation of the EFs is essential to estimate

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
	(particular EFs)	• Burned area is not assessed.	emissions from forest degradation. • Develop and implement methodology for the assessment of burned areas. • Include parameters related to forestland fire in plot measurements of the subsequent PSP assessments and next NFI
4. Accuracy assessment and verification	1. Understanding of error sources and uncertainties in the assessment process	• Sources of uncertainties associated with the AD and EFs are systematically and consistently identified and assessed. • The uncertainties are managed and minimized to the extent feasible. Remaining uncertainties are quantified using accepted international standards (Monte Carlo Simulation) and reported in FRL document. • Accuracy assessment and verification using Tier 2 level • Done by the consultant, no capacity exists MoFo/MSD	• No capacity in country for accuracy assessment and verification using Tier 2 level. • Long-term training is essential on statistical analysis in particularly to the government staff. • Appoint experts: an expert (statistician/biometrician) under the Forest Inventory Section and a RS analyst under GIS/RS Section of the MSD. • Implement methodology in final NFI and GHG-I analysis routines
	2. Knowledge on the application of best efforts using appropriate design, accurate data collection, processing techniques, and consistent and transparent data interpretation and analysis	• Approaches described in the FRL-methodology documentation and applied in FRL construction • Fiji is using different sampling approaches/designs and response designs for forest inventories, PSP program and long-term demonstration plots. • To a limited extent, data processing and interpretation accomplished. • Limited knowledge and skills exist within the MoFo/MSD related to satellite image process, analysis and interpretation	• No statistical information about sampling approaches/designs and response designs for the past NFIs, PSP program and long-term demonstration plots exist. The tasks were accomplished by foreign consultants. • Implement known approaches in NFI and GHG-I design • Develop knowledge (through long-term training) on using appropriate design, accurate data collection, processing techniques and consistent and transparent data interpretation and analysis.

Component	Capacity required	Existing capacity	Capacity gap Capacity development needs
	3. Expertise on the application of statistical methods to quantify, report and analyse uncertainties for all relevant information	• Sources of uncertainties associated with the AD and EFs are identified and assessed. • The uncertainties are managed, remaining uncertainties are quantified using accepted international standards (Monte Carlo Simulation) and reported in FRL document • Mostly foreign consultants are involved in statistical analysis of data, and uncertainty assessment and reporting.	• Expertise on application of statistical methods is inadequate within the MoFo. • Train government staff on statistical analysis, accuracy/uncertainty assessment and reporting • Implement accuracy assessment in remote sensing analysis • Introduce QA/QC approaches in field assessments • Introduce Monte Carlo Methods or equivalent for the application of models Appoint experts: an expert (statistician/biometrician) under the Forest Inventory Section and a RS analyst under GIS/RS Section of the MSD.

Table 17: Components and required capacities for establishing a national monitoring system for estimating emissions and removals from forests: **Analysis and reporting phase**

Component	Capacity required	Existing capacity	Capacity gap/ Capacity development needs
1. Analysis of drivers and factors of forest change	1. Understanding and availability of data for spatio-temporal processes affecting forest change, socio-economic drivers, spatial factors, forest management and land use practices, and spatial planning	• Fiji identified drivers of deforestation and forest degradation (DoDD). • Data are available for spatial temporal analysis of DoDD, economic drivers, spatial factors, forest management and land use practices and spatial planning. • Largely foreign experts are involved in generating data and analysis of DoDD. • GIS and RS lab is currently established in MSD of the MoFo.	• The MoFo does not have sufficient capacity to generate spatial and temporal data which are associated with drivers, land use practices. • Short term and long term training is needed for the MoFo staff. • The USP has expertise on RS and GIS. Collaboration between the MoFo and USP could be one option to build the capacity.
	2. Expertise in spatial and temporal analysis and use of modelling tools	• Mostly foreign experts are involved in spatial and temporal analysis and use of modelling tools. • A study on identification of DoDD will be accomplished by the end of this year.	• Expertise for spatial and temporal analysis and use of modelling tools is inadequate within MoFo. • MSD is responsible for spatial and temporal analysis of LU change, however the MSD has insufficient capacity to perform the task • Experts exist in the USP and FNU. MoFo collaborate with universities to develop its expertise. • Alternatively, MoFo should plan for long term and short training for its staff and send them abroad.
2. Establishment of a FRL and regular updating	1. Data and knowledge on deforestation and forest degradation (D&D) processes, associated GHG emissions, drivers and expected future developments	• Fiji has identified DoDD and its processes and future developments. • Training events were organised to deliver skills and knowledge on generating data on D&D.	• Foreign experts were engaged to identify the D&D. However, MoFo can generate data on D& D and expected future development. • MoFo has inadequate expertise on statistical analysis and use of needed software. • The country should develop short and long term plan to develop the skills and knowledge on data.

