ANNEXES TO FIJI ERP JUNE 2019

The Annexes are available via the following links and are listed in the following compilation for ease of reference.

Annex 2-1: Terms of Reference for REDD+ Steering Committee

Annex 4-1: Drivers of Deforestation and Forest Degradation in Fiji

Annex 4-2: Intervention Technical Note [01-06]

Annex 5-1: Capacity building activities undertaken by different organizations supporting REDD+ Development and Readiness Phase

Annex 6-1: Letter of Intent

Annex 8-1: Forest Reference Level Calculations

Annex 8-2: Generation of Activity Data (2000-2006)

Annex 8-3: Estimation of Emission and Removal Factors

Annex 8-4: Estimation of Emission from Fire and Fuelwood

Annex 14-1: Feedback Grievance and Redress Mechanism

This Annex is not included in the following compilation as it is a stand-alone report. Please follow the above link to access this Annex.

Annex 15-1: Types of Benefit Sharing Models in Fiji
Annex 15-2: Matrix on Definition of Beneficiaries and Types of Benefits

Annex 17-1: Cabinet Decision endorsing REDD+ and supporting Ministry of Economy

Contents

ANNEX 2-1: TERMS OF REFERENCE FOR REDD+ STEERING COMMITTEE

THE FIJI REDD+ NATIONAL STEERING COMMITTEE

TERMS OF REFERENCE

1. INTRODUCTION

Background

Scientists estimate that deforestation and forest degradation account for around 20 percent of the annual greenhouse gas emissions that fuel climate change. REDD (reducing emissions from deforestation and forest degradation) is an approach aimed at reducing the 20 percent of emissions related to forests through financial incentives. Forests are generally regarded as a source for financial and economical gain (agriculture, logging, land development etc.) and this often takes precedence over forest conservation or sustainable management. The REDD-plus concept links financial incentives to forest conservation, sustainable management, and enhancing and increasing carbon stocks for credits for carbon emissions avoided and/or carbon sequestered.

Fiji has a forest cover of almost 1.1 million hectares, covering about fifty-six percent of the total land mass. Forest clearance, largely attributed to agriculture, can be observed on parts of Fiji. The country also has large areas of degraded and unutilised lands which has potential for reforestation and afforestation to increase carbon stock.

Fiji recognises REDD-plus as an opportunity to contribute towards global efforts to reduce greenhouse gas emissions, strengthen the socio-economic status of its forest resource owners and protect its forest ecosystems.

The Fiji REDD-plus approach

Fiji's REDD+ initiative began in 2009 with support from the SPC[1]/GIZ[2] Regional Programme - Coping with Climate Change in the Pacific Island Region. Fiji is taking a phased approach in its REDD-plus programme. The first phase aims to put in place policy and institutional frameworks for the implementation of REDD-plus and addressing capacity needs for the establishment of a national MRV (measuring, reporting and verification) system. The second phase involves the development of a national REDD-plus strategy, the establishment of pilot sites and strengthening MRV capacities (towards Tier 2

---

[1] Secretariat of the Pacific Community

[2] Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

and 3[3] level reporting). The third phase will be the implementation of the strategy, participation in a REDD carbon financing mechanism, and the establishment of an operational MRV and IPCC reporting system.

Policy context

In December 2010 the Fiji REDD-Plus policy was endorsed by cabinet after a comprehensive consultation process involving relevant sectors and agencies. The end of 2010 also saw the drafting of a national REDD+ Strategy. The strategy document will provide directions on the implementation of the policy and the Fiji REDD+ programme. The Fiji REDD+ Programme is the cause of action taken by government and stakeholders to take Fiji through the REDD-readiness phase and to successfully access carbon financing mechanisms

The Fiji REDD-Plus Policy statement 5.5 calls for a transparent multi-stakeholder governance structure. The governance structure will be capable of:

- ensuring the participation and consultation of all relevant stakeholders in REDD-Plus activities;
- delivering efficient and effective decisions;
- enhancing donor and buyer confidence;
- using existing structures and, where possible, modifying them to suit the implementation of the Fiji REDD-Plus Programme;
- standing up to an independent, external, expert third party review.

Policy statement 5.8 emphasises effective engagement and communication. It identifies the need to put in place a communication and awareness strategy capable of ensuring an efficient, effective and transparent flow of information among all stakeholders, at all levels.

Stakeholder consultations identified the need for a national REDD+ steering committee to ensure good and transparent governance and facilitate effective and efficient communication. The establishment of a REDD+ steering committee was recognised as an essential mechanism for strengthening an inter-disciplinary and integrated approach for the implementation of the Fiji REDD+ programme.

2. FUNCTIONS OF THE FIJI NATIONAL REDD+ STEERING COMMITTEE

The overarching function of the Fiji National REDD+ Steering Committee is to "**coordinate and facilitate the implementation of the Fiji REDD+ programme**".

In fulfilling its function, the national REDD+ steering committee will ensure that a transparent and effective multi-stakeholder governance process is followed and that the safeguards identified under policy statement 5.1 (Fiji REDD-Plus Policy, 2011) are considered.

The National REDD+ Steering Committee will perform the following specific functions:

a. Monitor and evaluate the implementation of the Fiji REDD+ Strategy and associated action plans

---

[3] Tier 1 IPCC methods and IPCC default values (no data collection needed); Tier 2 IPCC methods and country specific data for key factors (including more detailed country specific strata); Tier 3 Country specific methods or models, national inventory of key carbon stocks, repeated measurements of permanent plots to directly measure changes in forest biomass

b. Facilitate inter-sectoral and inter-agency support in the implementation of the Fiji REDD+ Strategy and action plans

c. Ensure alignment with international and regional developments in forest governance integrity, and international REDD technical and policy developments

d. Serve as an advisory technical body on both national and project level REDD+ issues, including advising local community groups

e. Assess REDD+ project proposals and make recommendations to the Conservator of Forests and the Director of Environment on the feasibility of these proposals

f. Promote and support awareness-raising on REDD+ issues

g. Report to the Forestry board at each Board meeting

h. Inform the National Climate Change Country Team (NCCCT) and the National Environment Council (NEC) at each NCCCT and NEC meeting on REDD+ activities and progress

i. Provide advice and support to Fiji delegates participating at international negotiations relating to REDD+. Such international meetings include those on UNFCCC (United Nations Framework Convention on Climate Change), CBD (Convention on Biological Diversity), UNFF (United Nations Forum on Forests), UNCCD (United Nations Convention on Combating Desertification) and UNCSICH (United Nations Convention for the Safeguarding of the Intangible Cultural Heritage).

j. Facilitate the development and implementation of REDD+ guidelines (refer to Annex 1)

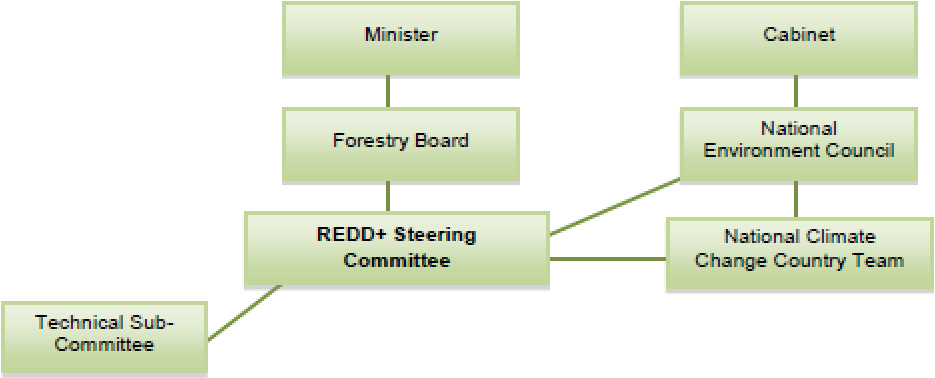
k. Submit an annual progress report to the following key stakholders, and other interested stakeholders, before the end of the fourth quarter:

    a. The national focal points of the UNFCCC, the CBD, the UNCCD
    b. the Permanent Secretary of Fisheries and Forests
    c. the General Manager of TLTB
    d. the Permanent Secretary of Ministry of iTaukei Affairs
    e. the Permanent Secretary of Ministry of Lands and Mineral Resources
    f. the Chairman of Fiji Sawmillers Association
    g. the Permanent Secretary of Agriculture
    h. the Permanent Secretary of Provincial Development and National Disaster Management
    i. the President of the Viti Land Resources Association
    j. the representative of the NGO network

3. STRUCTURE OF THE REDD+ STEERING COMMITTEE

a. The Fiji REDD+ Steering Committee is established by and reports to the Forestry Board. The REDD+ Steering Committee will also provide progress reports to the National Environment Council.

b. The REDD+ Steering Committee will establish Technical Sub-Committees when required for undertaking certain tasks associated with the implementation of the Fiji REDD+ Programme.



4. STEERING COMMITTEE MEMBERSHIP

The REDD+ Steering Committee is a multi-stakeholder committee comprising of key stakeholders. The key stakeholders are:

1. The Forestry Department
2. The Ministry of Foreign Affairs and International Cooperation – Climate Change Unit
3. The Department of Environment
4. The Department of Lands
5. The Department of Agriculture
6. iTaukei Land Trust Board
7. Private sector (industry)
8. Fiji Pine Limited
9. Fiji Hardwood Corporation Limited
10. REDD+ resource owner representatives
11. Ministry of Provincial Development
12. Ministry of iTaukei Affairs
13. Rpresenatives of non-governmental organisations carrying out REDD+ activties

14. Secretariat of the Pacific Community (SPC)
15. University of the South Pacific (USP)
16. German Agency for International Cooperation (GIZ)

5. ROLES OF COMMITTEE MEMBERS

a. The Steering Committee will consist of a minimum of a chair, deputy chair, secretary and six ordinary members[4].

b. The chair sets the agenda, convenes meetings, and ensures that they are properly conducted.

c. The deputy chair takes the role of the chair when the chair is not present.

d. The secretary plans, coordinates and monitors all Steering Committee-related activities including distributing the agenda, attending the meetings, preparing minutes and reporting to the REDD+ Steering Committee.

6. SIZE AND COMPOSITION OF THE STEERING COMMITTEE

The Steering Committee will consist of no fewer than 9 and no more than 18 individuals.

7. RULES OF PROCEDURE

The steering committee will be chaired by the Deputy Conservator of Forests - Services. The deputy chair person will either be the Director of the Climate Change Unit (Director Corporate Services – Ministry of Foreign Affairs and International Cooperation) or the Deputy Secretary of the Ministry of iTaukei Affairs. The secretary will be the Fiji REDD+ Project Coordinator.

If neither the chair nor the deputy chairs are present at a steering committee meeting the members present will elect one of their members to act as chair at that meeting.

8. METHODS OF WORK

a. The chair is responsible for convening meetings.

b. Meetings will take place every two months until such a time when the Committee is dissolved.

c. The chair may convene meetings at other times where it is the consensus opinion of the Steering Committee that it is necessary to do so.

---

[4] In the remainder of this document the word "members" includes all individuals participating in the Steering Committee unless there is an explicit distinction between the officials (chair, deputy chair and secretary) and the ordinary members.

d. The secretary is responsible for ensuring that the agenda of the meeting is made available to the members in good time before the meeting.

e. Recommendations shall be decided by consensus where possible.

f. Consensus means that after deliberation all members support a particular point of view. Where consensus is not achieved, recommendations shall be decided by simple majority vote of members voting on the question. In the case of a tied vote, the person acting as chair shall be entitled to a second or casting vote.

g. A quorum is constituted by no less than 9 members of the Steering Committee. Of these 9 members, at least 3 members will be from the Forestry Department, the Department of Lands, the Ministry of iTaukei Affairs, the iTaukei Land Trust Board and a landowner representative.

h. The Steering Committee may decide (by consensus or majority vote) to ask parties who are not members of the Steering Committee to participate in a meeting so that they can provide relevant information, material or knowledge to the Steering Committee.

i. The Steering Committee may establish sub-committees consisting of three or more of its members and refer to them any matter in the Steering Committee's mandate. Additional organisations can also be invited to contribute to or form a technical subcommittee.

9. CHANNELS OF COMMUNICATION

a. The Steering Committee secretary reports the meeting minutes within two weeks of each meeting to the members.

b. The Steering Committee Chair makes a report to the Forestry Board chairman at each Board meeting. Should there be urgent matters arising in the interim, a special Board meeting can be requested by the chair of the steering committee

c. The Steering Committee Chair will communicate to the National Environment Council (NEC) at each NEC meeting the progress of the Fiji REDD+ Programme

d. The Steering Committee chair, deputy chair, and secretary act as focal points of contact between the REDD+SC and external organisations.

10. REMUNERATION FOR EXPENSES AND TIME

Participation in the Steering Committee is at the expense of its members.

11. GLOSSARY

CBD	Convention on Biological Diversity
CO_2	Carbon dioxide
FAO	Food and Agriculture Organization of the United Nations
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German International Development Agency)
IPCC	Intergovernmental Panel on Climate Change
MRV	Measuring, reporting and verification
NCCCT	National Climate Change Country Team
NEC	National Environment Council
REDD	Reducing emissions from deforestation and forest degradation
REDD-Plus	REDD + forest conservation, sustainable management of forests, carbon stock enhancement
SPC	Secretariat of the Pacific Community
TLTB	iTaukei Lands Trust Board
UNCCD	United Nations Convention to Combat Desertification
UNCSICH	United Nations Convention for the Safeguarding of the Intangible Cultural Heritage
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
UNFCCC	United Nations Framework Convention on Climate Change
USP	University of the South Pacific

ANNEX 1

SPECIFIC TASK: National REDD+ Guidelines

The REDD+ Steering Committee will be responsible for preparing a set of National REDD+ Guidelines on REDD+ readiness and implementation. These guidelines will elaborate detailed aspects of the national REDD+ Programme, including issues not already clarified in the national REDD+ Policy and Strategy documents. The National REDD+ Guidelines become the operational template for the implementation of the National REDD+ Programme in conjunction with the REDD+ Strategy.

The REDD+ Guidelines will include, but not be restricted, to the following:

1. Define objectives of the REDD+ Steering Committee and define a framework for monitoring the performance of the REDD+ Steering Committee. This will include the development of a template for quarterly and annual reports produced by the REDD+ Steering Committee for presentation to the Forestry Board and relevant governance stakeholders
2. Define a process of periodic (e.g. annual) review of REDD+ Steering Committee and its TOR
3. Clarification of role of Designated National Authority (DNA) with respect to REDD+ including recommendations on how the DNA could be structured to accommodate REDD+ issues
4. Definition of REDD+ activity types available to implementation projects and programmes
5. Definition of REDD+ carbon property rights and transfer protocols
6. Definition of REDD+ Safeguards to be incorporated into REDD+ implementation activities including indigenous peoples rights and biological diversity
7. Definition of REDD+ benefit distribution protocols with particular regard to safeguards and benefit sharing with indigenous peoples
8. Definition of terms for carbon trading transactions in REDD+ (identify clear and transparent process of engagement)
9. Definition of guidelines on forest governance good practice – aligned with international developments in forest governance integrity and international REDD+ technical and policy developments
10. Clarification of the relationship between REDD+ and existing policies and strategies
11. Clarification of potential synergies with existing timber and forest certification schemes (e.g. FSC)
12. Clarification of communication procedures and channels, including clarification of communication channels between the Fiji UNFCCC focal point and the REDD+ Programme to enable the participation of relevant Fiji technical and policy representation at international technical and policy meetings. This could include simple communication procedures such as automatic email forwarding of UNFCCC emails to the Conservator of Forests
13. Clarification of alignment of Fiji national REDD+ Programme with Pacific regional REDD+ information platform

14. Clarification on elements of National REDD+ Guidelines that would be more appropriately framed as Regulations

Given the above issues, the National REDD+ Guidelines will contain the following sections:

1. REDD+ Governance Guidelines
2. REDD+ Activity Guidelines
3. REDD+ Financing Guidelines
4. REDD+ MRV Guidelines
5. REDD+ Safeguard Guidelines
6. REDD+ Legal and Regulatory Guidelines
7. REDD+ Distribution Guidelines
8. REDD+ Education, Training and Research Guidelines
9. REDD+ International Engagement Guidelines

The development of the guidelines is to be completed in 2011. However, any of the guidelines will be updated as and when required, with each version appropriately labelled (e.g. National REDD+ Guidelines V1.1 2011; National REDD+ Guidelines V2.1 2012 etc.).

ANNEX 4-1: DRIVERS OF DEFORESTATION AND FOREST DEGRADATION IN FIJI

Deforestation and forest degradation result from distinct drivers brought about by different agents. Some drivers affect deforestation in the immediate term and degradation in the long-term and vis-a-vis. Drivers for deforestation cause conversion of forest to another land use. Forest degradation is the long-term reduction of biomass resulting from poorly regulated extractive activity. Forest degradation is further intensified by the general undervaluation of forest ecosystems and the non-tangible benefits they provide (Barquero-Morales, et al., 2014; Skutsch, Torres, Mwampamba, Ghilardi, & Herold, 2011).

The analysis of drivers of deforestation and forest degradation was undertaken at a national level with assessment undertaken across the accounting area. Results from the drivers' analysis, SESA, R-PP and ER-PIN indicate six direct drivers identified as follows (not in order of priority):

Forest conversion to agriculture associated with crop production and livestock;
Traditional use;

- Poorly planned infrastructure development;
- Conventional Logging;
- Natural disaster;
- Invasive Species;
- Mining.

Drivers of Deforestation

Key Driver #1: Forest conversion to root crop production

Nature of the driver

In the accounting area, farmers on Viti Levu often transition forest-on-farms to agroforestry, or forest-on-farms to grazing livestock for cattle, goats, and sheep. On Vanua Levu, forest-on-farms are noted to transition to commercial root crop production – predominantly taro and kava, aquaculture and settlements. Expansion of kava production is characterised by upland cultivation, often with mixed crop of taro/kava followed by fallow period of 3-6 years. Commercial production is characterised by monocrop planting of either kava or taro in large tracts of land.

Conversion of forest-on-farms to other land use is prominent among agriculture lease holders. Farmers in rural and semi-urban areas are either landowners or lease holders. The latter are known as tenant farmers with 30- year Agriculture Lease from the iTaukei Lands Trust Board or the Department of Lands. The iTaukei Lands Trust Board issues leases on communally owned iTaukei lands while the Department of Lands issues leases on State lands. Lease holders with forest-on-farms can clear-fell these forests for agricultural production. Often, lease holders are commercial or semi-commercial farmers.

The accounting area covers Viti Levu, Vanua Levu and Cakaudrove. The provinces of Viti Levu – Naitasiri, Namosi, Rewa, Serua, TaiLevu, Ba, Nadroga/Navoda and Ra; the provinces of Vanua Levu – Bua, Macuata and Cakaudrove and the island of Taveuni that falls in the Province of Cakaudrove form part of the accounting area. A comparison of the number of farms in the accounting region indicates five Provinces have agriculture productive areas above 20,000ha. Assessment of the types of crops produced on farms indicate kava (yaqona), cassava and taro to be the most common crops cultivated.

One of the key contributors to deforestation is indiscriminate clearing of forest, especially around watershed areas for semi-commercial and commercial agriculture, predominantly for taro and kava cultivation. While taro market prices have been stable, increasing market demand and price for kava have made it the most popular semi-commercial and commercial alternative for many rural land owners. Kava cultivators are predominantly iTaukei subsistence farmers who are transitioning to semi-commercial operation.

On Viti Levu, farmers concentrate in rural areas of the Provinces of Naitasiri, Ba, Nadroga/Navosa and Ra. On Vanua Levu (including Taveuni) farmers are clustered in the Province of Macuata and Cakaudrove. On Viti Levu, farmers in Naitasiri and Ra predominantly cultivate banana, kava, cassava and taro while in Macuata, Bua, Cakaudrove commonly cultivate kava and dalo. Farmers in the accounting area of Taveuni are renowned for exports of taro and kava. Almost 70% of Fiji's exported taro comes from Taveuni. Commercialisation of taro and kava on the island of Taveuni have seen encroachment of farm-land into the Taveuni Forest Reserve, an area of biodiversity protection establishment by the Ministry of Forest. Literature indicates the extent of uphill cultivation of taro in the pursuit of tilling fertile land. Cash crop intensification on the island has resulted in 'agrodeforestation' where tree crops are cleared for mono culture cash crops.

Agents

For commercial exploitation, agents include commercial farmers who are lease holders on either native or state land. On Taveuni, private farmers make up a large portion of commercial farms. Other agents involved with the driver for forest conversion to agriculture production includes:

Overall Government Development policies driven by national efforts towards food security (in terms of self-sufficiency and import substitutions) in addition to commercial production for export.

Buyers of commodities, who place increased demand on agricultural production for international markets.

The Ministry of Agriculture and Department of Environment, who are responsible for implementing and enforcing regulations relating to agricultural expansion and land conversion.

Fiji Crop and Livestock Council, who is responsible for coordinating and aggregating large and small producers cultivating crops other than sugar.

All private and business entities that are involved with agriculture inputs, pre-harvest, post-harvest processing and sale (domestic and export) of all agricultural produce.

Local population, who is working to meet market demands for agricultural produce.

Lease holders driven by self-interest to maximize profit within the duration of lease tenure.

The Ministry of Tourism, tourism industry and all related sectors whose growth has placed increasing demand on domestic production in addition to imports.

Underlying Causes

Economic factors and market demand: Economic factors including improved market access and strong global demand for kava and taro have driven production in the accounting area. The trend is anticipated to increase as a result of consumer preferences from international markets such as New Zealand, Australia and the European market for kava.

Socio-political: Non-renewal of agriculture leases has caused an influx in migration farmers, particularly those producing sugarcane, to move out of agricultural activities and into an urban lifestyle. As a result, about 51% of Fiji's population live in urban areas, and this is expected to increase to 60% by 2030 when some 13,141 leases issued since 1997 under the Agricultural Landlord and Tenant Act will expire. Farmers with lease agreements have no security for a future on the farm hence they may not see the benefit of long term stewardship of natural resource and aim to maximising returns on investment for the duration of the lease is a potential driver of logging of forest-on-farms.

Key Driver #2: Forest conversion to pasture (livestock)

Nature of the driver

Beef production is the major contributor within the livestock industry with indication of steady increase1. In Viti Levu and Vanua Levu, rural communities are involved in livestock husbandry, root crop cultivation, vegetable gardening, fishing, collecting fuelwood, hunting wild pigs, bats and pigeons, rice farming and sugar-cane farming. In Taveuni, agroforestry system of cutnut tree (Barringtonia asiatica) inter-planted with taro on the hill and mid slopes with cattle raised in the forest valley flats. Coconut trees are planted as a significant cash crop via copra with cattle grazing underneath.

---

[1] Ministry of Agriculture. 2016. Fiji Livestock Sector Strategy

Commercial livestock farming is confined to the wetter areas of Viti Levu and Vanua Levu on land classified under land capability V-VII. Agriculture Census in 2009 indicate that 44% of farms are less than 1 ha, some 35% have less than 5 hectares with 20% over 10hectares. Famers with forest-on-farms continually convert forest to pastures for livestock farming – seeking fertile land for pasture. Small scale farmers on Viti Levu practice subsistence livestock farming. Similarly, the accounting area of Vanua Levu and Taveuni have subsistence dairy and beef farms. Subsistence beef farmers on leased lands clear the forest-on-farms and let livestock loose in the forest. Roaming livestock in the forest not only becomes a threat to hygiene in natural creeks but also an impendence to natural regeneration of tree species. Pasture clearing not only results in forest loss but has high potential to contribute towards forest degradation.

Agents

Over 60% of rural population participate in livestock related activities. Small holder farms adopt livestock for food security and additional cash stream. Small holders may hold a herd of 2-4 animals while large commercial farms up to 18 heads per hectare. Except for Viti Levu, dairy in other accounting areas – Vanua Levu and Taveuni are at subsistence level due to accessibility to processing plant. Small holders include sugar cane, vegetable, rice, crop as well as village dwellers of iTaukei origin.

Other agents involved with the driver would include:

- Logging companies, who are responsible for the active felling of trees. This includes Fiji Pine Ltd. & Fiji Pine Trust both of which are predominantly owned by the government and traditional landowners. Also includes the Mahogany Industry Council, FHCL, Fiji Mahogany Trust; landowners and loggers who are involved in mahogany logging, post-harvest, processing, branding and marketing.
- MOF whose role is to regulate, develop, and enforce restrictions within the logging industry.
- The Department of Environment, who is required to conduct an EIA for any commercial logging activity.
- The Department of Lands and Department of Fisheries, who together – along with the MOF and Department of Environment – manage Fiji's mangrove resources; Department of Land for native logging in State Land as well as the establishment of Protected Area or Conservation Leases on all types of land tenure on behalf of the MOF.
- Landowners, who either fell trees themselves or consent to activity on their property by commercial logging operations.
- Local population, whose growth requires building materials and cleared land for expansion.
- TLTB, whose consent is required for licenses to harvest timber on iTaukei land.
- Buyers of wood and timber, who place increased demand on timber production for international markets.
- Tourists, who have placed increased demand on the Fiji Sago Palm production for thatch shingles.
- Underlying Causes
- Economic factor: The value of livestock sector at farm gate is estimated at around $200m annually even without down- stream processing or post-farm processing.
- Socio-political: Increasing population and visitor numbers are believed to influence consumption patterns which are driven by raising incomes, better standard of living, change in consumer preference and an increase in consumption by food processors to produce sausages, tin meat and others.
- Ministry of Agriculture policy objective to reduce importation of meat and become self-sufficient continues to be the policy objective that under-pins development in the sector. The Fiji Livestock Sector Strategy recommends that Ministry of Agriculture focus on commercial livestock and divulge small scale livestock production to other government agencies and civil society organization that focus on food security and alternative livelihood.

Key Driver #3: Poorly planned infrastructure development

Nature of the driver

Several types of forest conversion to infrastructure are identified at the national level. In the context of deforestation, infrastructure development includes construction of roads, hydro dams and electricity; urban development and resettlement; tourism development. Fiji does not have a national land use plan, which is a major constraint to resource allocation and management in the rural sector and is of critical importance to ensure rationalised infrastructure development that considers impacts on all land-based resources such as forest, agriculture, minerals, rivers and streams (GoF, 2015a).
Road and transport: An estimated 4,254 km of road network exist in Fiji of which 1,483km are sealed. Main logging roads in newly logged forest are often upgraded for public assess by the Ministry of Rural, Maritime Development and Natural Disaster following logging operations; providing opportunities for settlements and conversion of forest to monocrop or mixed crop production systems. As such, the underlying catalyst for road construction is the need to meet economic and social needs of rural populations to access markets, urban centres, health and education services.
Hydro-power: The government's goal of bringing electricity to rural communities as a means of addressing poverty has driven the country towards hydroelectric development. Around 67% of the country's electricity requirements are met from renewable energy sources (62% hydroelectric, 4% biomass, 1% wind), with imported petroleum for thermal generation meeting the remaining 33% (Department of Energy, 2014). Fiji's potential for additional hydroelectric power generation in the accounting area is significant, particularly through micro-dams. Fiji aims to have 100% renewable energy by 2036.
Urban development and resettlement - Rural-Urban Drift: Increasing population and the influx from rural to urban areas have resulted in significant urban development ensuing in encroachment on first-class arable land, and the construction of homes on top grade agriculture soils. Conversion to real estate of prime agriculture areas have pushed agriculture to the marginalized rolling (unsuitable) hills of land capability class V-VII.
Tourism development: Fiji's tourism industry has grown dramatically over the past decade. Over 650,000 tourists visit Fiji annually. In 2012, tourism contributed 18% of GDP while in 2016, tourism had increased to contribute 39% of GDP. The increasing influx of tourists coming into the country pose increasing pressure on and competition for natural resources between agriculture, infrastructure, housing and tourism (Narayan, 2015). Continual large-scale tourism development and urban expansion along coastal areas habitats are drivers of coastal carbon emission through mangroves clearance.