Component	Capacity required	Existing capacity	Capacity gap/ Capacity development needs
	2. Expertise in spatial and temporal analysis and modelling tools	• Fiji established FRL but University of Hamburg was engaged in the establishment process. • Local experts were engaged in the entire process of the FRL, and to some extent, relevant knowledge and skills are transferred to MoFO/MSD.	• Though MoFO/MSD developed knowledge and skills on spatial and temporal analysis and modelling, this is not sufficient to work independently. • Under stepwise approach, the country needs to update the FRL according to a country improves its capacity. • The country should develop short and long term plan to develop the skills spatial and temporal modelling skills. • MoFo can collaborate with the USP for this skills and knowledge.
3. **National and international reporting**	1. Expertise in accounting and reporting procedures for LULUCF using the IPCC GPG	• Reporting relies not only on robustness of scientific methods used to analyse data and to estimate accuracy, but also depends on the way the information is inferred, compiled and presented. In the current FRL, the information is well documented, transparent and consistent with the reporting requirements and IPCC good practice guidance. • Fiji submitted its INC and SNC to the UNFCCC, and is preparing TNC. • The NCs follow the UNFCCC guidelines and guidance. • **In the SNC, forestry sector is net sink for GHG. In contrast the sector is a net source in TNC. Fiji FRL (2006- 2016) found forest sector is net sink**. • Fiji has been reporting to FAO FRA.	• According to IPCC guidance and guidelines estimations of changes in carbon stocks need to be reported for five carbon pools in forests: above-ground biomass, belowground biomass, dead wood, litter and SOC. Expertise in accounting and reporting for the changes in C-stocks using the most recent IPCC guidance and guidelines is lacking. • NFI data and activity data are available. However, current GHG-I do not use the data. There are methods and standards available for uncertainty identification, quantification and reporting. However, the GHG-I does not follow the standards. • The forest sector GHG-I does not follow the IPCC 'good practice guidance' e.g. transparency, accuracy, completeness principles. • Capacity building in terms of categories, gases pools of sources and sink of the GHG. • Trainings on accounting and reporting procedures for LULUCF using the IPCC GPG.

Component	Capacity required	Existing capacity	Capacity gap/ Capacity development needs
	2. Consideration of uncertainties and procedures for independent international review	• In June 2018, the first draft of the GHG-I –as a part of the TNC- is ready. However, the statistics are not reliable. The EFs estimates are taken from literatures, and are not based on available data (NFI, PSPs). • No uncertainty following international standards has been done.	• Training on identification and assessment of sources of uncertainties associated with the AD and EFs. • Training on uncertainties management, quantifying reporting remaining uncertainties using accepted international standards (e.g. Monte Carlo Simulation) and reporting.

6 Capacity development plan: Before 2020, 2021-2025 and beyond

The capacity assessment based on the selected indicators (i.e. SLMS, NFI, GHG-I and NFMS database) and the components of the three phases of the REDD+ NFMS (i.e. planning and design, monitoring, and analysis and reporting) indicated a substantial capacity gaps in national forest monitoring relative to the IPCC 'good practice' principles (requirements) of transparency, consistency, completeness, comparability and accuracy. The findings of our assessment resonate with those of previous studies (Mora et al., 2012; Romijn et al., 2012; Romijn et al., 2015; Trines, 2012). Since REDD+ aims to be a results-based mechanism, it is essential to bridge the capacity gaps through capacity-building initiatives (Herold et al., 2012). Capacity development strengthening plan needs to be developed considering internationally accepted guidance and guidelines (i.e. IPCC guidance and guidelines), and others e. g. GOFCGOLD REDD+ Sourcebook and FAO Voluntary Guidelines (FAO, 2017).

Capacities gaps are something that cannot be fulfilled at once. Nor there is a one-size-fits-all-approach. Capacity building activities should work towards achieving a level of monitoring capacity that can be used to report on forest carbon stocks and emissions to the UNFCCC and then further developed over time. The NFMS should meet the IPCC reporting requirements, including the five principles of consistency, transparency, comparability, completeness and accuracy. This simply resounds the UNFCCC's 'stepwise approach' while developing the REDD+ elements.

The process of planning and implementation of REDD+ MRV may lead to initial priorities for MRV capacity development being defined, based on 1) understanding of the national REDD+ strategies and policies that address the key activities and drivers of forest change nationally; 2) identification of high-priority areas in which to focus most of the detailed MRV activities as part of a stratified national approach; and 3) the evolution of national MRV capacity development as a process following a roadmap with simple, interim performance targets that can be defined as intermediate milestones (Mora et al., 2012).

Considering the facts discussed above, (i) substantial capacity gaps and a momentous and huge capacity bridging need; (ii) requirements to meet IPCC 'good practice' guidance; (iii) dearth of funding; (iv) our experiences on the guiding factors defining the initial priorities of capacity building as suggested by Mora et al. (2012); and most importantly, recognizing the UNFCCC's 'stepwise approach' to develop REDD+ elements, this study suggests a 'Capacity Development Plan' in Table 18. The capacity development plan is a sub-set of the comprehensive list of capacity building needs identified in Chapter 4 and Chapter 5 (Table 15, table 16 and Table 17).

Table 18: Capacity development plan for Fiji REDD+ NFMS

Component	Type of capacity	Capacity development (CD)	Form of CD	Target stakeholders	Responsibility	Estimated cost (USD) Per Unit	Year of capacity building			
							Before 2020	2021-2022	2023-2025	After 2025
Planning & Design for NFMS	Human	Enhance knowledge on key decisions relevant for REDD+ and on global landscape of climate finance	Orientation training	All relevant stakeholders	MoFo, REDD+ Unit, Consultant	35,000	√	√	√	√
	Institutional	Develop REDD+ Implementation Framework	Guidance	REDD+ program, All relevant stakeholders	MoFo, REDD+ Unit, Consultant	75,000	√			
	Institutional	Create and maintain an archive repository (system) to store the data, maps and documents.	Data archive system	MoFo, MoE, SPC-GEM	MoFo, Consultant	25,000	√	√	√	√
	Institutional /Logistics	Assess usefulness and reliability of the data source and information.	Study/report	MoFo, MoE, SPC-GEM	MoFo, Consultant	50,000	√			
	Institutional	Improve inter-ministerial and/or interdepartmental coordination and cooperation through and overall coherence	Participation Plan, Coordination meetings	Sectoral ministries, CSOs and I/NGOs	REDD+ coordinator, REDD+ SC	15,000	√	√	√	√
	Institutional /Logistics	Revive and enhance web hosting service	Webpage	All relevant stakeholders	MoFo, REDD+ Unit	25,000	√	√	√	√
	Institutional /Logistics	Develop National Web Portal for Forest Monitoring System	NFMS web portal	All relevant stakeholders	MoFo, REDD+ Unit, Consultant	25,000	√	√	√	√
	Logistics	Build a residential training hall/conference room (with multimedia, sound system)	Residential training hall	All relevant stakeholders	MoFo, MoE, I/NGOs, Development Organizations, CSO	200,000	√			

Component	Type of capacity	Capacity development (CD)	Form of CD	Target stakeholders	Responsibility	Estimated cost (USD) Per Unit	Year of capacity building			
							Before 2020	2021-2022	2023-2025	After 2025
	Logistics	Prepare training manuals targeting landowners on REDD+, REDD+ safeguards, inclusion of gender, REDD+ implementation and monitoring, carbon rights	Training Manuals	Local communities, Indigenous people, CSO, local NGO, FBO	MoFo, REDD+ Unit, Consultant	50,000	√	√	√	√
	Logistics	Prepare a community based forest and biodiversity inventory guideline	Manual/Guide line	Local communities, Indigenous people, CSO, local NGO, DFO,FBO	MoFo, REDD+ Unit, Consultant	100,000	√			
	Logistics/ Human	Prepare community focused audio/visual materials for awareness	Materials	Local communities, Indigenous people, CSO, local NGO	MoFo, REDD+ Unit, Consultant	50,000	√	√	√	√
Forest area change assessment	Institutional and Equipment/ Logistics	Establish a RS and GIS Section within the MSD	Institution/ Infrastructure	MoFo, MSD, MoE	MoFo, MSD, MoE	50,000	√			
	Institutional and Equipment/ Logistics l	Setting up/enhancing RS analysis lab (high definition computer, licensed software, high internet speed) at the RS and GIS Section	RS Laboratory	MoFo/MSD	MoFo/MSD	100,000	√			
	Human	Appoint a Remote Sensing Analyst to RS and GIS Section under MSD	Expertise	MoFo/MSD	MoFo	50,000	√	√	√	√
	Human	Appoint a GIS Analyst to RS and GIS Section under MSD with a profound knowledge on application	Expertise	MoFo/MSD	MoFo	50,000	√	√	√	√