Agents

Infrastructure development has generally been driven by national efforts in pursuit of economic development and improved livelihoods. Key actors include:
The Ministry of Infrastructure & Transport, along with the Fiji Roads Authority and Water Authority of Fiji, who is responsible for policy formulation, planning, regulation, coordination, and implementation of services relating to transportation and public utilities.
Local population, who requires infrastructure development to accommodate population growth.
The Department of Town and Country Planning, whose role is to control and regulate the appropriate use of land in Fiji.
Commercial agriculture producers, whose expansion necessitates improved infrastructure to deliver products to market and ports.
The Ministry of Agriculture, Sugar, and Land Resettlement, who is responsible for relocating farmers when their leases expire.
The Ministry of Tourism, along with hotels and tourism agencies, whose growth has placed increased demand on Fiji's energy production and transportation infrastructure.
The Department of Environment, who is required to conduct an EIA for any development proposals, as well as to enforce environmental codes and standards.
Tourists, who temporally increase Fiji's population and increase demand for infrastructure, products social and ecosystem services.
Underlying cause
Social factors: The Fiji Bureau of Statistics estimates a projected one million people in Fiji by 2030. A good proportion of the communities visited during field work were young and youthful. Statistics support this observation where the median age of Fiji's population is 27.5 years with 69% below the age of 40.
Expired agricultural land leases are contributing to large influx of rural – urban drift as farmers are relocated upon expiry of lease. Associated social problems that may result from such a situation

include increased demand for timber as a preferred building material, unemployment, deforestation and forest degradation associated with infrastructure development, agriculture and traditional wood extraction.

Economic factors: Strong performance of the tourist sector, driven by economic development has resulted in the influx of infrastructure development including roads, hotels, and other support structures. Fiscal tax incentives associated with construction and tourism tax measures directly support and encourage infrastructure development particularly along Fiji's coastal area.

Cultural factors: Given the land tenure system in Fiji, local decision-making and governance have a very strong impact on infrastructure development. Infrastructure developments have supported commercial farmers, driven by self-interest to maximize profits. Outcome of such a trend is a move towards commercialization of small holder farmers which pushes resource utilization at a faster rate towards the tipping point or a collapse of ecosystem services and benefits.

Key Driver #4: Mining

Nature of Driver

Mining is considered an emerging economic sector with great potential to become a key sector of growth and a main source of government revenue in the future.

History shows that mineral development poses special problems for communities adjacent to mineral deposits due to associated environmental and social impact. For these reasons, the government views the direct participation of residents and landowning communities as an integral part of a successful long-term relationship honoring the rights of landowners as well as immediate stakeholders in alignment with the Fiji Mining Act & Regulations (Cap 146). Overall, the lack of transparency and institutional capacity is a major barrier to understand and effectively police exploration, mining, and quarrying activities (MoSP, 2014).

Another threat from mining activities is related to freshwater vertebrates and invertebrates where habitat destruction brought about by excessive gravel extraction, may lead to species decline and in turn affects food security for rural communities. Similarly, a constant supply of clean water has been an expectation of rural living however mining and gravel extraction pose a threat to such expectation. Rivers and streams have always provided drinking water but have also been important for washing and bathing, as well as for livestock needs.

Future government plans include several prospective mining licenses and special mining license for copper, silver, manganese, molybdenum, limestone/ marble, petroleum, gas and geothermal heat that have been granted to investors. Given the long gestation period from prospecting to mining, the government is looking at opportunities to support investors fast track the transition. Under the Environment Management Act (EMA), EIAs are an obligatory requirement to safeguard against potential activities that may have negative environmental and social impacts.

Assuming that several mining projects may materialize at the same time the impact of mining on Fijian forest could be significant. However, mining is not considered a serious threat at the time of this assessment as there are no serious prospecting in the horizon.

Agents

Mining and other extractive activities have generally been driven by both domestic and international demand for minerals and construction materials.

Buyers of extracted materials, who place demand on extractive activities for valuable minerals and other materials.

Mining companies, who are responsible for prospecting works and activating mining and extraction of resources.

The Department of Environment, who is required to initiate the EIA study as well as to inform stakeholders and assess the EIA in an open and transparent manner

The Ministry of Lands and Mineral Resources, who is responsible for the administration, development and management all State Land initiatives including the facilitation of the country's mineral sector and ground water resources. The Ministry hosts two departments: the Department of Lands and the Mineral Resource Department (MRD).

Department of Lands, who is responsible for negotiating surface access rights and benefit sharing on lands designated under the Land Bank.

The MRD who regulates the mineral sector which includes all minerals whether of high or low value.

The Ministry of Forest for issuing Forest Right License to extract logs that are cleared during prospecting and mining operation however this will only become effective if the mining company wishes go sell the logs felled. Often, the logs are left to rot and the Ministry of Forest is not involved.
TLTB, whose consent is required for licenses to mine on iTaukei land.
Landowners, who may mine themselves or consent to activity on their property by commercial mining operations.

Underlying Causes
More extensive prospecting for minerals with possible mining activities has a big concern in Fiji in recent times given the large number of prospective licenses in place and the overarching nature of the Mining Act. While Fiji has the EMA (2005) to safeguard against potential activities that may have negative impacts, the country may have limited the capacity to fully enforce the legislation due to lack of resources and capacity.

Drivers of Forest Degradation

Key Driver #5: Conventional Logging

Nature of the driver

Commercial logging in Fiji largely follows conventional practices. In 2012, the Fiji Forest Harvesting Code of Practice (FFHCOP) was revised, incorporating results from the Nakavu sustainable forest management research site. Forest categorisation used by the Ministry of Forest for management purposes include forest functions or uses (hardwood plantations, softwood plantations, protection forest, multiple use forest) as well as forest classes (open forest or closed forest, depending on percentage canopy cover). The demand for construction materials over the past three years have been driven by investment in tourism projects such as the Grand Pacific Hotel, Denarau Casino Development, and others (ADB, 2014a). Additionally, housing demands from increasing urban population as well as rehabilitation after Tropical Cyclone Winston has boosted demand for timber to an all-time high.

Rapid re-logging of native forest after coupe closure exacerbates forest degradation in the absence of restocking or restoration. Further the issue of Annual Licenses for timber extraction in logged native forests limits and constraints long term planning, limiting investment to apply best practices for sustainable forest management. Although legal framework and policies allow for the issuance of long term license, there are only 2 long term licenses in Vanua Levu. Other logging licenses include clear fell licenses predominately for agricultural clearance and forest right license for harvest of mangroves (for cremation and firewood). Firewood license is also issued to collect waste logs from logging sites for sale to businesses with industrial boilers. Production from native forest have averaged at 38,000m3/yr. between 2012-2015.

Agents

The following actors and agents have direct influence over the driver of conventional logging:
Logging companies, who are responsible for the active felling of trees. This includes Fiji Pine Ltd. & Fiji Pine Trust both of which are predominantly owned by the government and traditional landowners. Also includes the Mahogany Industry Council, FHCL, Fiji Mahogany Trust; landowners and loggers who are involved in mahogany logging, post-harvest, processing, branding and marketing.
MOF, whose role is to regulate, develop, and enforce restrictions within the logging industry.
The Department of Environment, who is required to conduct an EIA for any commercial logging activity.
The Department of Lands and Department of Fisheries, who together – along with the MOF and Department of Environment – manage Fiji's mangrove resources; Department of Land for native logging in State Land as well as the establishment of Protected Area or Conservation Leases on all types of land tenure on behalf of the MOF.
Landowners, who either fell trees themselves or consent to activity on their property by commercial logging operations.
Local population, whose growth requires building materials and cleared land for expansion.
TLTB, whose consent is required for licenses to harvest timber on iTaukei land.

Buyers of wood and timber, who place increased demand on timber production for international markets.

Underlying Causes

Economic Factors: Attractive local and international market prices for timber and no-timber products have provided much motivation for maximizing extraction and utilization of forest products. Underlying factors associated with consumer preferences have seen an insatiable demand for forest products required in building projects. A study on the impact of logging regime on the undergrowth of forest stands indicate comparatively high growth rates in the remaining forest stand of conventional logging compared to lower intensity logging. Such observation on the concentration of incremental growth in the smaller trees, indicates heavily degraded forest and decreasing proportion of commercial trees after logging. Much of the remaining forest stands have only 40% of their initial biomass density due to severe degradation and high mortality from damage during felling and extraction (Kaitani & de Vletter, 2007).

Key Driver #6: Impact of Traditional Use

Nature of the driver

Fiji recognizes customary land ownership as enshrined in the Constitution. Traditional forest use rights for subsistence and customary purposes include harvesting of wood for firewood and other traditional uses, the collection of forest produce for food and medicinal purpose.

Traditional use rights: Although the annual population growth in Fiji is low at 0.7% per year compared to the global average of 1.2% per year (World Bank, 2017), there has been a gradual increase in the rural iTaukei population overtime. The protection of traditional forest use is strengthened by its exclusivity, given no person other than the traditional landowners may exercise these rights where the land is un-alienated. Men and women have equal access to timber and non-timber resources as sources of income and or food security.

Non-timber forest products: Communities in the accounting area collect medicinal plants, wild crops, edible ferns, fruit, nuts, pandanus leaves (for weaving mats), sago palm leaves (for roof thatching), and wild pigs in the forest. However, there is a lack of quantifiable information on the impact of such extraction to substantiate the impact of traditional practices.

Timber for subsistence use: Various species are selectively logged for traditional uses. Unsustainable harvesting changes the natural forest species composition. Traditional demand for selected species has been exacerbated with increasing iTaukei population. Traditional use of forest trees such as Vesi (Intsia bijuga) is also highly valued for its durability, attractive dark red-brown colouring, and traditional use for central poles in chiefs' houses, gongs, and canoes. Its' easy-to-work properties also make it suitable for woodcarving of valuable artefacts. The commercial production of kava bowls, weapons, and other artefacts to supply the growing tourist market has put additional pressure on the vesi population, particularly in the absence of replanting (Thaman, Thomson, DeMeo, Areki, & Elevitch, 2006).

Firewood: Firewood collected from the forest and used for subsistence purposes are free and readily available. Firewood collection is considered a driver for forest degradation. Communities consulted during the in the course of data collection noted that preferred firewood species which are highly flammable are now scarce and difficult to find. The scarcity indicates gradual depletion of such tree species such as yasiyasi, marasa, dawa, koka, vure, doi, davo. Currently, weedy species such as molau, onolulu and gadoa are the most commonly used firewood species as they are more accessible along the roadsides and degraded areas. Additionally, debris from logging areas (native, mahogany and softwood plantations) are also used for domestic firewood.

Use of Fires: Traditional techniques using fires for hunting and land clearing are popular among rural communities. Pig hunters use fires to locate their prey. At the same time, livestock owners lightly fire undergrowth of forest to generate new grass for fodder. Small holder crop farmers put plots under fire to minimise and manage waste from felled trees during land preparation and farm expansion. Fires are particularly risky during long drought periods. In rural area, when fires break out in the outskirt of villages and settlements, it is often left to die natural death unless it is burning assets such as crop field, infrastructure or other valuable interests.

Agents

Key actors and agents that use forest resources for traditional use are listed as follows:

iTaukei communities, who have inherent communal rights to use forest resources in traditional activities, such as the harvesting of firewood, collection of produce, and medicinal purposes.
Lease holders who have rights to use forest resources in traditional activities, such as the harvesting of firewood, collection of produce, and medicinal purposes.
TLTB, whose role is to manage and regulate the areas held under customary tenure arrangement in Fiji.
Tourists, who have placed increased demand on the production of traditionally made kava related goods.
Hoteliers and tourist who prefer the use of Sago Palm for roof thatching materials.
Consumer preference for sandalwood oils /scent
Biomass company such as Eltech – electricity generation from Gliricidia and other species.

Underlying Causes

Social factors: Cultural values and norms support the diverse and varied use of natural resources. Communities pass traditional knowledge from generation to generation. With increasing population, pressure on the use of natural resources calls for planning and resource allocation.
Economic factors: With limited cash reserves, local communities use timber and non-timber products to support good health and wellbeing. Some traditional commodities have market values and, in some cases, have established market chains such as sandalwood scented coconut oils.

Key Driver #7: Invasive Species

Nature of Driver

Invasive plant species are plants introduced by humans to localities outside their natural range that become established in their new environment (Lowe, Browne, Boudjelas, & de Poorter, 2000). The economic and ecological impacts of invasive alien plants worldwide have been widely documented and participants of the community consultations and divisional workshop identified introduced species as a drivers of forest degradation, and more specifically listed the following invasive plant species: African Tulip (Spathodea campanulata), Merremia vine (Merremia peltata), Broad-leaf mahogany (Swietenia macrophylla); and Caribbean pine (Pinus caribaea var. hondurensis), as the most notorious introduced species. Despite its invasive nature, such species enhance carbon stock through aggressive growth patterns.
The invasive plant species take over any gaps in the forest created either through fallow, disturbance along roads or streams or clearing of logged areas. Once established in an area, they rapidly grow and out-compete their native counterparts, forming large monotypic stands.
Two invasive plant species identified in this study are timber species and are described in section on logging: the Caribbean pine (Pinus caribaea var. hondurensis) planted in the drier regions and the Honduran or big-leaf mahogany (Swietenia macrophylla) planted mostly in wet regions of Fiji. Both timber species were introduced as part of government policy to provide a forest-based industry and employment to rural based communities, generate foreign exchange income, and establish plantations on logged forest to meet local timber demand.

Agents

The introduction of outside species can be particularly detrimental for islands like Fiji, and are generally driven by human actions, whether intentional or unintentional.
The Ministry of Forestry, who introduced some of these species to replenish natural stocks.
The Department of Agriculture, who studies and categorizes species by their level of impact and contributes to the management of introduced species.
The Biosecurity Authority of Fiji is mandated to protect Fiji’s agricultural sector from the introduction and spread of animal and plant pests and diseases, facilitate access to viable agro-export markets and ensure compliance of Fiji’s agro-exports to overseas market requirements.

Underlying Causes

Given the long growth cycle of forest species, market driven diversification of core commodities and self-interest have often seen the conversion of forest land into agriculture for faster, short-term returns as well as extensive encroachment of exotic and introduced tree species into native forests. Improved road access and construction of farm roads support may enhance supply chain for ease of market access but are detrimental in supporting influx of non-native pioneer species.

ANNEX 4-2: INTERVENTION TECHNICAL NOTE [01-06]

The technical notes are developed in support of Section 4.3:

TECH NOTE 01:	Development of integrated District Land Use & Management Plan
TECH NOTE 02:	Sustainable Management of Native Forest
TECH NOTE 03:	Carbon Enhancement PLANTATION
TECH NOTE 04:	Carbon Enhancement COMMUNITY PLANTING
TECH NOTE 05:	Carbon Enhancement AGROFORESTRY AND ALTERNATIVE LIVELIHOOD
TECH NOTE 06:	Forest Conservation

Summary table for GHG emissions data requirements

Enabling Activities
Tech Note 1 which includes
Land use planning
Strengthening forest governance and law enforcement
Forest Information System

Interventions
Sustainable Forest Management – Tech Note 2

Year	Forest Degradation (Reducing volumes extracted to meet sustainable harvesting rates) (ha)
2020	1700
2021	1700
2022	1700
2023	1700
2024	1700
Total	8,500

Carbon Enhancement -Tech Note 3 – Plantation; Tech Note 4 – Community Planting;

Year	Enhancement of Carbon Stocks (A/R) – (increasing planting on degraded lands by communities) (hectares planting increased)	Enhancement of Carbon Stocks (Softwood Plantations) – (increasing planting in softwood plantations) (hectares planting increased)	Enhancement of Carbon Stocks (Hardwood Plantations) – (increasing planting in Hardwood plantations) (hectares planting increased)
2020	550	1219	479
2021	950	1219	479
2022	1,350	1219	479
2023	1,750	1219	0
2024	2,150	1219	0
Total	5750	6,095	1,437

Tech Note 5 – Agro Forestry & Alternative Livelihoods

Year	Enhancement of Carbon Stocks (A/R) – (increasing planting of riparian zones) (ha)	Deforestation (areas of deforestation avoided as a result of shade grown agriculture) (ha)
2020	1000	300
2021	1000	300
2022	1000	300
2023	1000	300

2024	1000	300
Total	5000	1500

Forest Conservation – Tech Note 6

Year	Deforestation (areas of deforestation avoided)*
2020	1000
2021	1000
2022	2000
2023	2000
2024	2000
Total	8,000

*estimated production forest in Forest Conservation Area

Overall Summary of Interventions

Subcomponents:	2.5	2.3 & 2.4	2.2	2.1
Year	Deforestation (areas of deforestation avoided)*	Enhancement of Carbon Stocks (A/R) (hectares planting increased)	Enhancement of Carbon Stocks (Softwood Plantations) (hectares planting increased)	Forest Degradation (Reducing volumes extracted to meet sustainable harvesting rates) (areas under reduced impact logging)
2020	1000+300=1300	550+1000 = 1550	1219+479=1698	1700
2021	1000+300=1300	950+1000 = 1950	1219+479=1698	1700
2022	2000+300=2300	1350+1000 = 2350	1219+479=1698	1700
2023	2000+300=2300	1750+1000 = 2750	1219	1700
2024	2000+300=2300	2150+1000 = 3150	1219	1700
Total	9, 500	11,750	7,532	8,500

TECHNOTE 01: Development of integrated District Land Use & Management Plan

Intervention Title: Development of Integrated District Land Use and Management Plan			
Driver Impacted	Related REDD+ Activity	Impact Profile	Estimated Budget USD
Forest conversion to root crop production; Poorly planned infrastructure development Forest Conversion to Pasture and Livestock. Conventional Logging Impact of Traditional Use Settlement Firewood Forest Fire	Deforestation Forest Degradation Enhancement of Carbon Stocks	510,319 ha	$1,647,630

Description of the Intervention

This component aims to establish the enabling environment for ERP activities in Component 2 to be implemented. The component includes development of the Integrated District Land Use Plan, consolidation of both community and industry governance and law enforcement systems as well as the setting up of forest information systems to improve reporting, monitoring and evaluation.

INTEGRATED DISTRICT LAND USE PLAN

The Integrated District Land Use Plan (DILUP) ensures that drivers and underlying causes of deforestation and forest degradation are addressed albeit not directly by this activity but as the cornerstone to enable direct response in Component 2.

The National Development Plan (2017-2036) identifies private sector participation in plantation development as a critical policy moving forward in addition to issuance of forest management license. One of the strategies to fulfil this policy is the formulation of a National Land Use Plan. Under the ERP, multisectoral partnership and collaboration is noted as a critical requirement to ensure buy-in and implementation of such plans. This is recognized in the study of Drivers of Deforestation and Forest Degradation which recommends the formulation of District level integrated land use and management plans (IDLUP). The TLTB and Ministry of Agriculture are also operationalizing at national, district and community level respective initiatives of Greater Master Plan and District Land Use Plans. Both institutions cite financial resources, capacity and time as major constraints in their progress thus far. Further, the TLTB has also undertaken resource audit with land areas, forest coverage and type classification, gravel and water sources amongst others at land owning unit levels. This initiative is progressing albeit slow and similarly burdened by capital resource, capacity and time issues. Resource audit and the proposed integrated land use plan will consider the following for each site:

Food Security	Forest Production Areas	Tourism land and resource access and development
Increased Productivity	Clean Air Access	Gender Balance Measures
Best Practices	Conservation Measures	Livestock/Dairy
Enforcement/Compliance/Monitoring	Reforestation	Sugar Cane Production
Housing	Afforestation	Land Owning Unit Empowerment
Renewable Energy	Infrastructure Development	Environmental Protection
Climate Change Initiatives	Fair and Equitable returns	

Zonation of resource use according to resource capability will ensure sustainable land use to support the sustenance of current and future generations. The IDLUP will provide the platform for sectoral collaboration and bring all stakeholders together to discuss and agree on resource allocation that may in turn by construction, render a national land use master plan. The result will support establishment of Permanent Forest Estates (Forest Policy 2007) - an area that will remain under forest for ever, the allocation of water catchment, agriculture areas, areas that need rehabilitation and carbon enhancement planting opportunities as well as forest conservation areas and other land uses.

STRENGTHEN FOREST GOVERNANCE & LAW ENFORCEMENT AT COMMUNITY LEVEL

In view of the shortage of staff in the Ministry of Forestry, the existence of Forest Wardens in rural area, building capacity of rural communities and Forest Care Groups is potentially beneficial for forest law enforcement and governance. The National Forest Policy 2007 advocates devolution of power to local communities. Although complete devolution of power is not possible during the ERP, the opportunity to train and engage landowners to manage their own resources should not be overlooked. Project experiences from Drawa and Nakauvadra Community Based Reforestation Project have shown that landowners are capable to monitor resource around them. The Forest Wardens are tasked to monitor logging activities in their designate areas.

STRENGTHEN FOREST GOVERNANCE & LAW ENFORCEMENT AT INDUSTRY & Trade LEVEL

Application of the Fiji Forest Harvesting Code of Practice is the responsibility of all harvesting operators in the Forest Sector. Harvesting operators are trained regularly to ensure they understand forest laws and regulations. Network of Logging Supervisors and Timber Production Officers are supported to ensure that log production operations align to FFHCOP requirements. Timber Production Officers will be certified by the Ministry of Forest to Supervise logging activities. Timber Production Officers are Forest law enforcers who oversee logging operations to ensure compliance.

FOREST INFORMATION SYSTEM

Ministry of Forest undertake logging monitoring twice a year. Companies are selected at random, monitored and evaluated. Monitoring and assessment results are assessed by the Ministry and discussed with the Timber Production Officer, company representative and Forest Warden highlighting gaps in compliance to the FFHCOP. This activity aims to provide a platform for discussion of the logging monitoring results with the industry and landowners concerned to discuss gaps and agree on way forward for corrective actions.

Driver Impacted

This intervention will support resource planning and allocation of resources to the best suited end use (e.g. Without the intervention, unplanned agriculture production, unplanned infrastructure development and unplanned settlement will continue to plague resource utilization giving rise to unchecked deforestation and forest degradation.

Related REDD+ Activity(ies)

Deforestation, Forest Degradation, Enhancement of Carbon Stock
Actions of the Intervention

INTEGRATED DISTRICT LAND USE & MANAGEMENT PLAN

Desk top assessment – map layers – forest, soil classes, road/infrastructure, settlement, water catchment, Stakeholder analysis
Inception workshop in the District
Community planning workshops – verify land category, identify current land uses, identify future land uses based on resource capacity gathered in (1) above
Socio-economic base line assessment for all at least 20% of communities as representative sampling
Community validation of the socio-economic assessment and land use capacity resource allocation
Forest Care Groups Formed by Communities to support endorsed plan
Community workshop – prioritise management interventions endorsed
Plans submitted to District and Provincial Administrators for endorsement
Plans submitted to Town and Country Planning for registration and endorsement
Plans ready for implementation

STRENGTHEN FOREST GOVERNANCE & LAW ENFORCEMENT AT COMMUNITY LEVEL

Targeting Forest Wardens & Forest Care Group representatives:
Awareness and training on FFHCOP, SFM, Fire Management Strategy, all new regulations related to management of forest under SFM, FGRM mechanism, BSM mechanism and FPIC;
Standard operating procedure and monitoring protocol for planting in carbon enhancement activity to monitor growth of planted trees;
Standard Operating procedure in logging on monitoring protocols for FFHCOP;
Standard operating procedure for land leasing process to support issue of Forest Management License.

STRENGTHEN FOREST GOVERNANCE & LAW ENFORCEMENT AT INDUSTRY & Trade LEVEL

Training of Trainers for all Logging Supervisors to improve understanding of forest laws and regulation with commitment to train logging crew under their charge;
Refreshment building for Ministry of Forestry Field Officers on laws, regulations, monitoring and reporting framework
Specific training for Timber Production Officers and harvest planners to become certified

FOREST INFORMATION SYSTEM

Upgrade systems used by MSD
Engage additional staff to support FIS data entry and assessments
Train staff, private company representative on the FIS

Key Actors

Ministry of Forestry, Ministry of Agriculture, Ministry of iTaukei Affairs, are anticipated to provide technical advice and support
Taukei Lands Trust Board (TLTB) and Ministry of Lands are identified as a lead actor by virtue of the level ownership of land in Fiji
Fiji Crop and Livestock Council are incorporated in relation to stakeholder interest groupings and to provide issues that may be related to implementation and monitoring with regards to policies, regulations and laws.
All Government agencies in the capacity of advisory role at the Province/District
Provincial Council, District Council, Representative from all villages/settlement in the District for landowning unit issues and administration of related itaukei issues in general
Private Sectors trading agriculture commodity
Private Sector trading forest commodity
All Private Sector associated with Environment/Water resources
All NGO working in the District

Impact Profile

The districts of focus for integrated land use and management plans are listed in Table 1

Table 1: Districts of focus for integrated land use and management plans during the ER Programme period

Year	Districts Involved	Hectares impacted
2020	Bua Tikina (72,730ha); Tavua Tikina (70,797ha)	143,527
2021	Taveuni (43,755ha); Noikoro (34,937ha); Labasa (26,710ha); Saqani (26,460ha)	131,862
2022	Vaturova (24,650ha); Dreketi (24,290ha); Nadarivatu (24,157ha); Namataku (23,320ha)	96,417
2023	Wailevu (16,138ha); Seaqaqa (15,980ha); Yakete (14,058ha); Cuvu (12,916ha)	89,806
2024	Cuvu (12,916ha); Tunuloa (12,142ha); Naboubuco (10,141ha); Serua (9686ha); Saivou (3,822ha)	48,707
Total		510,319

Estimated Budget
Estimated the budget to implement this intervention for each year of the program period varied according to the area of the land use plan.