Component	Type of capacity	Capacity development (CD)	Form of CD	Target stakeholders	Responsibility	Estimated cost (USD) Per Unit	Year of capacity building			
							Before 2020	2021-2022	2023-2025	After 2025
		of GIS on forest resource management, on drivers of D&D.								
	Institutional	Establish a cooperation agreement between MoFo, SPC and relevant institutions, regulating tasks and responsibilities	Networking	Relevant stakeholders	MoFo, MoE, REDD+ Unit, SPC-GEM	12,000	√	√	√	√
	Equipment/ Logistics	Purchase software (e.g. ArcGIS) license to increase the spatial data analysis capacity	Software	RS/GIS lab, MSD	MoFo, SPC-GEM	25000	√	√	√	√
	Technical/ Logistics	Develop knowledge and capacity on; (i) Data procurement and pre-processing (ii) Cost analysis of RS imagery and decision on satellite imagery to use (iii) Develop an interpretation guidelines for LUC assessment including ground truthing (iv) Use new techniques such spectral mixture analysis to identify different land use classes.	Training, SOPs	MSD, DFO, SPC-GEM (mainly RS/GIS expert)	MoFo, SPC, Consultant	100,000	√	√		
Changes in carbon stocks	Institutional and Equipment/ Logistics	Establish a Forest Survey Unit (FSU) within the Licensing and Inventory Section (LIS) of the MSD	Institution, Infrastructure,	MSD, DFO, MoE, SPC-GEM	MoFo, MSD, MoE	50,000	√			
	Human	Appoint a biometrician/statistician for data analysis and reporting	Expertise	MoFo, MSD	MoFo	50,000	√	√	√	√

Component	Type of capacity	Capacity development (CD)	Form of CD	Target stakeholders	Responsibility	Estimated cost (USD) Per Unit	Year of capacity building			
							Before 2020	2021-2022	2023-2025	After 2025
		based on MSD								
	Institutional and Equipment/ Logistics	Establish a Forest Inventory Unit in each DFOs, and equip them with necessary equipment and logistics	Institution, Infrastructure, equipment	MoFo, MSD, DFO, MoE, FBO	MoFo, MSD, MoE, DFO	75,000	√			
	Technical	Forest inventory (stratification, sampling design, response design, measurements, data / sample collection, hot check apply and electronic transfer of data)	Residential training SOPs	MSD, DFO FBO, CSO Mataqali	Consultants, REDD+ Unit, MoFo	100,000	√			√
	Technical/ Logistic	Study on statistically justified and cost effective NFI and PSP sampling and response design	Report: Sampling and response designs (NFI, PSP)	MoFo, MoE, DFO, Mataqali	Consultant, MoFo, MoE	150,000	√			
	Logistics	Develop forest inventory protocol/field manual including QA/QC.	Protocol/SOPs	MSD, MoE	Consultants	25,000	√			
	Technical/ Logistic	(i) Data need assessment (ii) Conduct test NFI (iii) Inventory planning	NFI test report, Planning for NFI	MoFo, MoE, DFO, FBO, Mataqali	Consultant, MoFo, MoE	100,000	√			
	Technical/ Logistic	Conduct national forest inventory (NFI)	NFI FRA report	MSD, DFO, FBO, Mataqali	MoFo, MSD (FSU), Consultants	1,500,000	√	√		√
	Technical	Develop capacity for laboratory analysis of samples (litter, under-storey biomass, SOC, soil bulk-density)	Expertise, SOPs	MSD, MoE, USP, FNU	MoFo, MoE, USP, Consultants	50,000	√			
	Technical/ Logistics	(i) Quantify C-stocks of croplands, grasslands, wetlands,	Expertise, Data,	MSD, DFO, FBO, MoA	Consultants	150,000	√	√		

Component	Type of capacity	Capacity development (CD)	Form of CD	Target stakeholders	Responsibility	Estimated cost (USD) Per Unit	Year of capacity building			
							Before 2020	2021-2022	2023-2025	After 2025
		settlements, and other land for estimation of emissions due to land-use conversion (ii) Allometric biomass equations for post land use after deforestation	EFs							
	Technical	Build capacity of the MoFo/MSD (LIS, FSU, Mapping and Survey) staff on: (i) Data cleansing, statistical analysis, interpretation of the results and derivation of required information using R (ii) Biomass models (iii) Auxiliary data collection (iv) Time series NFI data analysis	Residential training	MSD, DFO, MoE	Consultants	75,000	√	√		√
	Technical/ Logistic	(i) Prepare sampling and response design for the inventory of Trees Outside Forestland (TOF) (ii) Conduct inventory of the TOF	Inventory report, Biomass/carbon estimates of TOF	MoFo, MSD, DFO, FBO, Mataqali	MoFo, MSD, Consultants	500,000		√		√
	Logistics	Prepare guideline for reduced impact logging (RIL)	Guideline	MSD, DFO, FBO, Mataqali, Forest concessions, harvesters, CSO, Local NGO	MoFo, Consultants	100,000	√			
	Technical	Develop knowledge on reduced impact logging (RIL)	Training	MSD, DFO, FBO, Mataqali, Forest		100,000	√	√		

Component	Type of capacity	Capacity development (CD)	Form of CD	Target stakeholders	Responsibility	Estimated cost (USD) Per Unit	Year of capacity building			
							Before 2020	2021-2022	2023-2025	After 2025
				concessions, harvesters, CSO, Local NGO						
	Technical	Enhance knowledge on adaptive forest management practices	Training including field work	MoFo, MSD, DFO, FBO, Mataqali	MoFo, Consultants	75,000	√			√
	Technical/ Logistics	Develop allometric biomass equations for selected native tree species and mangrove species	Training, Biomass model	MSD, DFO, Mataqali	Consultants, MSD	100,000	√	√		
	Technical/ Logistics	Develop allometric biomass equations for different native forest types	Training, Biomass model	MSD, DFO, Mataqali	Consultants, MSD	100,000	√	√		
	Technical/ Logistics	Develop allometric biomass equations to estimate carbon emissions due to firewood collection	Training, Biomass models	MSD, DFO, FBO, Mataqali	Consultants, MSD Mataqali	75,000	√			
	Technical/ Logistics	(i) Develop a growth (increment)model for native trees (ii) Develop a growth (increment)model for native forests	Training, Biomass models	MSD, DFO, Mataqali	Consultants, MSD Mataqali	100,000	√	√		
	Logistics	Prepare manual of afforestation, reforestation (A/R) and degraded land restoration activities	Manual	MSD, DFO, FBO, Mataqali, Forest concessions, harvesters, CSO, Local NGO	MoFo, Consultants	100,000	√	√		
	Technical	Training on A/R and degraded land	Training	MSD, DFO,		50,000	√	√		

Component	Type of capacity	Capacity development (CD)	Form of CD	Target stakeholders	Responsibility	Estimated cost (USD) Per Unit	Year of capacity building			
							Before 2020	2021-2022	2023-2025	After 2025
		restoration		FBO, Mataqali, Forest concessions, harvesters, CSO, Local NGO						
Emissions from biomass burning	Technical/ Logistics	(i) Study on fire on forestland: frequency of occurrence, intensity, size, pattern, season and severity (ii) Develop estimation procedures for NH_4 and CO_2 emissions from forest fires	Expertise Guidance	MoFO, MSD (also include RS/GIS experts) DFO, FBO, MoE, Mataqali, FPL, FHCL	MoFo, MoE	100,000	√	√		
Accuracy assessment and verification	Technical	Develop capacity in country for accuracy assessment and verification using Tier 2 level	Hands-on residential training	MoFo, MoE, MSD, DFO (also include RS/GIS experts)	Consultant	75,000	√	√		
National and international reporting	Human	(i) Develop knowledge in accounting and reporting procedures for LULUCF using the IPCC GPG (ii) Reporting: ○ GHG-I (forest sector) ○ BUR ○ REDD+ Annex ○ FAO FRA	Hands-on residential training	MoFo, DFO (also include RS/GIS experts)	MoFO, REDD+ Unit, Consultant	100,000	√		√	
	Human/	(i) Prepare NFI 2005-2007 reports	Documents,	MoFo, MSD,	Consultant	100,000	√			

Component	Type of capacity	Capacity development (CD)	Form of CD	Target stakeholders	Responsibility	Estimated cost (USD) Per Unit	Year of capacity building			
							Before 2020	2021-2022	2023-2025	After 2025
	Logistics	(ii) Prepare PSP assessment (periodic) reports	Training	MoE, Mataqali	MSD					
NFMS database	Institutional	Establish a Database Management Unit (DMU) under the Remote Sensing and GIS Section of MoFo/MSD	Institution, Infrastructure	MoFo, MSD, MoE, DFO, SPC-GEM	MoFo, MoE	50,000	√			
	Human	Appoint two personnel to the DMU: ○ Database officer- 1 ○ Assistant Database Officer- 1	Expertise	MoFo/MSD	MoFo, MoE	100,000	√	√	√	√
	Logistics	Establish a workstation provided with high definition computers, high speed internet	Workstation	MoFO, DFO, MoE, SPC-GEM	MoFo, MoE	100,000	√			
	Logistics	Enhance HAR and TRS at DFOs	Infrastructure	MoFo, MSD, DFO	MoFo, MoE, MSD	150,000	√	√		
	Technical	Data base reorientation and database running	Hands-on Training	Database Officers	Consultant	50,000	√	√		
NSS/SIS (including Biodiversity)	Technical	Develop knowledge on: ○ Implementation and Validation monitoring ○ Selecting rewarding safeguard indicators ○ Attributing REDD+ impacts to particular REDD+ activities ○ Linking safeguards indicators to REDD+ MRV ○ Linking safeguards to NFMS Database	Expertise, Guidance documents	MoFO and DFO (also include RS/GIS experts), MoE, FBO, TLTB, CSO, Mataqali	MoFo, REDD+ Unit	75,000	√	√		