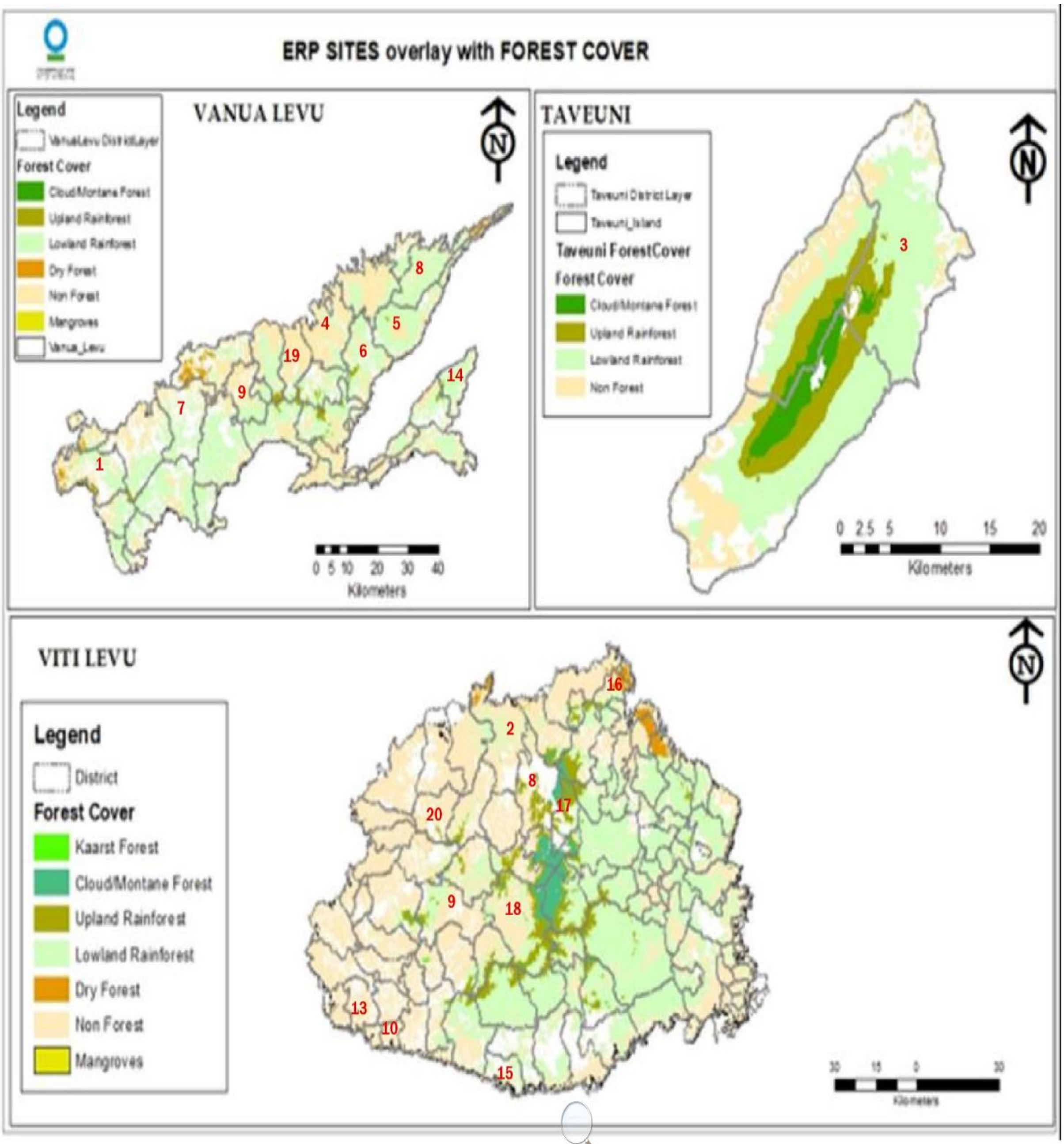
All the funds are anticipated to come from Government given that this is a direct outcome of the National Development Plan 2017-2036.

Table 2: Estimated budget for Activity 1.1, Development and implementation of District Land Use Plans

Year	Budget USD$	Source
2020	$ 353,617	Fiji Government
2021	$ 324,877	
2022	$ 237,549	
2023	$ 221,261	
2024	$ 120,003	
Total	$ 1,257,305	

MAP

The following maps depict the location of Integrated Land Use Plan intervention in the ERP area.



1-20 **Numbers - Represent Selected Districts [Old Tikina]**

Note: numbers in the following table correspond to the number of each District in the above map.

No.	Location (Districts)	Area of Forest	Area of Non-forest	Area of other land uses	Total District Area
1	Bua Tikina	24120	23450	25160	72730.00
2	Tavua	13036.00	38610.00	19151.00	70797.00
3	Taveuni*	30664	7405	5686	43755
4	Labasa	6682	18620	1408	26710
5	Saqani	18890	6150	1420	26460
6	Vaturova	14260	5788	4602	24650
7	Dreketi Tikina	16580	5367	2343	24290
8	Nadarivatu [Tikina Savatu]	3557	7731	12869	24157
9	NAMATAKU	4430	11950	6940	23320
10	Sigatoka	2611	15180	4399	22190
11	Dogotuki	12370	4060	5010	21440
12	seaqaqa (firewood)	3956	7427	4597	15980
13	Cuvu	927	9075	2914	12916
14	Tunuloa	6732	1795	3615	12142
15	Serua	4317	2500	2869	9686
16	Saivou	1438	2284	100	3822
17	Naboubuco	8451	393	1297	10141
18	noikoro	21404	13475	58	34937
19	Wailevu	3639	11054	1445	16138
20	Yakete	2628	10026	1404	14058
	TOTAL	**200,692**	**202,340**	**107,287**	**510,319**

TECHNOTE 02: Sustainable Management of Native Forest

Intervention Title: Sustainable Management of Native Forest			
Driver Impacted	Related REDD+ Activity	Impact Profile	Estimated Budget
Conventional Logging Impact of Traditional Use – Unplanned logging Settlements	Forest Degradation	8,500 ha	$974,140

Description of the Intervention

Conventional Logging in Fiji implies business as usual where minimum diameter limits are 35cm diameter at breast height (dbh) across all merchantable species administered under the Forest Decree 1992 and the Fiji Forest Harvesting Code of Practice. An integral component of the business as usual is the issuance of short-term annual licenses that results in inefficiency such as limitation in forward planning, investment opportunities in all-weather road access and in ability to undertake reduced impact logging. This intervention aims to address the establishment of long-term Forest Management Licenses and the application of the revised FFHCOP that integrates RIL principles.

Driver Impacted

Drivers impacted include reduced unplanned logging infrastructure and conventional logging. The impact of the intervention will reduce forest degradation and facilitate enabling environment for sustainable management of Fiji's Forest resources.

This intervention will also support resource planning of a large forest area and allocation of resources to the best suited end use for instance, forest areas with high biodiversity are reserved as conservation area, forest areas under timber production are utilised under the application of RIL. Without the intervention, conventional logging and degradation of remnant forest will result in gradual loss and decline of native timber flora and associated biodiversity.

Related REDD+ Activity

All ERP activities – deforestation, forest degradation, enhancement of carbon stock, forest conservation (reduced deforestation).

Actions of the Intervention

Public/Private Partnership and dialogue to establish Forest Management Licenses

Application of the new FFHCOP that incorporates Reduced Impact Logging and diameter treatment through close collaboration between private sector, statutory bodies and Government agencies

Public/Private Partnership between communities and logging companies to co-manage native forest resources through implementation of the FFHCOP in all Forest Management License Areas

Enable and support multi stakeholder dialogue and decision through the District and Provincial REDD+ Working Groups to support the Divisional REDD+ Working Groups

Key Actors

Ministry of Forest, Ministry of Agriculture, Ministry of iTaukei Affairs, iTaukei Lands Trust Board, Ministry of Lands

Private Forestry Companies undertaking logging and related operations

Local landowners where Forest Management License are implemented

Provincial/District/Community representatives

CSO – support facilitation and engagement

Impact Profile

Year	Priority Districts Involved	Available Native Forest	Area of Production of Native Timber (Ha)*	Volume harvested using conventional logging (m3)**	Volume harvested using reduced impact logging (m3)	Reduced Volume (m3)
2020	Bua/Tavua	37,156	1,700	52,972	35,700	17,272

2021	Noikoro/Saqani	40,294	1,700	52,972	35,700	17,272
2022	Dreketi/Vaturova	30,840	1,700	52,972	35,700	17,272
2023	Dogotuki	12,370	1,700	52,972	35,700	17,272
2024	Serua	4,317	1,700	52,972	35,700	17,272
Total		124,977	8,500	264,860	178,500	86,360

*Annual harvesting area of 1700 ha is based on the assumption that same annual rate of harvesting will take place as was occurring during the reference period. **Under current practice of conventional logging, an average harvesting per ha is 31 m3. If SFM is applied for logging the harvesting rate per ha will be 21 m3 (Haas, 2015).

Fiji FRL has used the approach proposed by Pearson et al. (2014) to estimate total carbon loss from logging of natural forest. The approach used total emission factor of 1.05 t C (m3)-1 for a conventional logging in the natural forest. On the other hand, a Haas's (2015) study estimated a total emission factor of 0.89 t C (m3)-1 for SFM. Hence, the difference of total emission factor will be emission reduction through using SFM instead of using conventional logging.

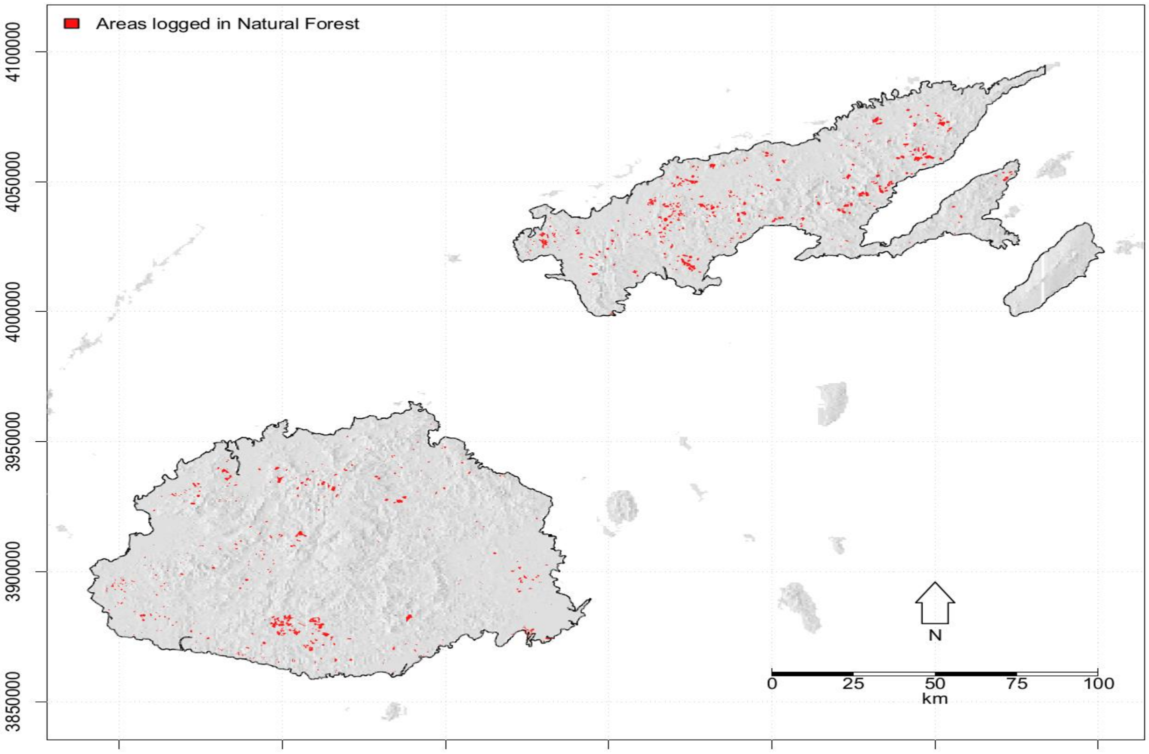
Since the harvesting is selective, there is always a natural growth in the logging areas. Data on net C stock gains after logging in the natural forest have not been assessed nationally in Fiji. However, REDD+ pilot site at Nakavu estimated that 0.99 tC ha-1 yr-1 is gained after logging operation.

Estimated Budget

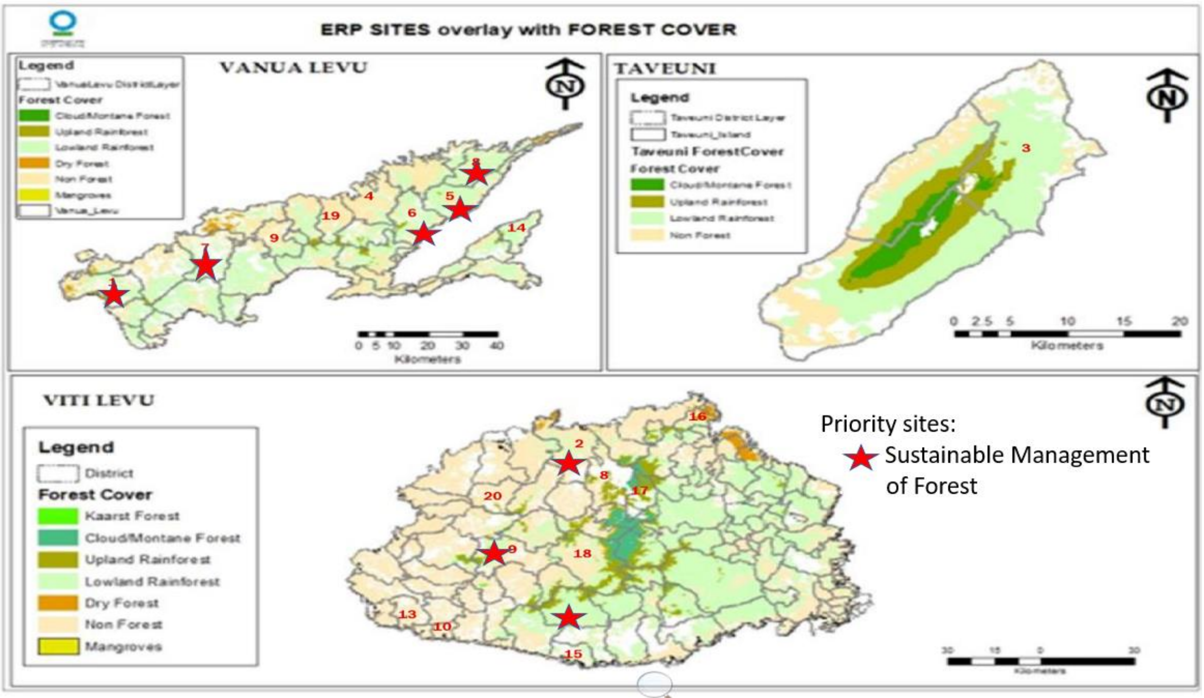
Year	Logging Industry	Fiji Govt.	TOTAL BUDGET
2020	$85,000	$109,828	$194,828
2021	$85,000	$109,828	$194,828
2022	$85,000	$109,828	$194,828
2023	$85,000	$109,828	$194,828
2024	$85,000	$109,828	$194,828
Total	$425,000	$549,140	$974,140

MAP

The following maps depict the location of logged area 2006-2016 in natural forest harvesting operations. The areas that will prioritised for this activity during ER_P is outlined in Map 2 below.



Map 2: Areas logged in Natural Forest during the Reference Period 2006-2016



TECHNOTE 03: Carbon Enhancement PLANTATION

Intervention Title: Carbon Enhancement PLANTATION			
Driver Impacted	Related REDD+ Activity	Impact Profile (ha)	Estimated Budget
Barriers to carbon enhancement *	Enhancement of Carbon Stocks Forest Degradation - Fire	6,095 FPL 1,437 FHCL 7,532 (total) 3,240	$ 7,845,478

Notes: FPL-Fiji Pine Ltd.; FHCL- Fiji Hardwood Corp. Ltd.

Description of the Intervention

Fiji Pine Ltd. And Fiji Hardwood Corp. are private Government owned companies that manage plantation estates in Fiji. Fiji Pine Ltd have an estate estimated at 76,171 ha while Fiji Hardwood Corp holds 58,978ha. This intervention aims to support establishment of plantation areas in logged over forest estates and the application of the FFHCOP.

Driver Impacted

Drivers impacted are related to the absence and lack of replanting effort after planation forest are logged by plantation companies. The barriers may be attributed to lack of capital, lack planting materials and other factors. Fiji Pine Ltd being on the drier side of the island and adjacent sugar cane field is more prone to threats from bush fires however there is a need to improve capacity to monitor fire.

Related REDD+ Activity

Enhancement of carbon stock (Afforestation/Reforestation).

Actions of the Intervention

The following activities apply to Fiji Pine Ltd. and Fiji Hardwood Corps.

Capacity building on the requirements of the FFHCOP

Strengthening of monitoring and evaluation of planted areas.

Implementation of the Fire Management Strategy

Key Actors

Ministry of Forestry, Ministry of Agriculture, Ministry of iTaukei Affairs, iTaukei Lands Trust Board, Ministry of Lands, Ministry of Women

Fiji Pine Ltd. and Fiji Hardwood Corp.

Fiji Pine Trust and Fiji Mahogany Trust

All Government agencies in the Province/District

Provincial Council, District Council, Representative from all villages/settlement in the District

Impact Profile

Fiji Pine Ltd. with and existing estate estimated at 76,171ha have been replanting (within its forest estate) at a rate of 1,281ha per year between 2006-2016. The company plans to increase replanting rate to 2500ha from 2020.

Fiji Hardwood Corporation has a total estate are of 58,978ha. Between 2006-2016 the company has been replanting logged over areas at a rate of 301ha. It plans to plant 780ha between 2020-2022.

Enhancement of Carbon Stocks

Year	Fiji Pine Limited Area Target (ha)			Fiji Hardwood Corp. Area Target (ha)		
	2006-2016	ERP Period (Ha)	Area above BAU (Ha	2006-2016	ERP Period (Ha)	Area above BAU (Ha)
2020	1281	2500	1219	301	780	479

2021	1281	2500	1219	301	780	479
2022	1281	2500	1219	301	780	479
2023	1281	2500	1219	301	0	0
2024	1281	2500	1219	301	0	0
Total			6,095			1,437

Forest Degradation - Fire

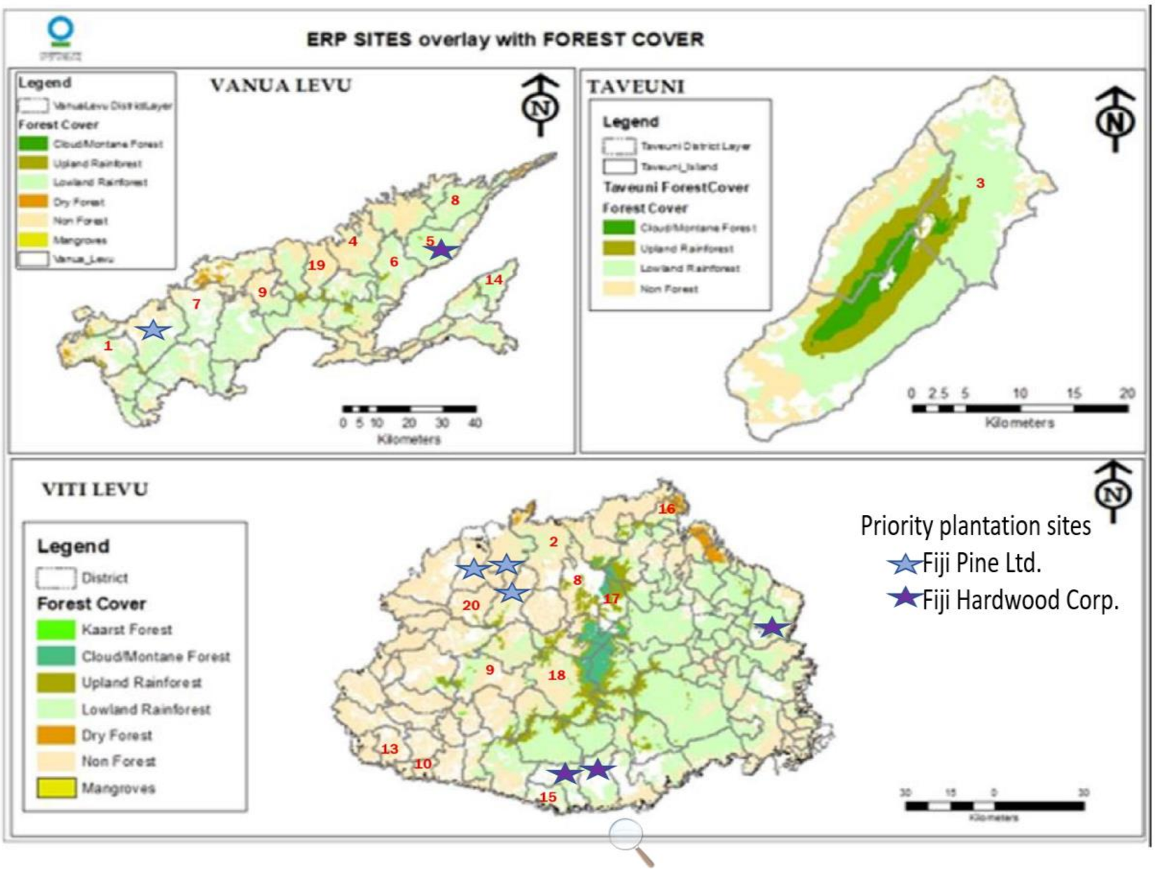
Year	Fiji Pine Limited Area Target (ha)		
	2006-2016	ERP Period (Ha)	Area above BAU (Ha
2020	1428	1000	428
2021	1428	1000	428
2022	1428	700	728
2023	1428	700	728
2024	1428	500	928
Total			3,240

Estimated Budget

Year	Fiji Pine Ltd.	Fiji Hardwood Corporation	Budget $USD	Funding Source
2020	$1,340,900	$380,326	$1,721,226	Private Forestry Companies
2021	$1,340,900	$380,326	$1,721,226	Private Forestry Companies
2022	$1,340,900	$380,326	$1,721,226	Private Forestry Companies
2023	$1,340,900	0	$1,340,900	Private Forestry Companies
2024	$1,340,900	0	$1,340,900	Private Forestry Companies
Total	$6,704,500	$1,901,630	$7,845,478	

MAP

The following maps depict the location of priority planting areas for the two large plantation operators in Fiji.



TECH NOTE 04: Carbon Enhancement COMMUNITY PLANTING

Intervention Title: Carbon Enhancement COMMUNITY PLANTING			
Driver Impacted	Related REDD+ Activity	Impact Profile (ha)	Estimated Budget
Fire Agriculture Expansion	Enhancement of Carbon Stocks (Afforestation/Reforestation)	5,750	13,846,750

Description of the Intervention

This intervention supports large scale planting. Successful models for community forestry exist in Fiji such as the Fiji Pine Trust and the Nakauvadra Community Based Reforestation Project and Reforest Fiji. Fiji Pine Trust focuses on community development and expansion of Fiji Pine (Pinus Caribbea var. hondurensis) while the latter focused on mix planting of native species, mahogany and teak. Willingness of local landowning units to engage with tree planting and availability of idle and degraded lands makes this intervention promising.

Intervention will entail community agreement to undertake planting trees and a long-term commitment that all members of the clan will protect and support the maintenance and care of the planted trees to be protected from fire, indiscriminate cutting or alternative future land use – at the very least, for 30 years being the average timber cycle for native and introduced species in Fiji. With Fiji's rich cultural heritage, the approach will combine traditional modes of communication and the FPIC while guided by REDD+ Communications Plan.

The Fiji Government launched its 4 million tree initiative in February 2019. This initiative is supported by the community planting with areas planted well over the 4million trees to buffer expected survival rate of 70-80%.

Driver Impacted

Drivers impacted include unplanned agriculture and unplanned settlement. The intervention will arrest agriculture clearing by replanting of In due course, planted trees may provide firewood, hose posts and timber.

Related REDD+ Activity

Enhancement of carbon stock (Afforestation/Reforestation).

Actions of the Intervention

The following activities apply to Fiji Pine Trust and Four Million Tree Initiative: Community Planting while Fiji Pine Ltd. and Fiji Hardwood Corps. have own plantation estates:

Community awareness and consultation about Four Million Tree Initiative : Community Planting

Community Expression of interest received (template to be made available)

Community consultation at mataqali level to discuss land use and ensure that the land is unencumbered

Desk top assessment of the land – map layers – forest, soil classes, road/infrastructure, settlement, water catchment, titles & registry check to ensure land is unencumbered

Community planning workshops – verify land category, identify current land uses, identify future land uses based on resource capacity

Community consultation to collect signed consensus to use the land for planting under ERP

Signed Consensus witnessed by Provincial Council and submitted to iTaukei Lands and Fisheries Commission2.

Mobilize order for planting materials

Community consultation to consolidate agreement, plans for planting and maintenance schedule, plans for risk management such as fire

Community led land boundary demarcation and mapping, verified by Govt. and quasi Govt. Agencies

Planting mobilised to establish wood lot

Community training on monitoring framework (post-planting)

Community based monitoring and reporting with verification from REDD+ Unit of the Ministry of Forestry.

---

[2] iTaukei Lands and Fisheries Commission holds the registry of all iTaukei landowners and must verify that the signatories are true landowners as per registry records

Key Actors

Ministry of Forestry, Ministry of Agriculture, Ministry of iTaukei Affairs, iTaukei Lands Trust Board, Ministry of Lands, Ministry of Women

All Government agencies in the Province/District

Provincial Council, District Council, Representative from all villages/settlement in the District

All NGO working in the District

Local communities and/or land owners

Impact Profile

For community-based planting under the ERP the following is supported by the Ministry of Forestry.

Community Woodlots

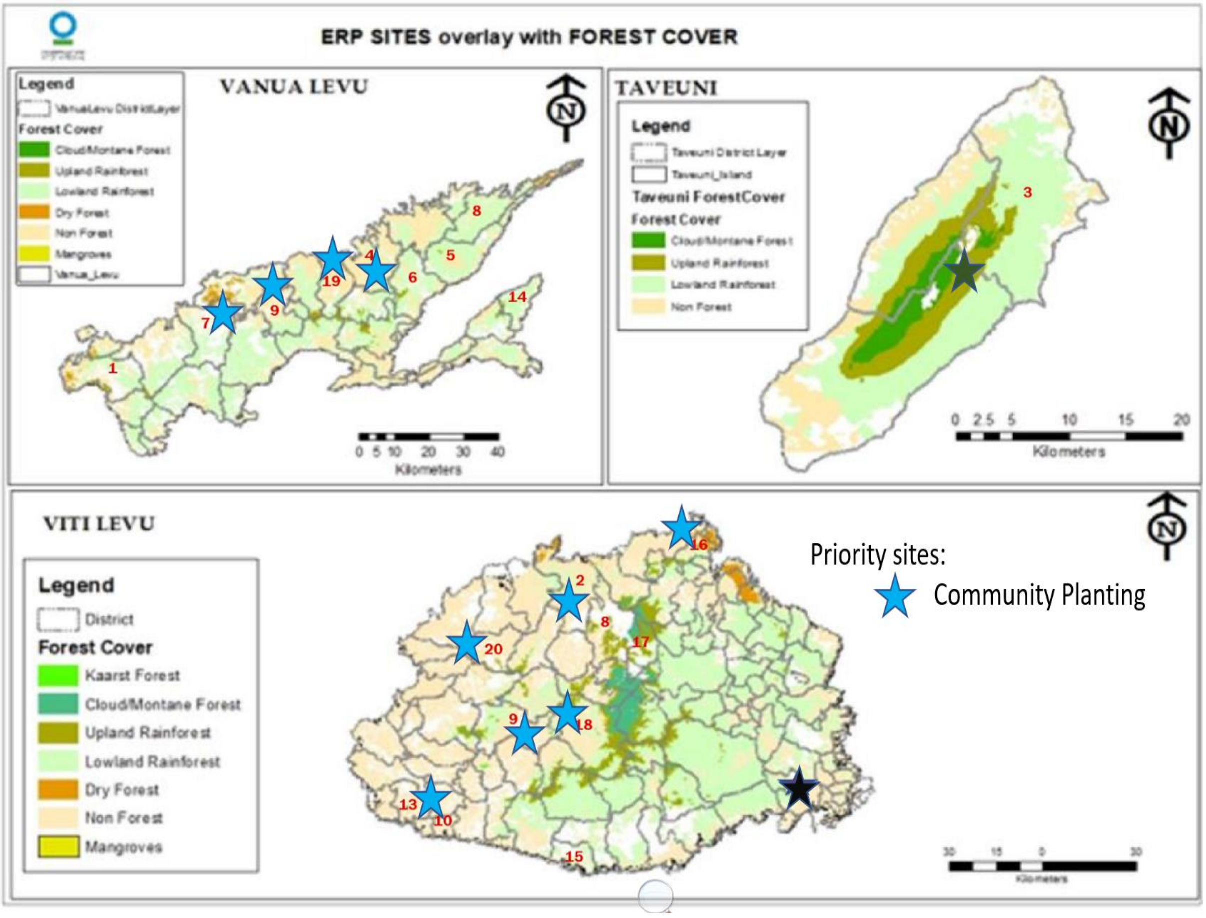
Year	IMPACTED AREA		
	Fiji Pine Trust (ha)	4 million trees Initiative	TOTAL
2020	50	300	550
2021	50	700	950
2022	50	1100	1,350
2023	50	1500	1,750
2024	50	1900	2,150
Total	250	5,500	5,750

Estimated Budget

Year	Fiji Pine Trust	4 million trees	Budget $USD	Funding Source
2020	$37,500	$745,050	$782,550	Fiji Govt.
2021	$37,500	$1,738,450	$1,775,950	Fiji Govt.
2022	$37,500	$2,731,850	$2,769,350	Fiji Govt.
2023	$37,500	$3,725,250	$3,762,750	Fiji Govt.
2024	$37,500	$4,718,650	$4,756,150	Fiji Govt.
Total	$187,500	$13,659,250	$13,846,750	

MAP

The following maps depict the priority location of Community Planting



Priority Districts for component 2.3

No.	Location (Districts)	Area of Forest	Area of Non-forest	Area of other land uses	Total District Area
2	Tavua	13036.00	38610.00	19151.00	70797.00
3	Taveuni*	30664	7405	5686	43755.00
4	Labasa	6682	18620	1408	26710.00
7	Dreketi Tikina	16580	5367	2343	24290.00
10	Sigatoka	2611	15180	4399	22190.00
13	Cuvu	927	9075	2914	12916.00
14	Tunuloa	6732	1795	3615	12142.00
16	Saivou	1438	2284	100	3822.00
18	noikoro	21404	13475	58	34937.00
19	Wailevu	3639	11054	1445	16138.00
20	Yakete	2628	10026	1404	14058.00
	TOTAL	**106,341**	**132,891**	**42,523**	**281,755**

TECH NOTE 05: Carbon Enhancement AGROFORESTRY AND ALTERNATIVE LIVELIHOOD

Intervention Title: Carbon Enhancement AGROFORESTRY AND ALTERNATIVE LIVELIHOOD			
Driver Impacted	Related REDD+ Activity	Impact Profile (ha)	Estimated Budget
Agriculture Expansion Unplanned Settlements	Enhancement of Carbon Stocks (Afforestation / Reforestation)	Riparian restoration – 5,000 Shade grown agriculture – 5,000 Alternative livelihoods – 1,000 farms	$10,750,000

Description of the Intervention

This intervention supports application of agroforestry and alternative livelihood for two reasons; (1) flood mitigation and (2) economic wellbeing.

Successful models for community agroforestry aimed at flood mitigation is demonstrated by the Ministry of Agriculture Land Use Division who have been establishing 2ha lots of riparian restoration along river banks in 8 districts across Fiji. The model plants tree species at 1111 seedlings per ha (3x3m spacing) along the both sides of the river bank with undergrowth filled with vetiver grass to hold soil together.

The Ministry of Agriculture has also been instrumental in demonstrating alternative livelihood to rural communities through range of initiatives including bee keeping, vegetable farming, cocoa, ginger and vanilla farming. These activities lead to reduced deforestation as they generate alternative economic benefit to the sustenance of the family. To address the issue of farmers expanding yaqona (kava) crop land into forested area, the Ministry of Agriculture has shown that vanilla planting is a possible substitute for kava due to its high cost and high demand. Training materials and planting materials have been developed by the Ministry of Agriculture over the past years and now ready for mass dissemination.

Driver Impacted

Drivers impacted include unplanned agriculture, unplanned logging. In particular, the activity addresses the drivers of deforestation and forest degradation associated with intensive agriculture expansion. It is assumed that intensive agriculture aims for 100% clearing, coupled with high dependency on chemicals to aid production. The intervention will ensure ground cover and soil retention in the medium and long term which would not only mitigate floods but will improve soil fertility over time due to accumulated humus cover from tree litter.

Related REDD+ Activity

Enhancement of carbon stock (Afforestation/Reforestation).

Actions of the Intervention

Flood Mitigation

Increase service and intervention by Ministry of Agriculture and Ministry of Forestry Extension Services through Agroforestry advice to local farmers and distribution of climate resilient crops varieties from the Koronivia Research Station;

Public/Private Partnership and dialogue through field school exchange among farmers facilitated by the Ministry of Agriculture and Ministry of Forestry Extension Services;

Shade Grown Agriculture

Establishment of kava, vanilla and other shade tolerant crops;

Aimed at mid-slope and lower slope cultivation to avoid deforestation;

Assume that alley cropping design may be relevant to maximize production by local farmers such that kava, vanilla and other share grown crops are intercropped in agroforestry system;

The proportion of forest that will be retained in 1ha is estimated at 0.3ha;
At national level, intervention is aimed at 1000ha per year hence the area of avoided deforestation is 300ha per year.

Alternative Livelihood activities

Increase services and intervention by Ministry of Agriculture supporting vanilla, bee keeping, and supply of pawpaw, breadfruit, pineapple and seedlings of other tradeable commodities;
Encourage and strengthen uptake of minimum tillage and shade grown agriculture including kava and vanilla among rural farmers at the fringe of forest areas to reduce deforestation.
Public/Private Partnership and dialogue through field school exchange among farmers facilitated by the Ministry of Agriculture and Ministry of Forestry Extension Services
Undertake value chain assessment of key commodities to support market access by rural communities while rationalising coordinated District level approach to agriculture production. This idea supports the "cluster" initiative and linked to the integrated land use plan. The aim is to develop target commodities per district. The commodity is dictated by the land capability. Participant farmers are than organised in clusters to produce "on-schedule" to avoid flooding the market with single commodity but to facilitate consistent supply of agriculture commodity all year around – sharing the proceeds in a consistent manner.

Key Actors

Ministry of Forestry, Ministry of Agriculture, Ministry of iTaukei Affairs, iTaukei Lands Trust Board, Ministry of Lands, Ministry of Women
All Government agencies in the Province/District
Landowners, tenant farmers, freehold landowners
Rural communities
Provincial Council, District Council, Representative from all villages/settlement in the District
All NGO working in the District

Impact Profit

The impact profile provides prediction of the spatial and temporal impact of the intervention; when the intervention will start to impact the Program Area and the magnitude of the impact where; although the reporting of where will be determined ex-post in the Program monitoring period. The magnitude is anticipated to be progressive from 19% in the first year. This means that in the first year, the program period as a 19% of the total land use affected from which hectares can be reported i.e. climate smart agriculture will reduce deforestation by 19% in the first year and so on. It is assumed that in the first year 50 farmers from the 10 Priority Districts will avoid deforestation by 1ha and that every year this will increase by 10 farmers from each of the 10 Priority District, hence in the first year 500ha of deforestation would be avoided and increased by 100 ha annually.

	Shade Grown Agriculture		Flood Mitigation	Alternative Livelihood	
YEAR	Target Area (ha) (A)	Impact Area (ha) (B)	Riparian restoration (ha) (C)	Target Area (ha) (D)	Total Area Impacted (ha) (B+C+D)
2020	1000	300	1000	200	1500
2021	1000	300	1000	200	1500
2022	1000	300	1000	200	1500
2023	1000	300	1000	200	1500
2024	1000	300	1000	200	1500

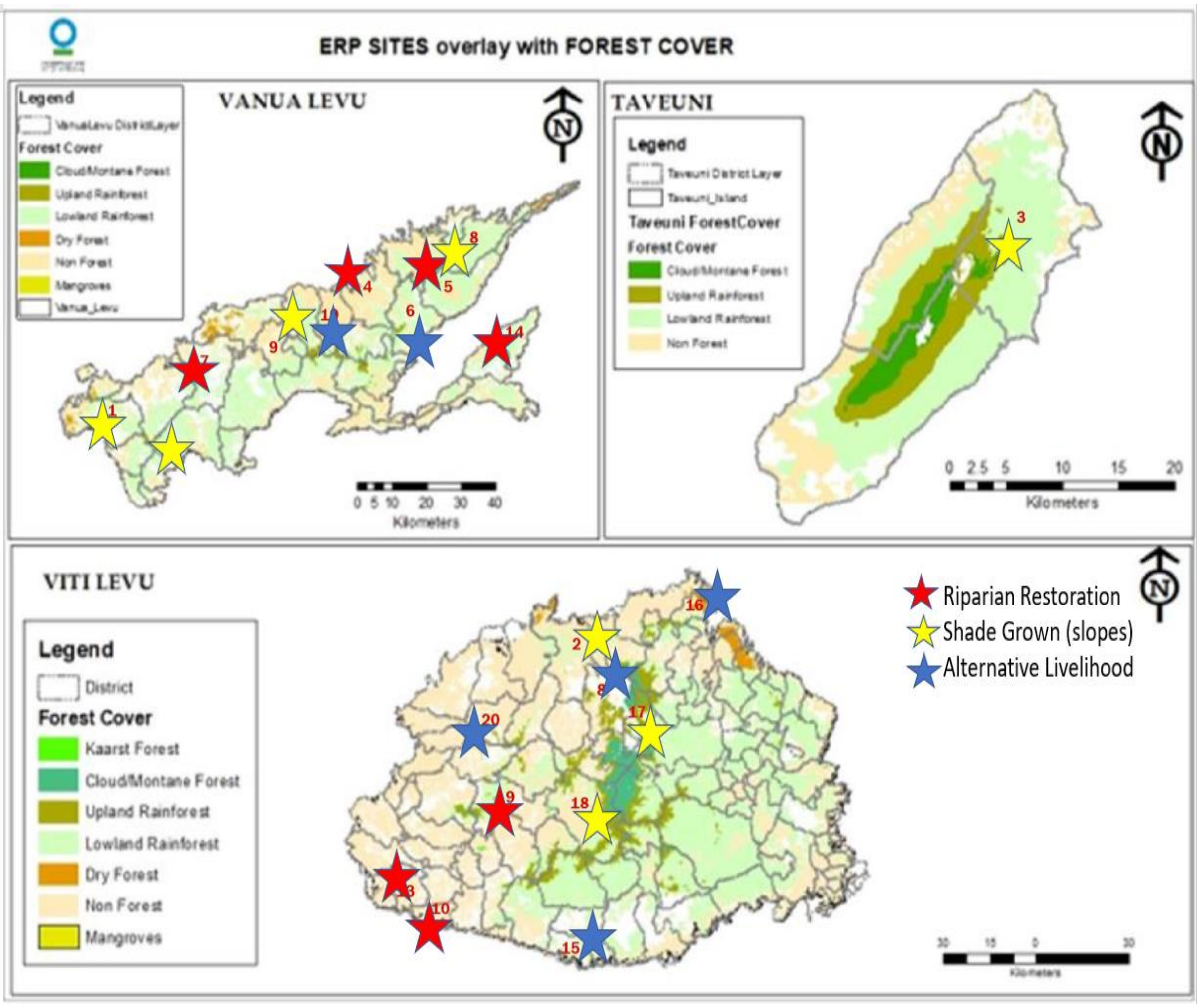
Year	Afforestation/Reforestation
	Riparian restoration (ha)
2020	1000
2021	1000
2022	1000
2023	1000
2024	1000
Total	5,000

Estimated Budget

Year	Implement CSA using riparian restoration	Implement CSA using shade grown agriculture	Support alternative livelihood through connecting farmers to market and improvements of agroforestry values
2020	$750,000	$600,000	$800,000
2021	$750,000	$600,000	$800,000
2022	$750,000	$600,000	$800,000
2023	$750,000	$600,000	$800,000
2024	$750,000	$600,000	$800,000
Total	$3,750,000	$3,000,000	$4,000,000

MAP

The following maps priority area for this intervention



Proposed Intervention	Priority Districts
Riparian restoration	Labasa, Sigatoka, Namataku, Tuniloa, Cuvu, Dreketi, Dogotuki
Shade grown cultivation	Tavua, Wailevu, Taveuni, Bua, Seaqaqa, Saqani, Naboubuco
Alternative Livelihood	Saivou, Vaturova, Nadarivatu, Serua, Yakete, Noikoro

TECH NOTE 06: Forest Conservation

Intervention Title: Forest Conservation			
Driver Impacted	Related REDD+ Activity	Impact Profile (ha)	Estimated Budget
Land use change to agriculture, road networks, settlement (from Forest)	Forest Degradation Deforestation	36,446	$3,264,774

Description of the Intervention

The intervention supports forest conservation and maintaining carbon sinks, the protection of watershed areas and ensuring clean water sources, the continuous supply of nutrients and soil fertility to maintain and enhance crop production. Forest conservation is related to long term management of forest resource with the aim of supporting areas that will remain forested into perpetuity. Without this intervention, important forest sites within Fiji will continue to face threats from degradation (logging) and deforestation (conversion).

Overall Fiji currently has 48 terrestrial protected areas covering 488 km2 or 2.7% of the nation's land area. Fifteen Forest Reserves and eight Nature Reserves were established under Forestry legislation in the 1914, and 1950-60s – all of these remain but they have never received any formal conservation management3. Of those 48 protected areas there are currently 23 protected terrestrial areas that meet the IUCN definition of protected areas and are currently protected under national regulation4. They include reserves, national parks, water catchments, sanctuaries and managed areas, which have been established under a range of legislative or other instruments. (Extract: Final Report of the Terrestrial Protected Area Law Review and Reform Project – Contract No. SC1604 (Part of the Forestry and Protected Area Management Project – GEF PAS4))

The global push is to establish a system of protected areas for the purpose of conservation, aligned to the Aichi Biodiversity 2020 target of protecting 17% of the country's total land mass. Fiji has not made much progress than the conservation initiatives of the colonial administrators, despite its commitment to international agreements and conventions. The lack of political support is mainly influenced by the unavailability of vital information and a clear understanding of the processes and mechanisms (including institutional arrangements and agreements) to establish and manage systems of protected areas in Fiji at all levels of decision-making.

In 2018, the review of existing policies and legislations, including the institutional arrangements, related to forest protection and conservation culminated in the development of a national framework for establishing and managing a system of terrestrial protected areas in Fiji. In support of this work, investigations into the opportunities and options for forest financing led to the development cost-models and fundraising strategies for Fiji. (Part of the Forestry and Protected Area Management Project – GEF PAS4). The information now available should now move Fiji forward in its conservation work towards the Aichi target.

To address the imminent threat of deforestation and forest degradation while increasing forest conservation in Fiji, all existing reserves must have formal leases with a clear set of management regimes that have been agreed and developed with the resource owners. Secondly, the landowning communities to co-manage the conservation site (protected area), and thirdly, to secure a sustainable funding mechanism that is less reliant on government funding, and meets the establishment and management costs of sites, including the livelihood and welfare of the local and landowning communities.

Box 1 - Sovi Basin Protected Area Model, Naitasiri Province, Viti Levu

The Sovi Basin PA, with an area over 17,000 Ha, was formally leased in May 2012 by the National Trust of Fiji. The conservation site is governed by a management plan and co-managed by the landowning communities. The site is financed by a trust fund worth $USD 3 million that is invested off-

---

[3] Implementation Framework 2010-2014 for the National Biodiversity Strategy and Action Plan 2007

[4] Fiji's Fifth National Report to the United Nations Convention on Biodiversity (2014)

shore. The annual dividends meet the management cost of the site and also finance the development plans of the villages that have contributed land to the Sovi Basin PA.
This is an ideal model that Fiji plans to replicate in other conservation sites. The investigative work on forest financing conducted in 2018 was based on assessing the operational effectiveness of the SB trust fund.

List of Priority and Potential Conservation Sites

A list of priority and potential conservation sites has been identified and mapped for Fiji. The objective is to improve coordination, ensure connectivity and prioritize critical sites, in particular the "cloud-forest" systems of the three (3) main islands, which are: (a) "Greater Tomaniivi" on Viti Levu; (b) "Greater Delaikoro" on Vanua Levu, and (c) the consolidation of the Taveuni and Ravilevu reserves on Taveuni island. Included in the list below are the Pilot Site (National REDD+) and the larger reserve areas within the ER-P area.

SITE	TYPE	LOCATION	Area (Ha)	THREATS
Emalu	Lowland	Navosa, Viti Levu	7,347	Deforestation – conversion for other land use
Greater Tomaniivi	Cloud-forest	Ba, Viti Levu	5,761	Deforestation – conversion for other land use
Greater Delaikoro	Cloud-forest	Cakaudrove-Macuata, Vanua Levu	6,778	Deforestation – conversion for other land use
Taveuni + Ravilevu	Cloud-forest	Cakaudrove, Vanua Levu	15,309	Deforestation – conversion for other land use
Nadarivatu-Nadala	Cloud-forest	Ba, Viti Levu	7,400	Deforestation – conversion for other land use
Buretolu	Cloud-forest	Ba, Viti Levu	1,198	Deforestation – conversion for other land use
Total Area Targeted			36,446	

Driver Impacted

Drivers impacted include unplanned conversion of forest area into agriculture, infrastructure and for settlement and logging.
Related REDD+ Activity
This intervention is related to reducing emissions from deforestation.
Actions of the Intervention
Landowner consultation and planning to:
Reaffirm and finalize lease agreements
Agreement to establish governance structures
Develop land use map (& plan)
Develop management plan + monitoring and evaluation system
Capacity building, education and training plan
Alternative livelihood and income generating ventures

Government to:

Acquire conservation lease with TLTB
Data collection and information system (reporting)
Pursue options of sustainable forest financing (Box 1)
Conduct LO community training

Key Actors

Ministry of Forestry will be key agency for implementing the Forest Conservation
Ministry of Environment under National Biodiversity Strategy and Action Plan in the ambit of the convention on Biological Diversity
All Government agencies in the Province/District/ Division
Provincial Council, District Council, Representative from all villages/settlement in the District
All landowning units in the area of interest
All NGO working in the District
Private Sector that may want to offset carbon or interested in CSR

Impact Profile

Year	Hectares impacted by Conservation (Ha)	Avoided Deforestation (Ha)*
2020	5,716	1000
2021	6,778	1000
2022	15,309	2000
2023	7,400	2000
2024	1,198	2000
Total	36,446	8,000

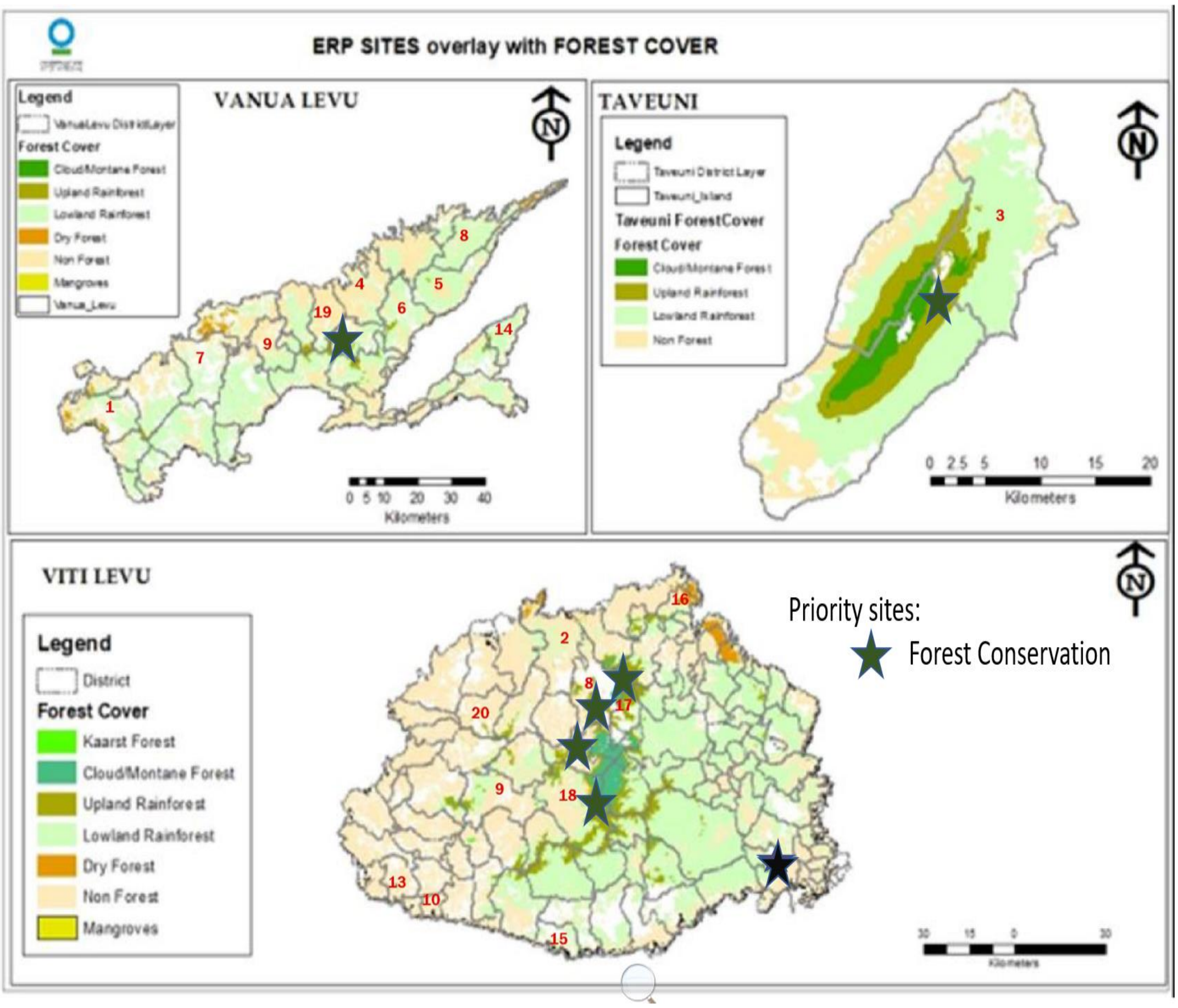
*estimated production forest in the proposed forest conservation area that will not be harvested and converted to agriculture

Estimated Budget

Year	$/yr USD
2020	$547,509
2021	$617,682
2022	$1,206,321
2023	$660,600
2024	$232,662
Total	$3,264,774

MAP

The following maps depict the location of Forest Conservation intervention in the ERP area where Districts are aligned to the Integrated Land Use and Management Plan that will be produced as an enabling condition for ERP.



ERP SITES overlay with FOREST COVER
VANUA LEVU
Legend
VanuaLevu DistrictLayer
Forest Cover
Cloud/Montane Forest
Upland Rainforest
Lowland Rainforest
Dry Forest
Non Forest
Mangroves
Vanua_Levu
1
7
9
19
4
6
5
8
14
0 5 10 20 30 40
Kilometers
N
TAVEUNI
Legend
Taveuni District Layer
Taveuni_Island
Taveuni ForestCover
Forest Cover
Cloud/Montane Forest
Upland Rainforest
Lowland Rainforest
Non Forest
3
0 2.5 5 10 15 20
Kilometers
N
VITI LEVU
Legend
District
Forest Cover
Kaarst Forest
Cloud/Montane Forest
Upland Rainforest
Lowland Rainforest
Dry Forest
Non Forest
Mangroves
16
2
8
17
20
9
18
13
10
15
Priority sites:
Forest Conservation
30 15 0 30
Kilometers
N

Annex 1

List of Forest & Nature Reserves (extracted from Ministry of Forests 2015 Key Statistics)

Name	Province	Area (Ha)	Year (Established)
Forest Reserves			
Taveuni	Cakaudrove	11,290.7	1914
Buretolu	Ba	1,197.9	1926
Nadarivatu-Nadala	Ba	7,400.7	1954
Maranisaqa & Wainiveitoa	Naitasiri	77.3	1955
Qoya	Rewa	67.2	1955
Naitasiri (Lot 54 M/1)	Naitasiri	30.4	1955
Tavua	Ba	2 roads	1958
Vago	Naitasiri	24.7	1959
Korotari	Cakaudrove	1,046.9	1961
Yarawa	Serua	161.9	1962
Savura	Naitasiri	447.6	1963
Colo-i-Suva	Naitasiri	369.5	1963
Suva/Namuka Harbour	Rewa	19	1963
Lololo	Ba	8.3	1968
Naboro	Rewa	19	1969
Saru Creek	Ba	3.2	1973
Nature Reserves			
Nadarivatu	Ba	93.08	1956
Tomaniivi	Ba	1,323.33	1958
Naqaranibuluti	Ba	279.23	1958
Ravilevu	Cakaudrove	4,018.45	1959
Draubota / Labiko	Rewa	2.22	1959
Vuo Island	Rewa	1.2	1960
Vunimoli	Cakaudrove	20.23	1968
Total Area (Ha)		27,902.04	

Conservation Agreement

Conservation Agreement is a commitment from the project proponent to support the legalization of proposed forest conservation area. Conservation Agreements are non-legally binding agreement between project proponent and iTaukei land owning communities to set aside the land for conservation purposes. This means that iTaukei land owning communities will not allow alternative developments such as livestock production, mining, logging, infrastructure development or others in the area agreed upon as the community have given their commitment to legally protected the area. Project proponent may be a Government agencies or civil society organisations.