Component	Type of capacity	Capacity development (CD)	Form of CD	Target stakeholders	Responsibility	Estimated cost (USD) Per Unit	Year of capacity building			
							Before 2020	2021-2022	2023-2025	After 2025
	Human	Deploy a Safeguard Officer to the DMU	Expertise	MoFo/MSD	MoFo, MoE	50,000	√	√	√	√
	Technical	Develop knowledge about forest, climate change, REDD+ and local livelihoods- introduction and interlinkages	Training/work shop	Local communities, Village leaders, local CSO/NGO	MoFo, Consultant, DFO, REDD+ Unit	50,000	√	√	√	√
	Technical	Develop knowledge on direct and indirect benefits, costs and risks of the REDD+ program; equitable benefit sharing and cost baring; potential risks	Training/work shop	Local communities, Village leaders, local CSO/NGO	MoFo, Consultant, DFO, REDD+ Unit	50,000	√	√	√	√
	Technical	Develop knowledge on guiding principle, and national policies, rules and regulation of Free Prior Informed Consent (FPIC), carbon rights and feedback grievance and redress mechanism (FGRM)	Training/work shop	Local communities, Village leaders, local CSO/NGO	MoFo, Consultant, DFO, REDD+ Unit	50,000	√	√	√	√
	Technical	REDD+ safeguards and community based forest and biodiversity monitoring	Training/work shop	Local communities, Village leaders, local CSO/NGO	MoFo, Consultant, DFO, REDD+ Unit	50,000	√	√	√	√

7 Participatory forest monitoring

Forests in Fiji play an important role in providing valuable ecosystem services with maintaining and enhancing human well-being. Fiji REDD-Plus Policy 2011 states that REDD+ actions assist Fiji in achieving core forest sector goals including sustainable management of forests and protecting indigenous forest areas of high cultural, biological diversity and ecosystem services value. Sectors other than forestry i.e. biodiversity conservation, livelihoods, ecosystem services, adaptation capacities and food security may benefits from REDD+ actions.

Nearly 88% of the land in Fiji is owned by iTaukei (the indigenous people) and is held as customary land. Approximately 90% of the iTaukei land is forested (Trenorden, 2013). This has given rise to many of the policy and legislative challenges faced. It requires complex processes prior to forest utilisation, especially to ensure the maintenance of high field standards.

We constructed a FRL for Fiji for the reference period of 2006 to 2016. The estimated average annual area of forest loss is 3385 ha, of which 3222 ha occurs in lowland (<600 m). The estimated average annual emission from deforestation is 868,219 tCO_2e, i.e. 52% of the estimated average annual gross emissions in Fiji. One of the main drivers of deforestation is conversion of native forests to agriculture land (Trenorden, 2013). Average annual gross emission from forest degradation (selective logging) is 195316 tCO_2e, i. e. 12% of the estimated average annual gross emissions. Unsustainable forest management practices are widespread and the logging operations in native forest have been unsustainable (Ministry of Fisheries and Forests, 2015). A "Fiji Forest Harvesting Code of Practice" (Ministry of Fisheries and Forests, 2013) has been developed. The harvesting code specifies, e.g., diameter cutting limits; however, (commercial) loggers resist its adoption and over-exploitation using conventional logging techniques persist. Divisional Forest Office has very low capacity to monitor the harvesting (severely understaffed), this has led to considerable degradation. It is estimated that twice of the harvested volume is left in the forest (ITTO, 2004). Current practices are assumed to not only cause a constant decline in harvestable volumes of commercial timber species, but also a constant decline in forest carbon stocks in Fiji's Natural Forests. On the other side of the Fiji forestland carbon ledger, the estimated average annual gross removals, from forest plantations and afforestation and reforestation activities outside the lease area, is 1744544 tCO_2e, which is higher than the gross emissions of CO_2e. The estimated emissions and removals suggested that there are potentials to reduce emissions and enhance removals through sustainable management of forests, including reduced impact logging, A/R activities, owned by the native people. There is long term potential for more **community engagement** in management and monitoring but this requires massive skills building of iTaukey people and local communities. While some progress has been made with these aspects there is much further to go.

An approach of involvement of communities (e.g., Mataqalis in Fiji) in forest monitoring provided with capacity-building can build an operational forest monitoring system. If such an approach could be tied to the delivery of financial benefits back down to the community, and could be developed at a national level, significant REDD+ benefits could be realised without the necessity of institutional effort on the behalf of governments (Hardcastle et al., 2008).