In Fiji, high biodiversity areas fall within high conservation forests. Most of these areas fall in rural area with the remaining intact forest along the ridge tops that run across the centre of large islands which are predominantly owned by iTaukei landowners.

The process of securing legalization is cumbersome and lengthy as 60% of the landowning units must sign standard lease consensus forms for conservation purposes. The process may take minimum of 5 years. For the Sovi Basin Protected Area this took 10 years. Sovi Basin PA is the largest terrestrial low land dry forest conservation area in Fiji which is under co-management between the National Trust of Fiji and iTaukei landowners.

Conservation Agreements (CA) may be considered equivalent to the Carbon REDD+ Agreement (CRA) however, CRA is registered with the Ministry of Forestry under the ER-P. CA are not registered but a tool advocated by civil society organisations to engage with iTaukei communities in an accountable and transparent manner. CRA will not affect the rights of existing land owners or tenant lessor as it is a platform that allows dialogue with all stakeholders identified within the high conservation value forest.

Consensus from iTaukei land owners

Collection of signatories for consensus is done in conjunction with field activities such as detail biodiversity assessment and boundary demarcation. At the same time, socio-economic base line data is gathered to support the development of Management Plan. Once signed consensus is gathered from at least 60% of mataqali members, the standard forms is submitted to the iTaukei Lands and Fisheries Commission for verification against the Vola ni Kawa Bula (iTaukei Register). If discrepancies are noted the standard consensus form is rendered incomplete and returned to the project proponent to improve and resubmit. Should the assessment qualify as complete, the project proponent may proceed to the next step.

Options for legalising Forest Conservation or Protected Areas

The next level involves two options. Option 1 is for the project proponent to self-finance (usually with support of external grant) the acquisition of conservation lease from either TLTB, Ministry of Lands (for state land) or freehold owner. The cost of legally protecting forest conservation areas include premium cost of the land (one off payment), annual land rental, annual timber royalty compensation for standing trees and community development trust fund. Legally protected forest conservation areas that adopted option 1 include Drawa – Nakau Program, Sovi Basin, Kilaka Forest and Nakanacagi Bat-caves. Option 2 involves working in close collaboration with the Ministry of Forestry to tag the proposed forest conservation under the Forest Decree 1992. In this case, approval by the Forestry Board, and the Minister of Forestry are critical. On approval the consensus form is submitted to the Ministry of Lands who will approach iTaukei Lands Trust Board on behalf of the Ministry of Forestry for leasing purposes. At this stage, cost of protecting the forest is clarified and Cabinet paper developed by Ministry of Forestry for the Minister of Forestry to present to Cabinet for approval. Once approved, the legalization involves the issue of a conservation lease and confirmation of annual budget allocation to the Ministry of Forestry to support leasing requirements. Legally protected forest areas that adopted Option 2 includes the Emalu REDD+ Pilot Site.

Application to ERP

In the case of the ERP, CA is replaced by the CRA. The Ministry of Forestry maintains an updated record of the CRA registry (Section 17). CRA can be initiated by land owners, tenant lessor or third-party project proponent where the project proponent is a civil society organisation. Once registered, the Ministry of Forest will be well positioned to identify CRA that need their direct assistance and those that can be supported by third party. It is impossible to ascertain the extent of intervention at the time of preparing the ERP however it can be assumed that the 38 Districts involved in the ER intervention will likely seek the Ministry of Forestry leadership and guidance to legalise forest conservation areas. In such cases the activity may be considered an amplification of experiences from the Emalu REDD+ Pilot Site.

ANNEX 5-1: CAPACITY BUILDING ACTIVITIES UNDERTAKEN BY DIFFERENT ORGANISATIONS SUPPORTING REDD+ DEVELOPMENT AND READINESS PHASE

Capacity building activities by Ministry of Forestry

Name	Date	No. of participants	Institutions
Stakeholder consultation events			
National REDD+ Steering Committee (NSRC)	18 August 2017 08 December 2017 28 February 2018 01 June 2018	28 21	NSRC members
Drivers Inception workshop	31 August 2017		Refer to report
Resource owner pilot site update and	13 Feb 2018	25	Ministry of Agriculture, Provincial Office, Ministry of Forests
CSO Platform Forum	Mar 5-7 2018	40	Live & Learn, SSV, NatureFiji-MareqetiViti, WWF, ECREA, Pacific Conference of Churches
Inception meeting for Divisional Working group – West	16 July 2018	13	Ministry of Agriculture, REDD+ pilot site resource owner reps, Ministry of waterways and Environment, USP, Ba Provincial Office, Grace Trifam (Faith-based NGO)
Capacity building/training & awareness			
Early Childhood Education (ECE) – forest conservation awareness Tacirua Kindergarten Supported by (RDF & AAD)	02 August 2017	20	Tacirua Kindergarten
FIVEM - Valuing and Assessing of Carbon	5th, 12th, 19th Aug 2017	30	FIVEM is an institute comprising of Valuers' and Estate Management
REDD+ awareness Sawani District School	29 Sept, 2017	250	Students, teachers & parents
Expert Exchange on REDD+ and Forest Landscape Restoration (FLR) for Asian-Pacific Countries	17-19 Oct 2017	1 – Planning Officer 1 – Senior Accounts Officer	Ministry of Economy, Ministry of Forests

27th Asia Pacific Forestry Commission, Colombo, Sri Lanka	23-27, Oct 2017	5 2	Ministry of Forests SPC/GIZ
REDD+ Awareness Dreketi (TEBTEBBA – SSVM)	25-27 April 2018	30	Tikina Dreketi (Men and women)
FGRM training	30-31 May		Ministry of Forests, TLTB, Ministry of iTaukei Affairs, LLEE, Drawa and Emalu resource owner reps, Fiji Environment Law Association (FELA), SPC/GIZ, Grace Trifam, USP-IAS, Integra
REDD+ Awareness Navosa (TEBTEBBA – SSVM)	May 21-24	100+	Tikina Namataku, Tikina Noikoro, Tikina Nasikawa

Capacity Building Activities by Conservation International

Name of training	**Training objective**	**Main topics**	**No of participants**	**Relevance to REDD+**
Trainings for communities				
Tree identification & Seed Collection	To ensure that communities can correctly identify native tree species and are aware of the best flowering and fruiting seasons to collect viable seeds for germination	• Tree identification using leaf, bark, flowers and seeds • Tree flowering seasons • Seed collection and predation • Basic Seed Storage	• Lololo Pine Station- 10 Nadarivatu Forestry Station- 10	Identification of high-quality viable seeds for carbon enhancement planting.
Polling and Planting	To be competent with the use of compass, line bearing	• Compass reading • Setting base line to aid planting • Setting up Line bearing • Weeding techniques • Mensuration techniques to determine the total number of seedlings needed • Planting techniques	• On the job training Mataqali Dreketi 10 local participants	Proper planting of seedlings to ensure survival before during and after carbon enhancement planting.
Nursery establishment & Management	To ensure that communities are able to establish and manage a successful nursery by themselves	• Requirements to consider before constructing nurseries • Different sizes of nurseries • Techniques on constructing simple community nurseries • Weed and pest management	• Nabalabala Village-30 participants • Nailawa Village-25 participants • Lagilagi Methodist Church Compound 15 participants	Raising of quality seedlings for carbon enhancement planting
Forest Health Monitoring	To assist Project Officer in the	• Measuring parameters and	• On the job training of CI	Monitoring of carbon enhancement plots

	collation of information to assess Forest Health	technique of measurement - Tree Health Assent data entry - Plot selection	casuals' staff 10 participants	to expand the forest habitat and enhance the populations of endangered and endemic species in the Nakauvadra Range thereby also promoting forest conservation.
Fire awareness and monitoring	To increase community awareness on wild fire risks and to assist field staff with the monitoring of fires in project area	- Laws pertaining to Fires, fire types, mitigation measures - Fire Warden Roles & Data Collection	- Fire awareness at high risk communities	Reduce the incidence of fires by carrying out fire awareness and educational campaigns with local communities thereby reducing forest degradation
Sustainable Land Management	To increase community awareness on the importance of soils resource and its management	- Importance of soils - Soil Fertility and plant growth - Land use capability - Soil Erosion & Degradation - Land management technologies	- Nayaulevu Village 60 participants - Rewasa Village 40 participants - Nananu Village 42 participants	- Demonstrate sustainable agriculture practices, good farming techniques to reduce deforestation and forest degradation.
Root Crop Production	To assist communities in methods to improve crop productivity.	- Ginger production - Taro production - Cassava Production - Sweet Potato Production	- 21 people from various villages	- Introduce alternative livelihoods to reduce pressure on nearby Nakauvadra Forests reducing deforestation and forest degradation.
Training on Traditional Crop Varieties	To ensure that communities understand the various crop varieties in Fiji and the importance of conserving them.	- Different crop varieties - Indigenous knowledge of traditional varieties - Advantages of conserving genetic diversity	- 21 people from various villages)	
Bee Keeping	To encourage community interest in bee keeping and to improve knowledge on productivity. This training was mainly targeted at women	- Basic hive components - Handling bees - Bee colony - Selection and rearing of queen bees - Harvesting and Marketing	- Distributed 35 boxes to 7 communities.	- alternative agriculture livelihoods to reduce deforestation and forest degradation. - Promote bee-keeping to help

				with the pollination of trees to sustain the forest health of the Nakauvadra forest to improve sustainable forest management.
Financial Literacy Training	To help community members manage their personal finances and gain understanding about the options available for savings and budget management	• Budgets • Financial management • Basic accounting principles • Savings plans	• 92 participants	• Manage personal finances through income derived from activities related to SFM and carbon enhancement planting.
Biodiversity monitoring	To assist CI staff in conducting biodiversity monitoring	• Basic bird identification training (Bird diversity in Fiji, bird calls) • Basic plant taxonomy training (bark slash, leaves, flowers identification)	• Narara Village- 10 participants	• Promote forest conservation through monitoring of biodiversity indicators.
Trainings for Project Field Supervisors and Assistants				
Project Management Training	To assist project Staff to effectively manage projects, both in a technical and supervisory capacity	• Project vision/goals/activities • Time and team Management • Planning & Target setting • Forest Technical Skills ○ Polling & Planting ○ Base Line Setting • Communication Skills • M & E and Report	• On the job training of CI interns and casuals including 25 Forestry Training School Forestry Technician students for one month at Tokaimalo.	• Capacity building of future Ministry of Forests staff on REDD+ activities including SFM and carbon enhancement planting.
Basic Map and GPS reading	To enable project staff to be proficient and efficient in using maps and GPS	• Map Reading ○ Different types of maps ○ Scales & Legends ○ Field Demonstration and Application	• On the job training of 3 CI staff	• Proper use of maps to map carbon enhancement planting.

Capacity Building Activities by GIZ, Fiji

SN	Activities	Agency	Implications of the activities

1	Fiji Carbon Rights Study	GIZ, Fiji	The study helped to define right over Carbon
2	Development of a variety of climate change and REDD+ informational materials such as brochures, booklets, posters and information briefs some of which have been translated to into the iTaukei language	GIZ, Fiji	Enhanced awareness of the communities on REDD+ and Climate Change
3	Participation of Forestry Government officers at International, regional and national level technical training / workshop / conference relating to forest inventory, carbon pool measurements, remote sensing and GIS, MRV requirements	GIZ, Fiji	Enhanced the exposure to REDD+ approach
4	Training of resource persons especially youths as community facilitators on climate change and REDD+	GIZ, Fiji	Created awareness to community members
5	Participation of local community representatives at national and international conferences	GIZ, Fiji	Enhanced exposure on REDD+ approach
6	Analytical study on Carbon Emissions from Forest Degradation caused by Selective Logging in Fiji	GIZ, Fiji	Estimated total emission factor from logging
7	Development of a national participatory land use planning guideline (draft)	GIZ, Fiji	Help to develop land use plan
8	Baseline surveys for Emalu REDD+ pilot site – 2012 – 2013 (multi-sectoral).	GIZ, Fiji	These surveys included socio-economic, present land use, cultural mapping, carbon inventory, biodiversity and archaeological mapping.
9	Hands on training for local field guides to undertake forest inventory, carbon pool measurements, biodiversity and cultural mapping surveys.	GIZ, Fiji	The community members will able to assess their local resources
10	Training and upskilling of local communities on various livelihood strategies for improved socio-economic wellbeing	GIZ, Fiji	Community members will generate income from other resources rather than relying on forest resources as result carbon stock in the forest will enhance

Capacity Building Activities by SPC/GIZ

SN	Description of the activity	Date	No of participants
1	Workshop on the 10th Executive Forest Policy Course, Sri Lanka,	May 2017.	2
2	Training on Results Based Finance for REDD+ and the linkages to Forest Landscape Restoration	Bangkok 10/17	2
3	National Communications Workshop for Divisional Forestry Staff, Fiji,	December 2017	15

List of capacity enhancement activities (Forest Monitoring)

Name of training/workshop	**Year**	**Conducted by**	**No. of participants from Fiji**
Forest inventory refresher training – REDD+ monitoring	6-8 Feb 2013		10

GPS (Trimble & Garmin)/GIS training – REDD+ monitoring	21 Feb 2013		6
Regional Forest Inventory Workshop	15-29 August, 2014	UN-REDD Programme by the Pacific Community	5
Regional National Forest Inventory Workshop, Solomon Islands	3-14 November, 2014	UN-REDD Programme by the Pacific Community	5
Regional National Forest Inventory Workshop, Solomon Islands	3-14 November, 2014	UN-REDD Programme by the Pacific Community	5
Forest Inventory Backstopping Data analysis (emission factors) training	17-19 June, 2015	UN-REDD Programme by the Pacific Community	2
Regional Forest Monitoring Capacity Building Workshop	18-19 Nov, 2015	UN-REDD Programme by the Pacific Community	21
National Forest Inventory Capacity Building Workshop on Data Analysis for Fiji	23-27 May, 2016	UN-REDD Programme by the Pacific Community	13
REDD+ Forest Reference Emission Level Workshop: Preparing a UNFCCC FREL/FRL Submission	26-28 Sep, 2016	UN-REDD Programme by the Pacific Community	3
Fiji Forestry Collect Earth training	13-15 Dec, 2016	Fiji FD with SPC/GIZ, UN-REDD & PNGFA	5
Study Tour to Germany: Sustainable Forest Management, Downstream Processing & Climate Science in the scope of REDD+	15-22 Sep, 2018	SPC/GIZ REDD+ II	4

ANNEX 6-1: LETTER OF INTENT

THE WORLD BANK
IBRD · IDA | WORLD BANK GROUP

May 31, 2018

The Hon. Aiyaz Sayed-Khaiyum
Attorney-General and Minister of Economy
Ministry of Economy
P O Box 2212
Government Building
Suva
REPUBLIC OF FIJI

Dear Minister,

Amendment to the Letter of Intent between the International Bank for Reconstruction and Development, acting as the trustee of the Carbon Fund of the Forest Carbon Partnership Facility, and the Republic of Fiji dated December 21, 2016 with respect to the Emission Reduction Program of the Republic of Fiji: Reducing Emissions and Enhancing Livelihoods in Fiji

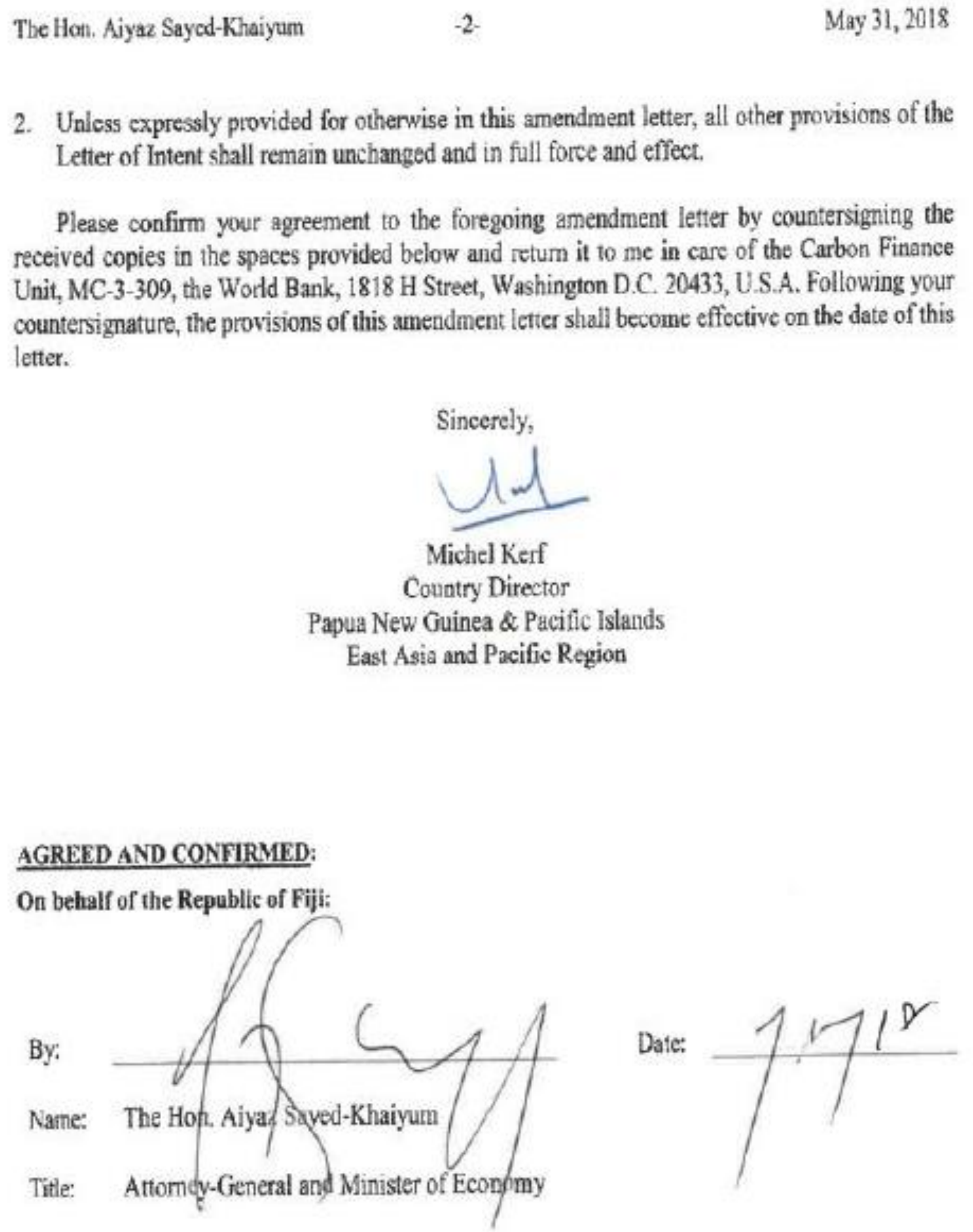
We refer to the Letter of Intent between the International Bank for Reconstruction and Development ("**IBRD**"), acting as the trustee ("**Trustee**") of the Carbon Fund of the Forest Carbon Partnership Facility ("**Carbon Fund**"), and the Republic of Fiji ("**Program Entity**", and together referred to as "**Parties**"), represented by the Ministry of Economy, Planning and Development, dated December 21, 2016 ("**Letter of Intent**") with respect to the Emission Reduction Program of the Republic of Fiji: Reducing Emissions and Enhancing Livelihoods in Fiji. Capitalized terms used in this amendment letter shall have the same meaning ascribed to them in the Letter of Intent.

1. The Parties agree to herewith amend the Letter of Intent as follows:

    (a) The Exclusivity Period specified in Section 3.1 of the Letter of Intent shall be extended from twenty four (24) months to forty four (44) months.

    (b) Section 7.2 of the Letter of Intent shall be deleted in its entirety and replaced as follows:

    > "7.2 If the ERPA Negotiation Period has not started within forty two (42) months from the date of this Letter of Intent, the Trustee may, at its sole and absolute discretion, either terminate this Letter of Intent and the understandings it provides or extend the deadline provided in this Clause 7.2."



2. Unless expressly provided for otherwise in this amendment letter, all other provisions of the Letter of Intent shall remain unchanged and in full force and effect.

Please confirm your agreement to the foregoing amendment letter by countersigning the received copies in the spaces provided below and return it to me in care of the Carbon Finance Unit, MC-3-309, the World Bank, 1818 H Street, Washington D.C. 20433, U.S.A. Following your countersignature, the provisions of this amendment letter shall become effective on the date of this letter.

Sincerely,

Michel Kerf
Country Director
Papua New Guinea & Pacific Islands
East Asia and Pacific Region

AGREED AND CONFIRMED:

On behalf of the Republic of Fiji:

By: Date: 7/7/18

Name: The Hon. Aiyaz Sayed-Khaiyum

Title: Attorney-General and Minister of Economy

ANNEX 8-1: FOREST REFERENCE LEVEL CALCULATIONS

The details of data, steps and procedures followed in the calculation of the Forest Reference Level methodology are presented below. For transparency and to assist replication of the calculations, examples of the ER program data and calculations are presented below the respective equations.

The estimates are generated by running a Monte Carlo simulation, where values are sampled at random from the input probability distributions for each variable. Each set of samples is called an iteration, and the resulting outcome from that sample is recorded. The Monte Carlo simulation was run 40,000 times, and the result is a probability distribution of possible outcomes for the FRL. In this way, the Monte Carlo simulation provides a much more comprehensive view of the emissions estimate by estimating what the ERs will be with a confidence interval. As a result of the Monte Carlo simulations the 'final estimates' can be slightly different to the simple multiplication presented in Equations below. The resultant estimate from Equations become the inputs to the Monte Carlo simulation which runs through iterations until it lands on the most likely estimate with a confidence interval. This should be noted when attempting to replicate the numbers as they will vary, somewhat, from the simple linear multiplication of variables as the confidence interval around each individual variable influences the final result.

A8.3.1 Annual Average Gross Emissions

Sources and sub-sources of gross emissions considered in the FRL were:

1. Emissions from deforestation, $\widehat{\emptyset}_{\boldsymbol{DF}}$
2. Emissions from logging in Natural Forest (forest degradation), $\widehat{\emptyset}_{\boldsymbol{FDem}}$
3. Emissions from logging in soft- and hardwood plantations, $\widehat{\emptyset}_{\boldsymbol{ECem}}$
4. Emissions from fire within softwood plantations, $\widehat{\emptyset}_{BSW}$

Gross emissions from all sources considered in the FRL were estimated by:

$$\widehat{\emptyset}_{em} = \widehat{\emptyset}_{DF} + \widehat{\emptyset}_{FDem} + \widehat{\emptyset}_{ECem} \qquad (1)$$

Where;

$\widehat{\emptyset}_{\mathrm{em}}$ = average annual gross emissions; $tCO_2e\ yr^{-1}$

$\widehat{\emptyset}_{DF}$ = average annual emissions from deforestation; $tCO_2e\ yr^{-1}$

$\widehat{\emptyset}_{FDem}$ = average annual gross emissions from forest degradation; tC $tCO_2e\ yr^{-1}$

$\widehat{\emptyset}_{ECem}$ = average annual gross emissions from enhancement of forest carbon stocks; tC $tCO_2e\ yr^{-1}$

A8.3.2 Annual Average Gross Removals

Gross removals linked to the different sinks/sub-sinks considered in the FRL were

1. Removals from growth after logging Natural Forest, $\widehat{\emptyset}_{FDre}$
2. Removals from afforestation/reforestation (AR) and removals from growth in softwood and hardwood plantations, $\widehat{\emptyset}_{ECre}$

Gross removals from all sinks considered in the FRL were estimated by:

$$\widehat{\emptyset}_{re} = \widehat{\emptyset}_{FDre} + \widehat{\emptyset}_{ECre} \qquad (2)$$

Where;

$\widehat{\emptyset}_{re}$ = average annual gross removals; $tCO_2e\ yr^{-1}$

$\widehat{\emptyset}_{FDre}$ = average annual gross removals from logging in Natural Forest; $tCO_2e\ yr^{-1}$

$\widehat{\emptyset}_{ECre}$ = average annual gross removals from afforestation/reforestation and soft- and hardwood plantations; $tCO_2e\ yr^{-1}$

A8.3.3 Average Annual Net Emissions

Historical average annual net emissions over the Reference Period in the Accounting Area (i.e. the FRL) were estimated by:

$$\widehat{\emptyset}_{FRL} = \widehat{\emptyset}_{em} + \widehat{\emptyset}_{re} \qquad (3)$$

Where;

$\widehat{\emptyset}_{FRL}$ = average annual net emissions over the Reference Period in the Accounting Area; $tCO_2e\ yr^{-1}$
$\widehat{\emptyset}_{em}$ = average annual gross emissions; $tCO_2e\ yr^{-1}$
$\widehat{\emptyset}_{re}$ = average annual gross removals; $tCO_2e\ yr^{-1}$

The average annual net emissions removals during the reference period were estimated to be:

Forest Reference Emission Level	**Emission / Removal** ($tCO_2e\ yr^{-1}$)	**Lower Confidence Interval** ($tCO_2e\ yr^{-1}$)	**Upper Confidence Interval** ($tCO_2e\ yr^{-1}$)
Deforestation	2,696,831	2,143,830	3,373,850
Forest Degradation	310,442	321,925	467,501
Enhancement of Carbon Stocks	-1,370,469	-960,855	-1,791,358
Net FRL	**1,636,804**	**953,458**	**2,444,030**

The equations used and associated activity data and emissions factors applied are outlined by REDD+ Activity in the sections below. Table 1 and Table 2 list the default and national specific variables used in the estimation of emissions and removals.

Table 2: Default variables and values applied in the FRL calculations

Default variable	Description	Value	Units	Source	Uncertainty
η_{CC}	ratio of the molecular weights of CO_2 and C	$^{44}/_{12}$	$tCO_2\ (C)^{-1}$	Default	Small source, not relevant; not included in the quantification of uncertainty.
$\boldsymbol{T} = \{\mathbf{2006}, \mathbf{2007},.. ,\boldsymbol{t},.., \mathbf{2016}\}$	length of the FRL Reference Period	11	years	ER Program Design	Not relevant; not included in the quantification of uncertainty.
η_{CF}	Conversion factor for biomass to carbon	0.47	$C\ (tB)^{-1}$	IPCC,2006, Vol. 4, Chap. 4, Tab. 4.3	Small source, not relevant; not included in the quantification of uncertainty.

Default variable	Description	Value	Units	Source	Uncertainty
$\boldsymbol{R_{wl}}$	Root-to-shoot ratio for tropical rainforest	0.37	dimensionless	IPCC, 2006, Vol. 4; Chap. 4; Tab. 4.4	Sampled from a Triangular distribution with lower bound $a = R_{wl} - R_{wl} \times 0.25$ upper bound $b = R_{wl} + R_{wl} \times 0.25$ and mode $c = R_{wl}$
$\boldsymbol{R_{dll}}$	Root-to-shoot ratio for tropical moist deciduous forest < 125 tB ha^{-1}	0.20	dimensionless	IPCC, 2006, Vol. 4; Chap. 4; Tab. 4.4	Sampled from a Triangular distribution with lower bound a = 0.09, upper bound b = 0.25, mode c = 0.20; a, b and c were taken from IPCC [2006, Vol. 4, Chap. 4, Tab. 4.4].
$\boldsymbol{R_{dlh}}$	Root-to-shoot ratio for tropical moist deciduous forest > 125 tB ha^{-1}	0.24	dimensionless	IPCC, 2006, Vol. 4; Chap. 4; Tab. 4.4	Sampled from a Triangular distribution with lower bound a = 0.22, upper bound b = 0.33, mode c = 0.24; a, b and c were taken from IPCC [2006, Vol. 4, Chap. 4, Tab. 4.4].
$\boldsymbol{R_{u}}$	shoot ratio for tropical mountain systems	0.27	dimensionless	IPCC, 2006, Vol. 4; Chap. 4; Tab. 4.4	Sampled from a Triangular distribution with lower bound a = 0.269, upper bound b = 0.0.28, mode c = 0.27; a, b and c were taken from IPCC [2006, Vol. 4, Chap. 4, Tab. 4.4].

Default variable	Description	Value	Units	Source	Uncertainty
$\boldsymbol{BCEF_{AR,I}}$	biomass conversion and expansion factor for volume increments in humid tropical natural forests	1.1	tB $(m^3)^{-1}$	IPCC [2006, Vol. 4, Chap.4, Tab. 4.5]; (growing stock level 21-40 m^3 ha^{-1})	Sampled from a triangular distribution with lower bound $a = BCEF_{AR,I} - BCEF_{AR,I} \times 0.25$ upper bound $a = BCEF_{AR,I} + BCEF_{AR,I} \times 0.25$and mode $c = BCEF_{AR,I}$
$\boldsymbol{BCEF_{HW,R}}$	biomass conversion and expansion factor for logging;	1.05	tB $(m^3)^{-1}$	IPCC [2006, Vol. 4, Chap.4, Tab. 4.5]; (growing stock level >200 m^3 ha^{-1})	Sampled from a triangular distribution with lower bound $a = BCEF_{HW,R} - BCEF_{HW,R} \times 0.25$ upper bound $a = BCEF_{HW,R} + BCEF_{HW,R} \times 0.25$, and mode $c = BCEF_{HW,R}$
$\boldsymbol{BCEF_{HW,I}}$	biomass conversion and expansion factor for increment taken from	1.1	tB $(m^3)^{-1}$	IPCC, 2006, Vol.4, Chap. 4, Tab. 4.5; growing stock level 21-40 m^3 ha^{-1})	Sampled from a triangular distribution with lower bound $a = BCEF_{HW,I} - BCEF_{HW,I} \times 0.25$ upper bound $b = BCEF_{HW,I} + BCEF_{HW,I} \times 0.25$, mode $c = BCEF_{HW,I}$
COMF $_i$	Combustion factor – proportion of prefire fuel biomass consumed)	0.46	dimensionless	(IPCC 2006 Vol. 2, Table 2.6)	Sampled from a Triangular distribution with lower bound a and b were 50% and 150% of the mode c.

Default variable	Description	Value	Units	Source	Uncertainty
$\mathbf{G_{g,CO2}}$		1580	g CO_2 kg^{-1} Dry matter burnt	IPCC 2006 Vol. 4, chapter 2, Table 2.5)	Sampled from a normal distribution N(μ= $G_{g,CO2;}$ σ^2=902; see Table 2.5 in IPCC, 2006, Vol 4, Chap. 2, Tropical Forest).
$\mathbf{G_{g,N2O}}$		0.2	g N_2O kg^{-1} Dry matter burnt	(IPCC 2006 Vol. 4, chapter 2, Table 2.5)	Sampled from a Triangular distribution with lower bound a and b were 50% and 150% of the mode c
$\mathbf{G_{g,CH4}}$		6.8	g CH_4 kg^{-1} Dry matter burnt	IPCC 2006 Vol. 4, chapter 2, Table 2.5)	Sampled from a Triangular distribution with lower bound a and b were 50% and 150% of the mode c

Table 8.3: Variables with Fiji specific values

Variables with Fiji specific values	Description	Value	Units	Source	Uncertainty
C_{AFTER}	C stock in biomass due to the conversion of Natural Forest to grassland	17.11	tC ha^{-1}	Rounds [2013]	Lower CI[8.31] Upper CI[25.96]
$C_{BEFORE,Lowland}$	Estimated C stocks stored in AGB and BGB in Lowland Natural Forest	87.86	tC ha^{-1}	Appendix A2 - Fiji FRL Report, 2018	Lower CI[84.25] Upper CI[93.21]
$C_{BEFORE,Upland}$	Estimated C stocks stored in AGB and BGB in Upland Natural Forest	71.57	tC ha^{-1}	Appendix A2 - Fiji FRL Report, 2018	Lower CI[66.45] Upper CI[78.58]
EM_{FELL}	carbon loss from the extracted logs, including logging residues	0.69	tC $(m^3)^{-1}$	Haas [2015]	Assessed in uncertainty emission factor TEF.

Variables with Fiji specific values	**Description**	**Value**	**Units**	**Source**	**Uncertainty**
$\boldsymbol{EM_{DAM}}$	damage to the remaining stand (all killed [snapped and up-rooted] trees 10 cm DBH), crown damage	0.15	tC $(m^3)^{-1}$	Haas [2015]	Assessed in uncertainty emission factor TEF.
$\boldsymbol{EM_{INFR}}$	infrastructure development (all trees _ 10 cm DBH on logging roads, skid trails and log landings)	0.21	tC $(m^3)^{-1}$	Haas [2015]	Assessed in uncertainty emission factor TEF.
$\boldsymbol{\delta_{tm}}$	the length of time interval available for growth on areas conventionally logged in year *t*	{10,9, …, $\boldsymbol{\delta_{tm}}$,…1}	yrs	Based on Fiji's Reference Period	None
$\boldsymbol{MAIV_{AR}}$	mean annual volume increment for afforestation/reforestation	3.71	m^3 ha^{-1} yr^{-1}	Derived from data provided from Fiji Hardwood Corporation Limited	Sampled from a Triangular distribution with lower bound $a = \mathrm{MAIV_{AR}} - \mathrm{MAIV_{AR}} \times 0.5$ upper bound $b = \mathrm{MAIV_{AR}} + \mathrm{MAIV_{AR}} \times 0.5$ and mode $c = \mathrm{MAIV_{AR}}$
$\boldsymbol{MAIC_{FD}}$	mean annual C increment after logging (above ground and belowground)	0.99	tC ha^{-1} yr^{-1}	Personal communication	Triangular distribution with lower bound $a = \mathrm{MAIC_{FD}} - \mathrm{MAIC_{FD}} \times 0.5$ upper bound $a = \mathrm{MAIC_{FD}} + \mathrm{MAIB_{SW}} \times 0.5,$ mode $c = \mathrm{MAIC_{FD}}.$
$\boldsymbol{\lambda_{Pine}}$	Softwood plantation recovery rate following harvest	0.76	Ratio - dimensionless	Waterloo [1994]	Drawn from a Normal distribution with $\mu = \lambda_{\mathrm{Pine}}$ and $\sigma^2 = [\lambda_{\mathrm{Pine}} \times 0.1]^2$
$\boldsymbol{\rho_{Pine}}$	Pine tree wood density	0.47	g cm^{-1}	Cown [1981]	Drawn from a Normal distribution with $\mu = \ \rho_{\mathrm{Pine}}$ and $\sigma^2 = \ 0.0031$

Variables with Fiji specific values	Description	Value	Units	Source	Uncertainty
$\boldsymbol{MAIB_{SW}}$	mean annual increment of above and belowground biomass in softwood plantations	10	tB ha^{-1} yr^{-1}	Waterloo [1994]	Triangular distribution with lower bound $a = \mathrm{MAIB_{SW}} - \mathrm{MAIB_{SW}} \times 0.25$ upper bound $a = \mathrm{MAIB_{SW}} + \mathrm{MAIB_{SW}} \times 0.25$, mode $c = \mathrm{MAIB_{SW}}$.
$\boldsymbol{CC_{SW}}$	length of the harvest cycle in softwood plantations	20	yrs	Personal communication Fiji Pine Limited (FPL) indicated that most pine plantations are harvested around 20 years ranging between 15 to 25 years.	Sampled from a Triangular distribution with lower bound $a = CC_{SW} - 5$, upper bound $a = CC_{SW} + 5$, mode $c = CC_{SW}$
$\boldsymbol{\overline{MAIV}_{HW}}$	Average mean annual increment in Fiji hardwood plantations	5.85	m^{3} ha^{-1} yr^{-1}	derived from data provided from Fiji Hardwood Corporation Limited	Sampled from a Triangular distribution with lower bound $a = \overline{\mathrm{MAIV}}_{\mathrm{HW}} - \overline{\mathrm{MAIV}}_{\mathrm{HW}} \times 0.25$, upper bound $b = \overline{\mathrm{MAIV}}_{\mathrm{HW}} - \overline{\mathrm{MAIV}}_{\mathrm{HW}} \times 0.25$, mode $c = \overline{\mathrm{MAIV}}_{\mathrm{HW}}$

A8.3.2 Deforestation

Activity Data
The area of deforestation over the Reference Period is generated from an annual time series of forest loss (refer to Annex 8.2 for details of how the data is generated).

The average annual forest area loss [ha] in stratum i (i.e., Low-and Upland Natural Forest) over the FRL Reference Period was calculated as follows

$$\hat{A}_{DF,i} = \mathcal{T}^{-1}\left(\frac{1}{2}\hat{A}_{DF,2005-2006,i} + \left[\sum_{T_m}\hat{A}_{DF,t_m,i}\right] + \frac{1}{2}\hat{A}_{DF,2016-2017,i}\right) \tag{4}$$

Where;

$\hat{A}_{DF,i}$ = Average annual area of deforestation in stratum i; ha yr^{-1}

$\mathcal{T}$ = Length of the FRL Reference Period $|T| = \mathcal{T} = 11$, where $T = \{2006, 2007, \ldots, t, \ldots, 2016\}$; yrs

$\hat{A}_{DF,2005-2006,i}$ = Forest area loss during the interval 2005-2006 in stratum i; ha

$\hat{A}_{DF,t_m,i}$ = Forest area loss during the interval t_m in stratum i, where $T_m = \{2006-2007, 2007-2008, \ldots, t_m, \ldots, 2015-2016\}$; ha

$\hat{A}_{DF,2016-2017,i}$ = Forest area loss during the interval 2016-2017 in stratum i; ha

The annual average area of deforestation was found to be:

Annual Average Deforestation	**Estimate [ha]**	**Lower Confidence Interval [ha]**	**Upper Confidence Interval [ha]**
Lowland	8,332	5,531	8,437
Upland	2,682	1,627	2,889

Description of the variable including the time period covered:	$\hat{A}_{DF,Lowland}$= average annual forest area losses in hectares in the strata Lowland Natural Forest
Explanation for which sources or sinks the variable is used:	This activity data is used on the estimation of emissions from deforestation.
Data unit:	Ha
Value:	8,332
Source of data:	Management Services Division of the Ministry of Forestry
Spatial level:	Sub-National; this data represents forest cover loss in Lowland Natural Forest within the Fijian islands of Viti Levu, Vanua Levu and Taveuni, covering approximately 90% of the land area of the Fijian islands.
Discussion of key uncertainties for this variable:	The key sources of uncertainty relate to errors of omission and commission in the image classification process.
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	The data are predicted values generated from semi-automated processing of Landsat imagery. The accuracy assessment following the methods of Olofsson et al 2014 is applied to developed error adjusted areas and confidence intervals which are then incorporated into the Monte Carlo simulation. Lower CI[ha] 5,531 Upper CI[ha] 8,437

Description of the variable including the time period covered:	$\hat{A}_{DF,Upland}$= average annual forest area losses in hectares in the strata Upland Natural Forest
Explanation for which sources or sinks the variable is used:	This activity data is used on the estimation of emissions from deforestation.
Data unit:	Ha
Value for the variable:	2,682
Source of data:	Management Services Division of the Ministry of Forestry
Spatial level:	Sub-National; this data represents forest cover loss in Lowland Natural Forest within the Fijian islands of Viti Levu,

	Vanua Levu and Taveuni, covering approximately 90% of the land area of the Fijian islands.
Discussion of key uncertainties for this variable:	The key sources of uncertainty relate to classification errors in the image classification process.
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	The data are predicted values generated from semi-automated processing of Landsat imagery. The accuracy assessment following the methods of Olofsson et al 2014 is applied to developed error adjusted areas and confidence intervals which are then incorporated into the Monte Carlo simulation. Lower CI[ha] 1,627 Upper CI[ha] 2,889

Emissions Factors

Emissions from deforestation were estimated by multiplying the average annual forest area loss by the amount of emissions that are released if one hectare of forest is lost. Emission factors for the source 'deforestation' were estimated from the difference between average C stocks in Lowand Upland Natural Forest [tC ha^{-1}] and the average C stocks in grassland [tC ha^{-1}]. The IPCC default equation was used to compute the C stock change [IPCC;2006, Vol. 4, Chap. 2, Eq. 2.16].

$$\Delta C_{B,i} = \Delta C_G + \Delta C_{CONVERSION,i} + \Delta C_L \tag{5}$$

where;

$\Delta C_{B,i}$ = change in carbon stocks in biomass in Natural Forest stratum I converted to Non-Forest; tC ha^{-1}

ΔC_G = annual increase in carbon stocks in biomass due to growth in Non-Forest; tC ha^{-1} yr^{-1}

ΔC_L = annual decrease in carbon stocks in biomass due to disturbances in Non-Forest; tC ha^{-1} yr^{-1}

And

$$\Delta C_{CONVERSION,i} = C_{AFTER} - C_{BEFORE_i} \tag{6}$$

$\Delta C_{CONVERSION,i}$ = initial change in carbon stocks in biomass in Natural Forest stratum *i* converted to Non-Forest; tC ha^{-1}

C_{AFTER} = carbon stocks in biomass in Non-Forest; tC ha^{-1}

C_{BEFORE_i}= carbon stocks in biomass in Natural Forest stratum *i*; tC ha^{-1}

ΔC_G and ΔC_L are assumed to be zero; the change in C stock in biomass due to the conversion of Natural Forest to grassland is captured in $\Delta C_{CONVERSION,i}$, hence $\Delta C_{B,i}$ = $\Delta C_{CONVERSION,i}$.
C_{AFTER} is the peak C stock in grassland as estimated by Rounds [2013] to be 17.11 ± 10.81 tC ha^{-1}.
A description of the data and methods used to estimate C_{BEFORE_i} is provided in University of Hamburg (2018). The carbon stock change due to deforestation was computed by:

$$\Delta C_{B,Lowland} = C_{AFTER} - C_{BEFORE,Lowland} \tag{7}$$

$$-70.74 = 17.11 - 87.85 \quad \text{(Example)}$$

$$\Delta C_{B,Upland} = C_{AFTER} - C_{BEFORE,Upland} \tag{8}$$

$$-54.45 = 17.11 - 71.56 \quad \text{(Example)}$$

Where;

$\Delta C_{B,Lowland}$ = change in C stock in biomass in Lowland Natural Forest due to deforestation; tC ha^{-1}

$\Delta C_{B,Upland}$ = change in C stock in biomass in Upland Natural Forest due to deforestation; tC ha^{-1}

C_{AFTER} = average carbon stock in grasslands in Fiji (Rounds, 2013); tC ha^{-1}

$C_{BEFORE,Lowland}$ = average carbon stock in Lowland Natural Forest in Fiji; tC ha^{-1}

$C_{BEFORE,Upland}$ = average carbon stock in Upland Natural Forest in Fiji; tC ha^{-1}

Carbon losses from deforestation are converted to emission factors by:

$$\Psi_{DF,Lowland} = \Delta C_{B,Lowland} \times n_{cc} \qquad (9)$$

$$-259.38 = -70.74 \times (\frac{44}{12}) \qquad \text{(Example)}$$

Where;
$\Psi_{DF,Lowland}$ = emission factor for deforestation in Lowland Natural Forest, $tCO_2e\ ha^{-1}$
$\Delta C_{B,Lowland}$ = change in carbon stock in biomass in Lowland Natural Forest due to deforestation; tC ha^{-1}
n_{cc} = ratio of molecular weights of CO_2 and carbon; $tCO_2e\ (tC^{-1})$

$$\Psi_{DF,Upland} = \Delta C_{B,Upland} \times n_{cc} \qquad (10)$$

$$-199.65 = -54.45 \times \left(\frac{44}{12}\right) \qquad \text{(Example)}$$

Where;
$\Psi_{DF,Upland}$ = emission factor for deforestation in Upland Natural Forest, $tCO_2e\ ha^{-1}$
$\Delta C_{B,Upland}$ = change in carbon stock in biomass Upland Natural Forest due to deforestation; tC ha^{-1}
n_{cc} = ratio of molecular weights of CO_2 and carbon; $tCO_2e\ (tC^{-1})$

Description of the variable including the forest class if applicable:	$\Psi_{DF,Lowland}$ - emission factor for deforestation in Lowland Natural Forest
Data unit:	$tCO_2e\ ha^{-1}$
Value for the variable:	- 259.40
Source of data or description of the assumptions, methods and results of any underlying studies that have been used to determine the variable:	This emissions factor has been calculated from National Forest Inventory Data and National specific studies on Grassland carbon stocks. For a detailed description of the data used and method adopted to estimate this emissions factor see Fiji's Forest Reference Level (University of Hamburg, 2018).
Spatial level:	Nationally relevant emission factor for the conversion of Lowland forest to Grassland.
Discussion of key uncertainties for this variable:	The key uncertainties associated with this emission factor considered in the Monte Carlo simulations relate to: 1. Measurement error (uncertainty in measurements of the DBH of trees); 2. Uncertainties in wood density estimates; 3. Modelling uncertainty (PSP height model and Chave et al.'s [2014] AGB model); 4. Uncertainty in root-to-shoot ratios (IPCC [2006] default values);
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	Lower CI[$tCO_2e\ ha^{-1}$] – 226.49 Upper CI[$tCO_2e\ ha^{-1}$] – 298.23

Description of the variable including the forest class if applicable:	$\Psi_{DF,Upland}$ - emission factor for deforestation in Lowland Natural Forest
Data unit:	$tCO_2e\ ha^{-1}$
Value for the variable:	- 199.68
Source of data or description of the assumptions, methods and results of any underlying studies	This emissions factor has been calculated from National Forest Inventory Data and National specific studies on Grassland carbon stocks. For a detailed description of the data used and method adopted to estimate this emissions factor

that have been used to determine the variable:	see Fiji's Forest Reference Level (University of Hamburg, 2018).
Spatial level:	Nationally relevant emission factor for the conversion of Lowland forest to Grassland.
Discussion of key uncertainties for this variable:	The key uncertainties associated with this emission factor considered in the Monte Carlo simulations relate to: 1. Measurement error (uncertainty in measurements of the DBH of trees); 2. Uncertainties in wood density estimates; 3. Modelling uncertainty (PSP height model and Chave et al.'s [2014] AGB model); 4. Uncertainty in root-to-shoot ratios (IPCC [2006] default values);
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	Lower CI[tCO_2e ha^{-1}] – 163.00 Upper CI[tCO_2e ha^{-1}] – 241.45

Average annual emissions from deforestation

Average annual emissions from deforestation are first estimated separately by strata using Monte Carlo:

$$\widehat{\emptyset}_{DF,Lowland} = \hat{\hat{A}}_{DF,Lowland} \times \Psi_{DF,Lowland} \tag{11}$$

$$\widehat{\emptyset}_{DF,Lowland} = 7{,}914 \times -259.40$$

(Example)[5]

Where;

$\widehat{\emptyset}_{DF,Lowland}$ = average annual emissions from deforestation of Lowland Natural Forest; tCO_2e yr^{-1}

$\hat{\hat{A}}_{DF,Lowland}$ = average annual loss of Lowland Natural Forest area; ha yr^{-1}

$\Psi_{DF,Lowland}$ = emissions factor for deforestation in Lowland Natural Forest, tCO_2e ha^{-1}

And

$$\widehat{\emptyset}_{DF,Upland} = \hat{\hat{A}}_{DF,Upland} \times \Psi_{DF,Upland} \tag{12}$$

$$\widehat{\emptyset}_{DF,Upland} = 2{,}112 \times -199.68$$

(Example)

Where;

$\widehat{\emptyset}_{DF,Upland}$ = average annual emissions from deforestation of Upland Natural Forest; tCO_2e yr^{-1}

$\hat{\hat{A}}_{DF,Upland}$ = average annual loss of Upland Natural Forest area; ha yr^{-1}

$\Psi_{DF,Upland}$ = emissions factor for deforestation in Upland Natural Forest, tCO_2e ha^{-1}

Then total average annual emissions from deforestation (Low- and Upland Natural Forest) were estimated by:

$$\widehat{\emptyset}_{DF} = \widehat{\emptyset}_{DF,Lowland} + \widehat{\emptyset}_{DF,Upland} \tag{13}$$

Where;

$\widehat{\emptyset}_{DF}$ = average annual emissions from deforestation; tCO_2e yr^{-1}

$\widehat{\emptyset}_{DF,Upland}$ = average annual emissions from deforestation of Upland Natural Forest; tCO_2e yr^{-1}

$\widehat{\emptyset}_{DF,Lowland}$ = average annual emissions from deforestation of Lowland Natural Forest; tCO_2e yr^{-1}

The average annual emission from deforestation were estimated to be:

---

[5] Note because the emissions are estimated using a Monte Carlo approach the final annual average emissions vary (slightly) from the linear calculation presented by virtue of the iterative process undertaken to estimate the most likely value.

Emissions from Deforestation	Emission (tCO2e yr-1)	Lower Confidence Interval (tCO2e yr-1)	Upper Confidence Interval (tCO2e yr-1)
Lowland	2,161,364	1,667,836	2,763,108
Upland	535,466	371,765	739,937
Total	**2,696,831**	**2,143,830**	**3,373,850**

A8.3.3 Forest Degradation

Emissions from degradation are estimated as the combination of the net emissions/removals from logging in Natural Forests and the emissions from Fire in Pine Plantations.

A8.3.3.1 Emissions from Logging of Natural Forests

Emissions related to logging practices in natural forest were estimated using the approach proposed by Pearson et al. (2014) which converts volumes extracted during logging operations to total carbon loss including loss from the felled tree itself (AGB and BGB), logging residues of the felled tree, logging damages to the remaining stand (AGB and BGB), and losses due to the establishment of logging infrastructure (e.g., skid trails, logging roads and log landings).

Gross emissions from forest degradation were estimated using the IPCC generic equation (Equation 8.1 above) where the volumes recorded in the Timber Revenue systems served as Activity Data and the Total Emission Factor (TEF) (multiplied by n_{cc}) served as the Emissions Factor.

Average annual gross emissions

Annual carbon loss due to logging in Natural Forest was estimated by:

$$\Delta C_{FD,L,t} = \left[V_{FD,t} \times TEF\right] \times (-1) \qquad (14)$$

$$-83{,}454_{FD,L,2006} = \left[79{,}480_{FD,2006} \times 1.05\right] \times (-1) \qquad \text{(Example)}$$

Year	V_{FD}	$\Delta C_{FD,L,t}$
2006	79,480	-83,454
2007	45,122	-47,378
2008	81,706	-85,791
2009	59,614	-62,595
2010	49,814	-52,305
2011	36,499	-38,324
2012	30,517	-32,043
2013	26,947	-28,294
2014	46,431	-48,752
2015	51,091	-53,645
2016	50,825	-53,366
Sum	**478,566**	**-502,494**

Where;
$\Delta C_{FD,L,t}$ = carbon loss in year *t* due to logging in Natural Forest; tC
$V_{FD,t}$ = wood volume extracted from Natural Forest in year *t*; m^3
TEF = total emission factor, TEF = 1.05 (Haas, 2015); tC $(m^3)^{-1}$

The multiplication of the brackets by -1 is required because carbon losses are always reported with a negative sign.

Average annual gross emissions from forest degradation were estimated by:

$$\widehat{\emptyset}_{FDem} = T^{-1}\left[\sum_{T} \Delta C_{FD,L,t} \times n_{cc}\right] \quad (15)$$

$$-168{,}498 = 11^{-1}\left[-502{,}494 \times (\frac{44}{12})\right] \quad \text{(Example)}$$

Where;
$\widehat{\emptyset}_{FDem}$ = average annual gross emissions from forest degradation; $tCO_2e\ yr^{-1}$
T = length of the Reference Period $|T|$ = 11; yrs
$\Delta C_{FD,L,t}$ = carbon loss in year *t* due to logging in Natural Forest; tC
n_{cc}= ratio of molecular weights of CO_2 and carbon; $tCO_2e\ (tC^{-1})$

Average annual gross removals

Removals are computed based on data of areas logged and mean annual increment (MAI) in logged forests in year *t* is estimated by:

$$\Delta C_{FD,G,t} = \delta_t \times A_{FD,t} \times MAIC_{FD} \quad (16)$$

$$1{,}739_{FD,G,2006} = (0.5)_{2006} \times 3{,}513_{FD,2006} \times 0.99 \quad \text{(Example)}$$

Where;
$\Delta C_{FD,G,t}$ = carbon gains over the Reference Period on areas logged in year *t*; tC
δ_t = 2006 – t + 0.5, i.e. the length of time interval available for growth on areas conventionally logged in year *t*; yrs
$MAIC_{FD}$ = mean annual C increment after logging (above ground and belowground); $tC\ ha^{-1}\ yr^{-1}$
$A_{FD,t}$ = the area logged in Natural Forest in year *t*; ha

Average annual gross removals on Natural forest areas conventionally logged were estimated by:

$$\widehat{\emptyset}_{FDre} = \mathrm{T}^{-1}\left[\sum_{T} \delta_t \times MAIC_{FD} \times A_{FD,t} \times n_{cc}\right] \times (-1) \quad (17)$$

$$= \mathrm{T}^{-1}\left[\sum_{T} \Delta C_{FD,G,t} \times n_{CC}\right] \times (-1) \quad (18)$$

Where;
$\widehat{\emptyset}_{FDre}$ = average annual gross removals on Natural Forest areas conventionally logged; $tCO_2e\ yr^{-1}$
T, T, t = length of the Reference Period. i.e. 11 years; yrs
δ_t = 2006 – t + 0.5, i.e. length of time interval available for growth on conventionally logged area in year *t*; yrs
$MAIC_{FD}$ = mean annual carbon increment after logging (AGC and BGC); i.e.
$A_{FD,t}$ = the area logged in Natural Forest in year *t*; ha
n_{cc} = ratio of molecular weights of CO_2 and carbon; $tCO_2e\ (tC^{-1})$

The emissions from Logging in Natural Forest were estimated to be:

Emissions/Removals from Forest Degradation (Logging)	**Estimate** (tCO$_2$e yr^{-1})	**Lower Confidence Interval** (tCO$_2$e yr^{-1})	**Upper Confidence Interval** (tCO$_2$e yr^{-1})
Emissions	195,316	167,487	223,343
Removals	-42,362	-57,222	-27,794
Net Total	**152,955**	**121,701**	**184,309**

Activity Data

Description of the variable including the time period covered:	$V_{FD,t}$ = wood volume extracted from Natural Forest in year t;
Explanation for which sources or sinks the variable is used:	This variable is used in the estimation of emissions from Forest Degradation from the long-term loss of carbon stocks in Natural Forests in Fiji's a result of commercial harvest activities.
Data unit:	m^3
Value for the variable:	Year — V_{FD} (m^3) 2006 — 79,480 2007 — 45,122 2008 — 81,706 2009 — 59,614 2010 — 49,814 2011 — 36,499 2012 — 30,517 2013 — 26,947 2014 — 46,431 2015 — 51,091 2016 — 50,825
Source of data:	Volume data were extracted from Fiji's Timber Revenue System (TRS).
Spatial level:	Sub-National; this data represents volume extracted within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the land area of the Fijian islands.
Discussion of key uncertainties for this variable:	The main sources of uncertainty related to the volume relate to systematic and random errors associated with field assessment of extracted volume by the staff (i.e. log-scalers) from the Division of Forest Offices (DFOs).
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	Once a licence is issued and the logger has hauled the timber to the log-landings, log-scalers from the Division Forest Offices (DFOs) assess the amount of timber extracted and enter the data into the Timber Revenue System (TRS) database to determine the amount of royalty fees the logger has to transfer to the MoF. As the accuracy of the data is linked to royalties there is confidence in these figures. The uncertainty is considered to be zero.