Benefits of and recommendations to involving of local communities in forest monitoring; and incorporating of community based forest monitoring into national forest monitoring are discussed elsewhere. But in practice, establishment of a functional and responsible participatory forest monitoring system is very challenging. We discuss here an example of setting up a participatory forest inventory - which could be a subset of community based forest monitoring system. To establish such a participatory forest inventory demands a significant financial investment, partly due to ongoing coordination, training and quality control costs, and also because communities must be compensated for their participation. For example, to establish a national participatory inventory scheme, capable of providing sample data from 400 locations, will require 200 Mataquali's to be recruited to the scheme. Each Mataquali carries out inventory measurements within 2 sample blocks. Moreover, the settlement pattern and accessibility to forests are the factors of consideration for such a scheme. Participatory approach would not be feasible where the settlements are far away from the forests. In case of Fiji, many forest owners are residing in the cities and nearby towns. When the GDP per capita (or a daily wage) of a country is high, and the benefits from the participation might not be attractive, the scheme might fail. Considering all of the contexts, participatory approach of national forest monitoring is unlikely to be a major forest monitoring strategy in the immediate future. In addition, once sampling units are assessed by locals their location is known and they might be managed differently form the remaining forest area (e.g restricted logging activities conducted on permanent sample plots). This is a likely source of a major bias which could make the NFI sample non-representative for Fiji's forest area. This would render the NFI worthless in terms of objective, representative reporting (Köhl et al., 2016, Köhl et al., 1995).

Maraseni et al. (2014) found that the revenue (REDD+ payment) received by community forest user groups (CFUGs) in Nepal was not sufficient to cover forgone benefits of the CFUGs who were implementing the REDD+ project. After the implementation of the REDD+ project, the frequency of the CFUG meeting increased substantially. The CGUF members had to spend additional days for the meetings. The additional revenue from the REDD+ project was not sufficient even to cover the opportunity costs of the increased number of days. These examples suggest that before designing any kinds of community based monitoring system i.e. safeguards, biodiversity under the REDD+, the additional costs to and forgone benefits of the communities should be carefully analysed. We strongly recommend that Ministry of Forests and REDD+ program should explore and test designs of and options for incorporating community based forest monitoring into national forest monitoring and safeguards information system.

8 Discussion

Development of monitoring systems for REDD+ is an area of investment for participation in the REDD+ process (GOFC-GOLD, 2016). Investments in capacity development enable countries to obtain accurate and reliable data/information on forest area/resources which provides necessary input to refine policies and decisions to track drivers of deforestation and forest degradation, to conserve forests and to improve forest management (Romijn et al., 2015). Provision and timely capacity building support is a main challenge the REDD+ process faces today (Maniatis et al., 2013). Without timely and enhanced capacity, countries might not able to absorb the readiness finance provided by multilateral funds (e.g., FCPF Readiness and Carbon Fund) and bilateral financial supports.

An assessment of Fiji's existing capacities for establishing a national monitoring system for estimating emissions and removals from forests provided the basis for defining the capacity-development needs for a NFMS for the country. The capacity-gap assessment was based on the selected indicators (i.e. SLMS, NFI, GHG-I and NFMS database) (Romijn et al., 2012; Romijn et al., 2015) and several components of the three phases of the REDD+ NFMS: (i) planning and design, (ii) monitoring, and (iii) analysis and reporting (GOFC-GOLD, 2016). A capacity development plan (Table 18) is proposed to bridge the capacity gaps and focus on capacity building for the key action areas.

Since REDD+ aims to be a results-based mechanism, it is essential to bridge the current capacity gaps through capacity-building initiatives (Herold et al., 2012). Effective capacity building programmes are needed to meet operational needs for REDD+ MRV and reference level (Goetz et al., 2015). Capacity development plan needs to be developed considering internationally accepted guidance and guidelines (IPCC guidance and guidelines), as well as others such as the GOFC GOLD Sourcebook and FAO Voluntary Guideline (FAO, 2017).

We found substantial capacity gaps in national forest monitoring relative to the IPCC 'good practice' requirements of transparency, consistency, completeness, comparability and accuracy. Despite the high evidence of political interest in forest, climate change and REDD+; positive institutional and political framework; and early financial and technical support (FCPF, UN-REDD, other targeted support); limited improvement was observed in national forest monitoring capacities. Modest improvements were observed in forest inventory capacities and we noticed a dormant inventory capacity that could be usefully resuscitated. However, capacities in forest area change monitoring and carbon pool reporting showed little or no improvements since the recent NFI (2005- 2007). The NFI system needs to be institutionalized to ensure a practical way for proficient monitoring and analysis of forest biomass and carbon. The institution (i.e. MSD) which carries out NFI requires continued institutional support and adequate and predictable finance provided with qualified and committed professionals from relevant disciplines e.g., forest mensuration/inventory, remote sensing, statistics for design, monitoring, analysis and reporting. Links to SPC-GEM for remote sensing analyses has to be institutionalised.