<table>
<tr><td>Description of the variable including the time period covered:</td><td>$A_{FD,t}$ = area of natural forest logged each year</td></tr>
<tr><td>Explanation for which sources or sinks the variable is used:</td><td>This variable is used in the estimation of emissions from Forest Degradation from the long-term loss of carbon stocks in Natural Forests in Fiji’s a result of commercial harvest activities.</td></tr>
<tr><td>Data unit:</td><td>Ha</td></tr>
<tr><td>Value for the variable:</td><td>
<table>
<tr><th>Year</th><th>$A_{FD,t}$ (ha)</th></tr>
<tr><td>2006</td><td>3,513</td></tr>
<tr><td>2007</td><td>2,545.57</td></tr>
<tr><td>2008</td><td>3,258.55</td></tr>
<tr><td>2009</td><td>1,165.19</td></tr>
<tr><td>2010</td><td>1,641.17</td></tr>
<tr><td>2011</td><td>905.43</td></tr>
<tr><td>2012</td><td>795.66</td></tr>
<tr><td>2013</td><td>1,354.02</td></tr>
<tr><td>2014</td><td>1,427.76</td></tr>
<tr><td>2015</td><td>1,738.04</td></tr>
<tr><td>2016</td><td>1,438.37</td></tr>
</table>
</td></tr>
<tr><td>Source of data:</td><td>Annual data on the areas harvested between 2006 and 2016 were taken from digital logging maps provided by logging companies.</td></tr>
<tr><td>Spatial level:</td><td>Sub-National; this data represents area of natural forest logged within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the land area of the Fijian islands.</td></tr>
<tr><td>Discussion of key uncertainties for this variable:</td><td>These maps were edited by staff from the Management Service Division (MSD). Editing was necessary if the logger provided paper maps, the area of the proposed logging compartment did not match the data collected by MSD/DFO staff during field checks, or the digital maps were poorly edited.</td></tr>
<tr><td>Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:</td><td>Small source, highly relevant; included in the quantification of uncertainty.
Confidence in the data collected by Ministry staff, however systematic and random errors can occur in mapping of areas. QA/QC checks have found evidence of errors which are considered small.
In the Monte Carlo simulation this values is sampled from a triangular distribution with lower bound $a = A_{FD,\mathrm{t}} - A_{FD,\mathrm{t}} \times 0.25$; upper bound $a = A_{FD,\mathrm{t}} + A_{FD,\mathrm{t}} \times 0.25$, mode $c = A_{FD,\mathrm{t}}$.</td></tr>
</table>

Emissions Factors

Description of the variable including the forest class if applicable:	TEF - conversion factor for timber volumes extracted to total carbon loss
Data unit:	tC $(m^3)^{-1}$
Value for the variable:	1.05
Source of data or description of the assumptions, methods and results of any underlying studies that have been used to determine the variable:	Haas, M., 2015. Carbon Emissions from Forest Degradation caused by Selective Logging in Fiji. Regional project Climate Protection through Forest Conservation in Pacific Island Countries, GIZ, SPC. The TEF derived for Fiji is estimated by: $TEF = EM_{FELL} + EM_{DAM} + EM_{INFR}$ Where; TEF = conversion factor for timber volumes extracted to total carbon loss; tC $(m^3)^{-1}$ EM_{FELL} = carbon loss from the extracted logs, including logging residues; tC $(m^3)^{-1}$ EM_{DAM} = damage to the remaining stand (all killed [snapped and up-rooted] trees 10 cm DBH), crown damage; tC $(m^3)^{-1}$ EM_{INFR}= infrastructure development (all trees _ 10 cm DBH on logging roads, skid trails and log landings), tC $(m^3)^{-1}$ AND $\mathrm{EM_{FELL}}$ = 0:69 includes: (i) C loss from the logs and (ii) C loss from timber waste from the felled trees (crown-, bole-, stump-, and below-ground biomass), $\mathrm{EM_{DAM}}$ = 0:15 includes: (i) C loss from killed (uprooted and snapped) trees _ 10 cm DBH (AGB and BGB) and (ii) C loss from sever crown damage, $\mathrm{EM_{INFR}}$= 0:21 includes: (i) C loss from clearings of all trees _ 10 cm DBH (AGB and BGB) for logging road construction, (ii) C loss from clearings of all trees _ 10 cm DBH for skid trail construction, and (iii) C loss from all trees _ 10 cm for the construction of log-landings.
Spatial level:	The *TEF* was derived from data collected at the REDD+ pilot site at Nakavu.
Discussion of key uncertainties for this variable:	The key uncertainties associated with this emission factor considered in the Monte Carlo simulations relate to: 1. Measurement error; 2. Small sample size
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	Large source of uncertainty, highly relevant; included in the quantification of uncertainty.

Description of the variable including the forest class if applicable:	$MAIC_{FD}$ = mean annual C increment after logging (above ground and belowground);
Data unit:	tC ha^{-1} yr^{-1}
Value for the variable:	0.99
Source of data or description of the assumptions, methods and results of any underlying studies that have been used to determine the variable:	(Mussong; personal communication; unpublished data). These data are the only data on carbon growth in logged Natural Forest currently available in Fiji. This value the best (and only) estimate of mean annual carbon increment in natural forest available in Fiji. When compared to default values listed in the IPCC 2006, Table 3A.1.5 suggests that natural regeneration after logging in Asia & Oceania / Insular for Wet to Moist Tropical forest for >20 years ranges from 2.0 - 3.4 t d.m. ha^{-1} yr^{-1} which is equivalent to between 1 – 1.7 t C ha^{-1} yr^{-1}. The national figure is comparable and more conservative than applying the default value.
Spatial level:	Data on net C stock gains after logging in Natural Forest have not yet been assessed nationally in Fiji. For the FRL, these data were taken from the REDD+ pilot site at Nakavu. The estimated net carbon gain (AGB and BGB) REDD+ pilot site at Nakavu but considered applicable to Fijian natural forest.
Discussion of key uncertainties for this variable:	The key uncertainties associated with this emission factor considered in the Monte Carlo simulations relate to: 1. Measurement error 2. Small sample size
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	Large source, highly relevant; included in the quantification of uncertainty.

A8.3.3.2 Emissions from Fire

Data from Fiji Pine Limited (FPL) were used to estimate emissions from fire in Softwood Plantations. The dataset provided by FPL lists plantation compartments (coupes) that burned between 2015 and 2018. For each compartment the following attributes were provided: the year of burning (year), the area burnt in hectares (ha), and the age in years (yrs) of each compartment, i.e., the time elapsed since planting. Where compartments listed in the FPL dataset had an area of zero, these compartments were dropped from the dataset.

The greenhouse gases (GHGs) included in the estimation of emissions are: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). To estimate GHG emissions, the biomass available for combustion in a compartment was estimated first. It is assumed that the entire above-ground biomass (AGB) is available for combustion. AGB in a compartment that burnt in year t_b, with T_b = {2015;…..; tb;….; 2018}, was predicted as follows (note that this is the amount of AGB that is available for combustion — it is not to be confused with the AGB that actually burns during a fire).

$$AGB_{l,t_b} = \Lambda_{l,t_b} \times \frac{MAIB_{SW}}{(1+R_{dll})} \qquad (20)$$

Where;

Λ_{l,t_b}= the age of a compartment that burnt in year t_b, L = {1; 2;…..;l; ….; $\mathcal{L}$}
$\mathcal{L}$ = the total number of compartments \
$MAIB_{SW}$= the mean annual total biomass (above-and below-ground biomass) increment [tB ha^{-1} yr^{-1}]

R_{dll} = root-to-shoot ratio in tropical moist deciduous forest < 125 tAGB ha.

If AGB burns some amount of below-ground biomass (BGB) is also lost, e.g., if the stem and crown of a tree is lost, the BGB of the tree is, in the majority of cases, also lost.
It is assumed that only CO_2 is released from the BGB (since it does not burn, or at least only a small fraction of it burns). The amount of BGB available for combustion was predicted as follows:

$$BGB_{l,t_b} = \Lambda_{l,t} \times MAIB_{SW} \times R_{dll}.$$

(21)

CO_2 emissions from AGB in compartment that burnt in year tb was estimated as follows (cf. IPCC [2006, Vol. 4, Chap. 2, Eq. 2.27])

$$EACO2_{l,t_b} = A_{l,t_b} \times AGB_{l,t} \times C_f \times G_{ef,CO_2}$$

(22)

Where;
A_{l,t_b}= the area burnt [ha] in compartment *l* at time t_b,
C_f = the combustion factor, i.e., the proportion of prefire biomass consumed (the value was taken from IPCC 2006, Vol. 4, Chap. 2, Tab. 2.6, young secondary tropical forest (3-5) year])
G_{ef,CO_2}= the emission factor [g kg^{-1}] taken from IPCC [2006, Vol. 4, Chap. 2, Tab. 2.5, Tropical forest].

CO_2 emissions from BGB were estimated by:

$$EBCO2_{l,t_b} = A_{l,t_b} \times BGB_{l,t_b} \times C_f \times \eta_{CF} \times [\eta_{CC} \times -1]$$

(23)

Where;

n_{CF}= 0:47 and n_{CC}= 44/12 are the conversion factors of biomass to carbon and carbon to carbon dioxide equivalents, respectively.

Methane (CH_4) emissions were estimated as follows:

$$ECH4_{l,t_b} = A_{l,t_b} \times AGB_{l,t_b} \times C_f \times G_{ef,CH_4} \times GWP_{CH_4}$$

(24)

Where:
G_{ef,CH_4}= the emission factor for CH_4
GWP_{CH_4} = the global warming potential of CH_4 , taken from IPCC [2014, Box 3.2, Tab. 1].

Nitrous oxide (N_2O) emissions in compartment l that burnt in year t_b were estimated by

$$EN2O_{l,t_b} = A_{l,t_b} \times AGB_{l,t_b} \times C_f \times G_{ef,N_2O} \times GWP_{N_2O}.$$

(25)

Where:
G_{ef,N_2O}= the emission factor for N_2O
GWP_{N_2O} = the global warming potential of N_2O , taken from IPCC [2014, Box 3.2, Tab. 1].

Total GHG emissions from compartment l were computed by:

$$E_{l,t_b} = EACO2_{l,t_b} + EBCO2_{l,t_b} + ECH4_{l,t_b} + EN2O_{l,t_b}$$

(26)

The sum of GHG emissions from individual compartments was computed for each year:

$$E_{t_b} = \sum_{L} E_{l,t_b}$$

(27)

The average of E_{tb} was used as an estimate of the average annual GHG emissions from biomass burning in Softwood Plantations [$tCO_2e\ yr^{-1}$] over the Reference Period.

$$\hat{\theta}_{BSW} = \frac{\sum_{T_b} E_{t_b}}{|T_b|} = \frac{\sum_{T_b} E_{t_b}}{4} \qquad (28)$$

The emissions from Fire were estimated to be:

Emissions/Removals from Forest Degradation (Fire)	**Estimate** ($tCO_2e\ yr^{-1}$)	**Lower Confidence Interval** ($tCO_2e\ yr^{-1}$)	**Upper Confidence Interval** ($tCO_2e\ yr^{-1}$)
Emissions from fire	157,488	98,855	219,937

Activity Data

<table>
<tr><td>Description of the variable including the time period covered:</td><td>A_{l,t_b} = Area burnt in softwood plantations at time t.</td></tr>
<tr><td>Explanation for which sources or sinks the variable is used:</td><td>This activity data is used to estimate emissions from fire which contribute to and are reported under Forest Degradation.</td></tr>
<tr><td>Data unit:</td><td>Ha</td></tr>
<tr><td>Value for the variable:</td><td>The values for this variable include a combination of actual and modelled data. Actual data were provided from Fiji Pine Limited for the years 2015 – 2018 (clear cells in table). The average annual area burnt over these 4 years was used to estimate the annual area burnt historically.
<table>
<tr><th rowspan="2">Year</th><th>Softwood Plantations</th></tr>
<tr><th>Area Burnt</th></tr>
<tr><td>2015</td><td>1447</td></tr>
<tr><td>2016</td><td>830</td></tr>
<tr><td>2017</td><td>2709</td></tr>
<tr><td>2018</td><td>729</td></tr>
</table></td></tr>
<tr><td>Source of data:</td><td>Fiji Pine Limited</td></tr>
<tr><td>Spatial level:</td><td>National - This data is recorded in all Fiji Pine Plantation areas within Fiji</td></tr>
<tr><td>Discussion of key uncertainties for this variable:</td><td>Burnt areas provided by Fiji Pine Limited are measured in the field using a GPS. This data will have measurement errors associated, however as there are no QA/QC or verification processes in place these random and systematic errors cannot be quantified.</td></tr>
<tr><td>Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:</td><td>Large source, highly relevant; included in the quantification of uncertainty.</td></tr>
</table>

Emissions Factors

<table>
<tr><td>Description of the variable including the forest class if applicable:</td><td>AGB_{l,t_b} Average aboveground biomass stock before burning in softwood plantation at time t;</td></tr>
<tr><td>Data unit:</td><td>tonnes d.m. ha^{-1}</td></tr>
<tr><td>Value for the variable:</td><td>
<table>
<tr><th rowspan="2">Year</th><th colspan="2">Softwood Plantations</th></tr>
<tr><th>Average age of compartment that burnt in year t$_b$</th><th>Average aboveground biomass in a compartment that burnt in year t$_b$</th></tr>
<tr><td>2015</td><td>17.5</td><td>145.8</td></tr>
<tr><td>2016</td><td>16.3</td><td>135.8</td></tr>
<tr><td>2017</td><td>10.2</td><td>85</td></tr>
<tr><td>2018</td><td>9.8</td><td>81.6</td></tr>
</table>
</td></tr>
<tr><td>Source of data or description of the assumptions, methods and results of any underlying studies that have been used to determine the variable:</td><td>The data are sourced from Fiji Pine Limited and the variable is calculated according to Equation 20: An example is presented below:
$$AGB_{l,2015} = 17.5 \times \frac{10}{1.2} = 145.8$$</td></tr>
<tr><td>Spatial level:</td><td>National Data</td></tr>
<tr><td>Discussion of key uncertainties for this variable:</td><td>The key areas of uncertainty that relate to the estimates of available aboveground biomass are the measurement errors and modelling errors relating to the estimate of annual increment in Pine plantations (Waterloo, 1994) as well as the uncertainty in the use of default root:shoot ratios for adjusting the mean annual increment.</td></tr>
<tr><td>Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:</td><td>The measurement and modelling uncertainty related to the mean annual biomass increment were considered to be medium and probability functions for the Monte Carlo runs adopted as outlined in Annex 12.1</td></tr>
</table>

<table>
<tr><td>Description of the variable including the forest class if applicable:</td><td>BGB_{l,t_b} Average belowground biomass stock before burning in softwood plantation at time t;</td></tr>
<tr><td>Data unit:</td><td>tonnes d.m. ha^{-1}</td></tr>
<tr><td>Value for the variable:</td><td>
<table>
<tr><th rowspan="2">Year</th><th colspan="2">Softwood Plantations</th></tr>
<tr><th>Average age of compartment that burnt in year t$_b$</th><th>Average belowground biomass in a compartment that burnt in year t$_b$</th></tr>
<tr><td>2015</td><td>17.5</td><td>35</td></tr>
<tr><td>2016</td><td>16.3</td><td>32.6</td></tr>
<tr><td>2017</td><td>10.2</td><td>20.4</td></tr>
<tr><td>2018</td><td>9.8</td><td>19.6</td></tr>
</table>
</td></tr>
<tr><td>Source of data or description of the assumptions, methods and results of any underlying studies that have been used to determine the variable:</td><td>The data are sourced from Fiji Pine Limited and the variable is calculated according to Equation 21: An example is presented below:
$$BGB_{l,2015} = 17.5 \times 10 \times 0.2 = 35$$</td></tr>
<tr><td>Spatial level:</td><td>National Data</td></tr>
</table>

Discussion of key uncertainties for this variable:	The key areas of uncertainty that relate to the estimates of available aboveground biomass are the measurement errors and modelling errors relating to the estimate of annual increment in Pine plantations (Waterloo, 1994) as well as the uncertainty in the use of default root:shoot ratios for adjusting the mean annual increment.
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	The measurement and modelling uncertainty related to the mean annual biomass increment were considered to be medium and probability functions for the Monte Carlo runs adopted as outlined in Annex 12.1

Average annual net emissions from forest degradation

Average annual net emissions from forest degradation were estimated by:

$$\widehat{\emptyset}_{FD} = \widehat{\emptyset}_{FDem} + \widehat{\emptyset}_{BSW} + \widehat{\emptyset}_{FDre} \qquad (29)$$

where

$\widehat{\emptyset}_{FD}$ = average annual net emissions from forest degradation; $tCO_2e\ yr^{-1}$

$\widehat{\emptyset}_{FDem}$ = average annual gross emissions from forest degradation; $tCO_2e\ yr^{-1}$

$\widehat{\emptyset}_{BSW}$ = average annual gross emissions from fire in softwood planations; $tCO_2e\ yr^{-1}$

$\widehat{\emptyset}_{FDre}$= average annual gross removals from forest degradation; $tCO_2e\ yr^{-1}$

Note: Gross removals are added to gross removals because gross removals always have a negative sign.

The emissions from Forest Degradation were estimated to be:

Emissions/Removals from Forest Degradation	**Estimate** (**$tCO_2e\ yr^{-1}$**)	**Lower Confidence Interval** (**$tCO_2e\ yr^{-1}$**)	**Upper Confidence Interval** (**$tCO_2e\ yr^{-1}$**)
Emissions from Logging	195,316	167,487	223,343
Removals from re-growth on logged areas	-42,362	-57,222	-27,794
Emissions from Fire	157,488	98,855	219,937
Net Total	**310,442**	**321,925**	**467,501**

A8.3.4 Enhancement of Forest Carbon Stocks

The sink “enhancement of forest carbon stocks” includes removals from afforestation/reforestation (AR), as well as gross emissions and removals from forest plantation management.

A8.3.4.1 Afforestation/Reforestation

Afforestation/Reforestation is defined as the conversion of land in the land-use sub-category Non-Forest to land in the sub-category Natural Forest (Low- or Upland) and Plantations (Softwood and Hardwood). Afforestation/reforestation if the crown-cover percent on a patch of land (min. 0.5 ha) reaches or exceeds the threshold value of 10%. Afforestation/reforestation cannot occur within lands defined as plantations as this land is classified as Forest Land regardless of canopy cover as it primarily land use is forest. It is assumed that afforestation/reforestation always has anthropogenic causes in Fiji.

Initial carbon stocks on land afforested/reforested is considered to be zero. Carbon gains on afforestation/reforestation land were estimated by taking the average forest area gain in each sub-period and multiply the average by the mean annual carbon increment for the forest strata.

Afterwards annual carbon gains were available for each year (t). These carbon gains for each year are subsequently multiplied by the time elapsed since conversion to estimate carbon gains over the FRL Reference Period for each year. Finally, the average annual carbon gain over the Reference Period was estimated by taking the average of the carbon gains of each year over the Reference Period.

Average annual gross removals

To compute the average annual removals from forestation, the removals over the Reference Period for each time interval were computed first. The area of reforestation over the Reference Period is generated from an annual time series of forest gain (see Annex 8.2 for detail on how this data is generated).

For the first time interval 2005-2006 it was assumed that half of the area was afforested (or reforested) during the first half of 2006.

$$A_{AR,2006} = \frac{1}{2} A_{AR,2005-2006} \tag{30}$$

where

AAR;$_{2005-2006}$ is the total area that was afforested/reforested during the interval 2005-2006 (including Low-and Upland Natural Forest), i.e., from mid 2005 to mid 2006. It is assumed that this area is not deforested during the FRL Reference Period.

The area AAR;$_{2006}$ is assumed to grow for 10.75 years. That is, from the mid of the first half of 2006 until the end of the Reference Period.

For example for the interval 2005-2006 (i.e., mid 2005 to mid 2006) there is a forest area gain of 4,841 ha. Only half of this is considered (i.e., 4,841/2 = 2,420 ha), since it is assumed that half of the area was afforested/reforested in the second half of the year 2005 (which is not covered by the FRL Reference Period). Hence, there are 2,420 ha of forest area gain in the 'first half of 2006'. It is assumed that the 2,420 ha were afforested/reforested in the mid of the first half of 2006 (i.e., April 1, 2006). If these 2,420 ha grow from April 1, 2006 to December 31, 2016, they grow for 10.75 years.

The total carbon gains on AAR;$_{2006}$ over the Reference Period were calculated as follows:

$$\Delta C_{AR,2006} = A_{AR,2006} \times 10.75 \times MAIC_{AR} \tag{31}$$

Carbon gains for the last time interval 2016-2017 were estimated in a similar way.

$$A_{AR,2016} = \frac{1}{2} A_{AR,2016-2017} \tag{32}$$

However, AAR,$_{2016}$ does not grow for 10.75 years but for 0.25 years (mid of the second half of 2016 until the end of the FRL Reference Period, i.e., from October 1, 2016 on).

$$\Delta C_{AR,2016} = A_{AR,2006} \times \frac{1}{4} MAIC_{AR} \tag{33}$$

Carbon gains for year t_1 generated over the rest of the FRL Reference Period were estimated by

$$\Delta C_{AR,tm} = \delta_{t_m} \times A_{AR,t_m} \times MAIC_{AR} \tag{34}$$

Where;

$\Delta C_{AR,t_1}$= carbon gains for the year t_1 generated over the Reference Period; tC

δ_{t_1}= {10,9,…. δtm,…,1}, yrs

$MAIC_{AR}$= mean annual carbon increment for afforestation/reforestation (above ground and belowground); tC ha^{-1} yr^{-1}
A_{AR,t_m} = forest area gain in each interval t_b, ha

Total carbon gains over the Reference Period were calculated using:

$$\Delta C_{AR} = \Delta C_{AR,2006} + \left[\sum_{T_m} \Delta C_{AR,t_m} \right] + \Delta C_{AR,2016} \tag{35}$$

Activity Data

Description of the variable including the time period covered:	A_{AR,t_m}= forest area gain This area represents the total area afforested/reforestated.
Explanation for which sources or sinks the variable is used:	This variable is used in the estimation of removals from afforestation/reforestation activities.
Data unit:	Ha
Value for the variable:	6,180
Source of data:	Management Services Division of the Ministry of Forestry
Spatial level:	Sub-National; this data represents areas of afforestation/reforestation within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the land area of the Fijian islands.
Discussion of key uncertainties for this variable:	The key sources of uncertainty relate to errors of omission and commission in the image classification process.
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	The data are predicted values generated from semi-automated processing of Landsat imagery. The accuracy assessment following the methods of Olofsson et al 2014 is applied to developed error adjusted areas and confidence intervals which are then incorporated into the Monte Carlo simulation. Lower CI[ha] 4,415 Upper CI[ha] 8,124

Emissions Factors

Description of the variable including the forest class if applicable:	$MAIC_{AR}$= mean annual carbon increment for afforestation/reforestation (above ground and belowground)
Data unit:	tC ha^{-1} yr^{-1}
Value for the variable:	2.63
Source of data or description of the assumptions, methods and results of any underlying studies that have been used to determine the variable:	$MAIC_{AR}$ was calculated from estimates of mean annual volume increments reported by Fiji Hardwood Corporation Limited as follows: $MAIC_{AR} = MAIV_{AR} \times BCEF_{AR,I} \times (1 + R_{wl}) \times \eta_{CF}$ $2.63 = 3.71 \times 1.1 \times (1 + 0.37) \times 0.47$ Where; $MAIC_{AR}$ = mean annual carbon increment for forestation including C in AGB and BGB; tC ha^{-1} yr^{-1} $MAIV_{AR}$ = mean annual volume increment for forestation derived from data from FHCL; m^3 ha^{-1} yr^{-1} $BCEF_{AR,I}$ = biomass conversion and expansion factor for volume increments in humid tropical natural forests (growing stock level 11-20 m^3 ha^{-1}) taken from IPCC [2006, Vol. 4, Chap.4, Tab. 4.5]; to be 1.1 tB $(m^3)^{-1}$ R_{wl}= root-to-shoot ratio for tropical rainforest (see Table A.9); dimensionless η_{CF} = biomass to carbon conversion factor (IPCC default); C $(tB)^{-1}$
Spatial level:	Nationally relevant
Discussion of key uncertainties for this variable:	The sources of uncertainty with this emissions factor include: 1. Volumes provided by FHCL considered to be a large source 2. Uncertainty in root-to-shoot ratios (IPCC [2006] default values); 3. Uncertainty in biomass expansion factor (IPCC [2006] default values); 4. Uncertainty in root:shoot ratio (IPCC [2006] default values);
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	lower CI[tC ha^{-1} yr^{-1}]: 1.61 upper CI[tC ha^{-1} yr^{-1}]: 3.66

Average annual net removals from Afforestation/Reforestation

Total carbon gains were converted to tCO_2e and annualized:

$$\hat{\theta}_{ECAR} = \mathcal{T}^{-1}\left[\Delta C_{AR} \times \eta_{CC}\right] \qquad (36)$$

Where;
$\widehat{\emptyset}_{ECAR}$= average annual removals from afforestation/reforestation; tCO_2e yr^{-1}
ΔC_{AR} = average annual carbon gains from afforestation / reforestation over the Reference Period; tC yr^{-1}
η_{CC} = conversion factor C to CO_2; tCO_2 $(tC)^{-1}$

The removals from Afforestation / Reforestation were estimated to be:

Removals from A/R	**Estimate** (tCO_2e yr^{-1})	**Lower Confidence Interval** (tCO_2e yr^{-1})	**Upper Confidence Interval** (tCO_2e yr^{-1})
	-327,541	-470,832	-202,971

8.3.4.2 Forest Plantation Management

Fiji's forest definition lists two types of Forest Plantations, namely Hardwood Plantations and Softwood (or Pine) Plantations. By definition, deforestation and afforestation/reforestation are not possible within Forest Plantations. Forest Plantations remain in the land-use category Forest Land even if the crown-cover is completely removed following harvest, e.g., temporarily unstocked.