Though some progress has been made in REDD+ capacity building at country level in Fiji, it is yet to realize at local level. We observed that Divisional Forest Office, Forest Beat Office and local communities have less involvement in REDD+ landscape in Fiji. They are the key actors who play a decisive role for the successful implementation and monitoring of REDD+ activities in the future. There are opportunities to incentivize the actors for the effective implementation of REDD+ whilst increasing the resources available to them to do so. Thus, Fiji should actively pursue efforts towards local capacity building through both local and international sessions, targeting key technical experts (Divisional, Forest Beat), and through civil society groups, NGOs, faith based organizations and universities. Enhanced local legitimacy and capacity building tends to increase feasibility, i.e., political realism of the REDD+ (Neupane, 2009, 2015).

In most of the REDD+ implementing countries, capacity building is vastly underfunded, so is in Fiji. The Fiji REDD-Plus Policy 2011 guided the country to adopt a 'hybrid' scale REDD+ approach, enabling both national and sub-national or project-scale activities where appropriate. The Policy expected that there will be both national and project level engagement with REDD+ financing instruments to maximize opportunities and minimize costs. Fiji is supported by the FCPF REDD+ readiness fund and by other regional REDD+ projects. The government has been allocated some funds from its Reforestation of Degraded Forests (RDF) program. To execute the proposed capacity development plan, a large investment is needed. Fiji needs to raise a substantial and predictable finance from new sources and improve effectiveness of spending.

Strengthening national capacity is an inherent component of the development and implementation of the NFMS. Neither the capacity gaps are something that can be fulfilled within a short period of time, nor there a one-size-fits-all-approach to fill the gaps. The concept of stepwise progress and continuous improvements underpins the model applied by many countries in building a monitoring system. This concept recognizes that it takes time to implement emissions and removals methodologies and to collect the required data consistently in space and time (Mora et al., 2012). Thus we recommend Fiji REDD+ to follow a stepwise approach of capacity building in parallel to UNFCCC's 'stepwise approach' to develop REDD+ elements.

The overall goal of the capacity development in Fiji is the establishment of a sustained MRV to support annual estimation, reporting, and verification of forest-related carbon emissions and removals on the national level. The system should build on existing capacities and data, taking into account international requirements and national needs. It should be flexible so that activities can be adjusted according to international agreements and national policies. Development of the MRV system is directly linked with REDD+ policy development, and implementation and national policies should drive MRV activities and vice versa. Capacity building should result in sustainable national forest monitoring systems that are able to report on carbon stocks and changes in compliance with IPCC reporting requirements, including the five principles. Once a country acquire those capacities, it needs to keep investing in the national forest monitoring programme in order to maintain and retain its capacities (Romijn et al., 2015). **Only maintained capacities provide the consistent updates**.

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Annex 1: List of stakeholder consultation

Name	Organization	Designation	Date of consultation
Christine Fung	GIZ Office	Land Use Planning and Facilitation Specialist/ Deputy Team Leader	16/08/2018
Deeptika Chand	Ministry of Economy	Climate Change Officer	31/08/2018
Jeanette S Mani	Ministry of Economy	National Communication Coordinator	31/08/2018
Marama Tuivuna	REDD+ Office Colo-i-Suva	Project Officer	23/08/2018
Narendra Chand	REDD+ Office Colo-i-Suva	Technical Advisor	31/08/2018
Reama Naco	REDD+ Office, Colo-i-Suva	Communication and Knowledge Management Specialist	23/08/2018
Viliame Tupua	REDD+ Office Colo-i-Suva	REDD+ ICT	31/08/2018

Annex 2: List of participants of capacity assessment survey

Name	Organization	Designation
Akosita Lewai	MSD, Colo-i-Suva	Principle Forest Officer
Archana Gauli	Freelancer consultant/University of Hamburg, Germany	Scientist/Consultant
Armin Bajramovic	INTEND Geoinformatik GmbH; Germany	IT/Database specialist/Consultant
Hans Jörg Schnellbächer	INTEND Geoinformatik GmbH; Germany	IT/Database specialist/Consultant
Maika Tabukovu	Fiji National University, Suva	Lecturer/Consultant
Michael Köhl	University of Hamburg, Germany	Professor/Consultant
Narenda Chand	REDD+ Office Colo-i-Suva	Technical Advisor
Peter Navratil	Remote Sensing Solution GmbH, Germany	Remote Sensing Specialist/Consultant
Philip Mundhenk	University of Hamburg, Germany	Research Associate/Consultant
Reama Naco	REDD+ Office, Colo-i-Suva	Communication and Knowledge Management Specialist
Timoci Lagataki	Ministry of Forests, Suva	Database Officer
Viliame Tupua	REDD+ Office Colo-i-Suva	REDD+ ICT
Vilisi Naivalevu	GIZ, Suva/ REDD+ Secretariat	