For the FRL it was assumed that field data, i.e., records on the current stocking, volumes and areas harvested and areas planted available at FPL and FHCL, would provide more reliable estimates of emissions and removals from Forest Plantations. As spatial data on the extent of Hard- and Softwood Plantations was available, the methods used may still be considered to follow IPCC Approach 3.

To estimate gross emissions from Forest Plantations, records on the timber volumes extracted in the years 2006 to 2016 provided by the plantation management companies were used. Timber volumes extracted were converted to total tree biomass, to total carbon and finally to CO_2 emissions. The conversion from logging to emissions was calculated differently for Hardwood and Softwood Plantations as described below.

Removals from Forest Plantations were estimated based on the mean annual increment (MAI) reported for Hard- and Softwood Plantations. Removals originate from areas that were planted during the FRL Reference Period and plantations that were planted before the start year 2006 and were not harvested until the end of the Reference Period.

Average annual gross emissions from softwood plantations

Emissions from logging in softwood plantations were estimated from data on extracted volumes provided by Fiji Pine Limited (FPL) for the years of the Reference Period.

$$AGB_{SW,L,t} = V_{SW,L,t} \times \frac{1}{\lambda_{Pine}} \times \rho_{Pine} \qquad (37)$$

Where;
$AGB_{SW,L,t}$= aboveground biomass loss in year *t* in softwood plantations; tAGB
$V_{SW,L,t}$ = wood volumes harvested in softwood plantations in year *t*; m^3
λ_{Pine} = recovery rate in softwood plantations; dimensionless
ρ_{Pine} = wood density of pine wood harvested in softwood plantations; g cm^{-3}

Total biomass loss was estimated by:

$$TB_{SW,L,t} = AGB_{SW,L,t} \times (1 + R_{dlh}) \qquad (38)$$

Where;
$T_{SW,L,t}$ = total biomass loss in year *t* in Softwood Plantations; tB
$AGB_{SW,L,t}$ = aboveground biomass loss in softwood plantations; tB
R_{dlh} = root-to-shoot ratio for tropical moist deciduous forest >125 tB ha^{-1}, taken from IPCC, 2006, Vol.4, Chap. 4, Tab. 4.4; dimensionless

Carbon loss due to harvest in softwood plantations was estimated by:

$$\Delta C_{SW,L,t} = \left[TB_{SW,L,t} \times \eta_{CF}\right] \times (-1) \qquad (39)$$

Where;
$\Delta C_{SW,L,t}$ = carbon loss in softwood plantations in year *t* due to logging; tC
$TB_{SW,L,t}$ = total biomass loss in year *t* in softwood plantation; tB
n_{CF} = conversion factor for dry matter to C; tC $(tB)^{-1}$

Average annual gross emissions from softwood plantations were estimated by:

$$\widehat{\emptyset}_{ECS_{em}} = \mathrm{T}^{-1}\left[\sum_{T} \Delta C_{SW,L,t} \times \eta_{CC}\right] \qquad (40)$$

Where;
$\widehat{\emptyset}_{ECS_{em}}$ = average annual gross emissions from softwood plantations; $tCO_2e\ yr^{-1}$
T = length of the FRL Reference Period, i.e. 11 years; yrs
$\Delta C_{SW,L,t}$ = carbon loss in softwood plantations in year *t* due to logging; tC
η_{CC} = conversion factor C to CO_2e; $(tCO_2\ (C)^{-1})$

Average annual gross removals from softwood plantations

Average annual gross removals from softwood plantations were estimated based on the mean annual increment of above and belowground biomass, $\mathrm{MAIB_{SW}}$(taken from Waterloo [1994]), areas planted during the Reference Period and growth on areas that were planted before 2006 and were either harvested or not harvested before the end of the Reference Period.

Fiji Pine Limited provided inventory data from which growth curves for volume could have been derived. However, the data were erroneous and a reliable estimate could not be obtained.
Spatial data on areas planted and areas harvested per year were provided by Fiji Pine Limited, however, data on areas harvested were erroneous and could not be used. For example, for the year 2012 Fiji Pine Limited reported that about 158,214 m3 of pine wood were harvested. The area reported as harvest in 2012 was, however, zero hectares. As the area harvested was needed to estimate the area on which removals were generated in Softwood Plantations these data were estimated using data on harvested volumes.

To estimate C accumulation on areas planted during the Reference Period and areas that have been planted before 2006 (and were not harvested until the end of the Reference Period), the MAIBSW was converted to C increment by:

$$MAIC_{SW} = \left[MAIB_{SW} \times \eta_{CF}\right] \qquad (41)$$

$MAIC_{SW}$ = mean annual C increment in Softwood Plantations; $tC\ ha^{-1}\ yr^{-1}$
$MAIB_{SW}$ = mean annual biomass increment (AGB + BGB) in Softwood Plantations; $tB\ ha^{-1}\ yr^{-1}$
η_{CF} = conversion factor biomass to C; dimensionless

Using the same methods as for Hardwood Plantations, C gains on areas planted during the Reference Period were estimated for each year (over the Reference Period) by:

$$\Delta C_{SW,G,t} = \delta_t \times A_{SE,PL,t} \times MAIC_{SW} \qquad (42)$$

$\Delta C_{SW,G,t}$ = carbon gains for year t in Softwood Plantations over the Reference Period; tC
δ_t = 2016−t + 0.5; yrs
$A_{SE,PL,t}$ = area planted in Softwood Plantations in year t; ha
$MAIC_{SW}$ = mean annual C increment in Softwood Plantations; $tC\ ha^{-1}\ yr^{-1}$

To estimate C gains on areas that were planted before 2006 and were not harvested until the end of the Reference Period, data on these areas were needed. As Fiji Pine Limited did not report on the area stocked with trees at the beginning of the Reference Period, these areas were estimated from data on harvested volumes and data on areas planted. As no reliable data for the area harvested were provided by Fiji Pine Limited, these areas harvested were estimated first. To estimate harvested areas, data on the $MAIC_{SW}$, the cutting cycle (CC_{SW}; currently 20 years in Softwood Plantations and ii) the C loss due to harvests in each year were used. The area logged in year t was estimated by:

$$\hat{A}_{SW,LG,t} = \ [CC_{SW} \times MAIC_{SW}]^{-1} \times \Delta C_{SW,L,t} \tag{43}$$

Where;
$\hat{A}_{SW,LG,t}$ = area logged in Softwood Plantations in year t; ha
CC_{SW}= length of the cutting cycle in Softwood Plantations; yrs
$MAIC_{SW}$ = mean annual C increment in Softwood Plantations; tC ha^{-1} yr^{-1}
$\Delta C_{SW,L,t}$ = carbon loss in Softwood Plantations in year t due to logging; tC

— For 2006, FPL reported a stocking area of 49,503 ha (December 31, 2006). The stocking area at the start of the Reference Period was estimated by

$$\hat{A}_{SW,S,2005} = A_{SW,S,2006} + \hat{A}_{SW,LG,2006} - A_{SW,PL,2006} \tag{44}$$

Where;
$\hat{A}_{SW,S,2005}$ = stocking area of Softwood Plantations in 2005; ha
$A_{SW,S,2006}$ = stocking area of Softwood Plantations in 2006; ha
$\hat{A}_{SW,LG,2006}$= area harvested in Softwood Plantations in 2006; ha
$A_{SW,PL,2006}$= area planted in FPL's plantation lease area in 2006; ha

The area that was planted before 2006 and was not harvested until end of 2016 was estimated by:

$$\hat{A}_{SW,S,GR} = \hat{A}_{SW,S,2005} - \sum_{T} \hat{A}_{SW,LG,t} \tag{45}$$

$\hat{A}_{SW,S,GR}$ = stocking area in Softwood Plantations that was planted before 2006 and was not harvested until the end of the Reference Period; ha
$\hat{A}_{SW,S,2005}$ = stocking area of Softwood Plantations in 2005; ha
$\hat{A}_{SW,LG,t}$ = area harvested in Softwood Plantations in year t; ha

The average annual C gain on $\hat{A}_{SW,S,GR}$ were computed by:

$$\Delta C_{SW,GR} = \hat{A}_{SW,S,GR} \times MAIC_{SW} \tag{46}$$

$\Delta C_{SW,GR}$ = average annual C gain on areas that were planted before 2006 and were not harvested until the end of the Reference Period; tC yr^{-1}
$\hat{A}_{SW,S,GR}$ = stocking area in Softwood Plantations that was planted before 2006 and was not harvested until the end of the Reference Period; ha
$MAIC_{SW}$ = mean annual C increment in Softwood Plantations; tC ha^{-1} yr^{-1}

Average annual removals on compartments in Softwood Plantations that were harvested during the Reference Period were estimated as follows:

$$\Delta C_{SW,GRH} = \mathrm{T}^{-1}\left[\sum_{T} \acute{\delta}_t \times \hat{A}_{SW,LG,t} \times MAIC_{SW}\right] \tag{47}$$

$\Delta C_{SW,GRH}$= average annual C gain on areas that were planted before 2006 and harvested during the Reference Period; tC yr^{-1}
$\acute{\delta}_t$ = the time a compartment logged in year t grew during the Reference Period, $\acute{\delta}_t$= t−2016 + 10.5, i.e., the reversal of δ_t; yrs
$\hat{A}_{SW,LG,t}$t = area logged in Softwood Plantations in year t; ha

$MAIC_{SW}$ = mean annual C increment in Softwood Plantations; tC ha^{-1} yr^{-1}

Total average annual C gain, including gains on areas planted during the Reference Period, areas harvested during the Reference Period and areas that were planted before 2006 and were not harvested until the end of the Reference Period, was computed by:

$$\Delta C_{SW,G} = \left[\mathrm{T}^{-1} \sum_{T} \Delta C_{SW,G,t}\right] + \Delta C_{SW,GRH} + \Delta C_{SW,GR} \qquad (48)$$

Where;

$\Delta C_{SW,G}$ = total average annual C gains including gains from areas that were planted in Softwood Plantations during the Reference Period, areas that were harvested during the Reference Period, and areas that were planted before 2006 and were not harvested until the end of the Reference Period; tC yr^{-1}
$\Delta C_{SW,G,t}$ = carbon gains for year t in Softwood Plantations over the Reference Period; tC
$\Delta C_{SW,GRH}$ = average annual C gain on areas that were planted before 2006 and harvested during the Reference Period; tC yr^{-1}
$\Delta C_{SW,GR}$ = average annual C gain on areas that were planted before 2006 and were not harvested until the end of the Reference Period; tC yr^{-1}

Estimated total average annual carbon gains in softwood plantations were converted to average annual removals by:

$$\widehat{\emptyset}_{ECS_{re}} = \Delta C_{SW,G} \times \eta_{CC} \qquad (49)$$

Where;
$\widehat{\emptyset}_{ECS_{re}}$ = average annual gross removals from softwood plantations; tCO_2e yr^{-1}
$\Delta C_{SW,G}$ = total average annual carbon gains including gains from areas that were planted before 2006 and were not harvested until the end of the Reference Period and areas that were planted in softwood plantations during the Reference Period; tC yr^{-1}
η_{CC} = carbon to carbon dioxide equivalents conversion factor; (tCO_2 $(C)^{-1}$)

Activity Data

Description of the variable including the time period covered:	$V_{SW,L,t}$ = wood volumes harvested in softwood plantations in year *t*
Explanation for which sources or sinks the variable is used:	Emissions from logging in softwood plantations estimated from data on extracted volumes.
Data unit:	m^3
Value for the variable:	

Year	$V_{SW,L}$
2006	282,102
2007	294,685
2008	265,046
2009	249,769
2010	256,040
2011	306,684
2012	158,214
2013	668,833
2014	393,519
2015	544,902
2016	259,301

Source of data:	Provided by Fiji Pine Limited (FPL) for the years of the Reference Period.
Spatial level:	Sub-National; this data represents volumes extracted from softwood plantations within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the total land area of the Fijian islands.
Discussion of key uncertainties for this variable:	Small source of uncertainty; not included in the quantification of total uncertainty. Note that the data are census data (i.e., no sampling error). Data are census data (i.e., no sampling error). High confidence in the data collected by Ministry staff as systematic and random errors are considered nil due to QA/QC checks and training and strong links to Ministry revenues.
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	None.

<table>
<tr><td>Description of the variable including the time period covered:</td><td>$A_{SW,PL,t}$ = area planted in softwood plantations in year t</td></tr>
<tr><td>Explanation for which sources or sinks the variable is used:</td><td>Carbon gains on areas planted with softwood plantations during the Reference Period</td></tr>
<tr><td>Data unit:</td><td>ha</td></tr>
<tr><td>Value for the variable:</td><td>
<table>
<tr><th>Year</th><th>$A_{SW,PL}$</th></tr>
<tr><td>2006</td><td>1,477.80</td></tr>
<tr><td>2007</td><td>2.87</td></tr>
<tr><td>2008</td><td>14.09</td></tr>
<tr><td>2009</td><td>16.70</td></tr>
<tr><td>2010</td><td>177.40</td></tr>
<tr><td>2011</td><td>273.12</td></tr>
<tr><td>2012</td><td>871.02</td></tr>
<tr><td>2013</td><td>12.51</td></tr>
<tr><td>2014</td><td>201.71</td></tr>
<tr><td>2015</td><td>1,031.91</td></tr>
<tr><td>2016</td><td>0.00</td></tr>
</table>
</td></tr>
<tr><td>Source of data:</td><td>Provided by Fiji Pine Limited (FPL) for the years of the Reference Period.</td></tr>
<tr><td>Spatial level:</td><td>Sub-National; this data represents area planted in softwood plantations in each year within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the total land area of the Fijian islands.</td></tr>
<tr><td>Discussion of key uncertainties for this variable:</td><td>The area planted is used as a proxy for stocked plantations growing in the estimation of removals. The uncertainty related to this figure relates to systematic and random errors in recording the area planted as well as the uncertainty arising from failed areas which are not captured in this dataset.</td></tr>
<tr><td>Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:</td><td>The uncertainty of this data on planted area being used in the context of growing plantations is considered medium and relevant and as such is included in the quantification of uncertainty.</td></tr>
</table>

<table>
<tr><td>**Description of the variable including the time period covered:**</td><td>$A_{SW,LG,t}$ = area logged in softwood plantations in year t;</td></tr>
<tr><td>**Explanation for which sources or sinks the variable is used:**</td><td>Carbon gains on areas planted with softwood plantations during the Reference Period</td></tr>
<tr><td>**Data unit:**</td><td>ha</td></tr>
<tr><td>**Value for the variable:**</td><td>
<table>
<tr><td>Year</td><td>$A_{SW,LG}$</td></tr>
<tr><td>2006</td><td>1,081.64</td></tr>
<tr><td>2007</td><td>1,129.88</td></tr>
<tr><td>2008</td><td>1,016.24</td></tr>
<tr><td>2009</td><td>957.67</td></tr>
<tr><td>2010</td><td>981.71</td></tr>
<tr><td>2011</td><td>1,175.89</td></tr>
<tr><td>2012</td><td>606.63</td></tr>
<tr><td>2013</td><td>2,564.45</td></tr>
<tr><td>2014</td><td>2,089.27</td></tr>
<tr><td>2015</td><td>1,508.83</td></tr>
<tr><td>2016</td><td>994.21</td></tr>
</table>
</td></tr>
<tr><td>**Source of data:**</td><td>Areas stocked with trees at the beginning of the Reference Period were not available from Fiji Pine Limited records or the remote sensing data and therefore were estimated from data on harvested volumes and data on areas planted. To estimate harvested areas, data on the $MAIC_{SW}$, the cutting cycle (CC_{SW}; currently 20 years in Softwood Plantations and the carbon loss due to harvests in each year were used. The area logged in year *t* was estimated by:

$$\hat{A}_{SW,LG,t} = [CC_{SW} \times MAIC_{SW}]^{-1} \times \Delta C_{SW,L,t}$$
Where:
$\hat{A}_{SW,LG,t}$ = area logged softwood plantations in yeat *t*; ha
CC_{SW} = length of the cutting cycle in softwood plantations; yrs
$MAIC_{SW}$ = mean annual carbon increment in softwood plantations; tC ha^{-1}
$\Delta C_{SW,L,t}$ = carbon loss in softwood plantations in year *t* due to logging; tC

The stocked area at the start of the Reference Period was estimated by:
$$\hat{A}_{SW,S,2006} = A_{SW,S,2006} + \hat{A}_{SW,LG,2006} - A_{SW,PL,2006}$$
Where;

$\hat{A}_{SW,S,2006}$ = stocked area of softwood plantations in 2005; ha
$A_{SW,S,2006}$ = stocked area of softwood plantations in 2006; ha
$\hat{A}_{SW,LG,2006}$ = area of softwood plantations harvested in 2006; ha
$A_{SW,PL,2006}$ = area of softwood plantations planted in 2006; ha

The area planted before 2006 and not harvested until the end of 2016 was estimated by:
$$\hat{A}_{SW,GR} = \hat{A}_{SW,S,2005} - \sum_{T} \hat{A}_{SW,LG,t}$$
Where;</td></tr>
</table>

$A_{SW,GR}$ = stocked area of softwood plantations that was planted before 2006 and was not harvested until the end of the Reference Period; ha
$A_{SW,S,2005}$ = stocked area of softwood plantations in 2005; ha
$A_{SW,LG,t}$ = areas of softwood plantation harvested in year t; ha

Year	$\hat{A}_{SW,S}$
2006	49,503.00
2007	47,979.83
2008	48,104.68
2009	48,165.88
2010	48,302.52
2011	48,204.06
2012	49,371.23
2013	46,554.90
2014	47,219.28
2015	48,629.91
2016	48,112.62

Spatial level:	Sub-National; this data represents volumes extracted from softwood plantations within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the total land area of the Fijian islands.
Discussion of key uncertainties for this variable:	The key uncertainties related to area logged relate to the = length of the cutting cycle in softwood plantations (CC_{SW}) and the mean annual carbon increment in softwood plantations ($MAIC_{SW}$).
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	Refer to the probability density functions of the key variables [(CC_{SW}) and $MAIB_{SW}$, used to estimate $MAIC_{SW}$] which were applied in the Monte Carlo simulations.

Emissions Factors

Description of the variable including the forest class if applicable:	$MAIC_{SW}$ = mean annual carbon increment in softwood plantations;
Data unit:	tC ha^{-1} yr^{-1}
Value for the variable:	4.7
Source of data or description of the assumptions, methods and results of any underlying studies that have been used to determine the variable:	To estimate carbon accumulation on areas planted during the Reference Period and areas that have been planted before 2006 (and were not harvested until the end of the Reference Period), the $MAIB_{SW}$ was converted to C increment by: $MAIC_{SW} = MAIB_{SW} \times \eta_{CF}$ Where; $MAIC_{SW}$ = mean annual carbon increment in softwood plantations; tC ha^{-1} $MAIB_{SW}$ = mean annual increment of above and belowground biomass; tB ha^{-1} yr^{-1} η_{CF} = conversion factor for biomass to carbon; tC $(tB)^{-1}$
Spatial level:	Sub-National; this data represents volumes extracted from softwood plantations within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the total land area of the Fijian islands.
Discussion of key uncertainties for this variable:	The two key variables applied in the estimation of this emissions factor had the following uncertainty ranking: η_{CF} = small source, not relevant; not included in the quantification of uncertainty. $MAIB_{SW}$ = large source, highly relevant; included in the quantification of uncertainty.
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	Refer to the probability density functions of the variables [η_{CF} and ($MAIB_{SW}$) which were applied in the Monte Carlo simulations.

Average annual net emissions from Softwood plantations

Average annual net emissions from softwood plantations were estimated by:

$$\widehat{\emptyset}_{ECS} = \widehat{\emptyset}_{ECS_{em}} + \widehat{\emptyset}_{ECS_{re}} \quad (50)$$

Where;

$\widehat{\emptyset}_{ECS}$ = average annual net emission from softwood plantations; tCO_2e yr^{-1}
$\widehat{\emptyset}_{ECS_{em}}$ = average annual gross emissions from softwood plantations; tCO_2e yr^{-1}
$\widehat{\emptyset}_{ECS_{re}}$ = average annual gross removals from softwood plantations; tCO_2e yr^{-1}

Average annual removals are added to the average annual emissions because removals have a negative sign.

The net emissions from Softwood Plantations were estimated to be:

Emissions/Removals from Softwood Plantations	Estimate (tCO2e yr-1)	Lower Confidence Interval (tCO2e yr-1)	Upper Confidence Interval (tCO2e yr-1)
Emissions from Softwood Plantations	442,001	363,766	543,364
Removals from Softwood Plantations	- 774,225	-929,732	-620,622
Net	**- 332,224**	**-501,514**	**-135,751**

Average annual gross emissions from hardwood plantations
Gross emissions from hardwood plantations utilise annual logged volume data reported by Fiji Hardwood Corporation Limited (FHCL).

$$AGB_{HW,L,t} = V_{HW,L,t} \times BCEF_{HW,R} \qquad (51)$$

Where;
$AGB_{HW,L,t}$= aboveground biomass removed in hardwood plantations in year *t*; tAGB
$V_{HW,L,t}$ = volume of hardwood extracted in year *t*; m^3
$BCEF_{HW,R}$ = biomass conversion and expansion factor for logging; tAGB m^{-3}

Aboveground biomass is converted to total biomass (above- and belowground biomass) by:

$$TB_{HW,L,t} = \left(AGB_{HW,L,t} \times (1 + R_{wl})\right) \qquad (52)$$

Where;
$TB_{HW,L,t}$ = total biomass loss due to harvesting in hardwood plantations in year *t*; tB
$AGB_{HW,L,t}$ = aboveground biomass removed in softwood plantations in the year of harvest; tAGB yr^{-1}
R_{wl} = root-to-shoot ratio for tropical rainforests; dimensionless

Extracted total biomass was converted to carbon loss by:

$$\Delta C_{HW,L,t} = \left[TB_{HW,L,t} \times \eta_{CF}\right] \times (-1) \qquad (53)$$

Where;
$\Delta C_{HW,L,t}$ = carbon loss in hardwood plantations in year *t* due to logging; tC
$TB_{SW,L,t}$ = total biomass loss in year *t* in hardwood plantation; tB
n_{CF} = conversion factor for dry matter to C; tC (tB)$^{-1}$

Average annual gross emissions from hardwood plantations were estimated by:

$$\widehat{\emptyset}_{ECH_{em}} = \mathrm{T}^{-1}\left[\textstyle\sum_{T} \Delta C_{HW,L,t} \times \eta_{CC}\right] \qquad (54)$$

Where;
$\widehat{\emptyset}_{ECS_{em}}$ = average annual gross emissions from hardwood plantations; tCO$_2$e yr^{-1}
T = length of the FRL Reference Period, i.e. 11 years; yrs
$\Delta C_{SW,L,t}$ = carbon loss in hardwood plantations in year *t* due to logging; tC
η_{CC} = conversion factor C to CO$_2$e; (tCO$_2$ (C)$^{-1}$)

Average annual gross removals from hardwood plantations

Removals within hardwood plantations were estated based on mean annual volume increments on areas planted during the reference period (i.e. between 2006 and 2016) and growth on areas that were planted before 2006 and were either harvested or not harvested before the end of the Reference Period.

$$MAIAGB_{HW} = \overline{MAIV}_{HW} \times BCEF_{HW,I} \qquad (55)$$

$$6.44 = 5.85 \times 1.1 \qquad \text{(Example)}$$

Where;
$MAIAGB_{HW}$ = mean annual AGB increment in Hardwood Plantations; tB ha^{-1} yr^{-1}
$\overline{MAIV}_{HW}$ = average mean annual increment in Hardwood Plantations; m^{3} ha^{-1} yr^{-1}
$BCEF_{HW,I}$ = biomass conversion and expansion factor for increment taken from IPCC, 2006, Vol. 4, Chap. 4. Tab. 4.5; $BCEF_I$for humid tropical natural forest; growing stock level 21-40 m^{3} ha^{-1}; tB (m^{3})$^{-1}$

Total carbon increment, including both aboveground and belowground, was estimated by:

$$MAIC_{HW} = [MAIAGB_{HW} \times (1 + R_{wl})] \times \eta_{CF} \qquad (56)$$

Where;
$MAIC_{HW}$ = mean annual carbon increment in Hardwood Plantations; tB ha^{-1} yr^{-1}
$MAIAGB_{HW}$ = mean annual biomass increment; tB ha^{-1} yr^{-1}

Carbon gains over the Reference Period on areas that were planted between 2006 and 2016 in FHCL's lease area were estimated for each year by:

$$\Delta C_{HW,G,t} = \delta_t \times A_{HW,PL,t} \times MAIC_{HW} \qquad (57)$$

Where;
$\Delta C_{HW,G,t}$ = carbon gains for year *t* in hardwood plantations over the Reference Period; tC
δ_t = 2016 – *t* + 0.5; yrs
$A_{HW,PL,t}$ = area planted in hardwood plantations in year *t*; ha
$MAIC_{HW}$ = mean annual carbon increment in hardwood plantations; tC ha^{-1} yr^{-1}

For the year2011, FHCL reported a stockingarea of AHW,S,2011 = 56,652 ha. The stocking area is the area of the plantation lease area that was stocked with trees. No data were provided for a date prior to 2011. The area stocked at the end of 2005 was calculated by:

$$A_{HW,S,2005} = A_{HW,S,2011} + \sum_{t=2006}^{2010} A_{HW,LG,t} - \sum_{t=2006}^{2010} A_{HW,PL,t} \qquad (58)$$

Where;

$A_{HW,S,2005}$= stocking area in Hardwood Plantations in 2005; ha
$A_{HW,S,2011}$ = stocking area in Hardwood Plantations in 2011; ha
$A_{HW,LG,t}$ = area logged in Hardwood Plantations in year t; ha
$A_{HW,PL,t}$ = area planted in Hardwood Plantations in year t; ha

The total of the areas harvested between 2006 and 2016 was subtracted from the stocking area of 2005, $A_{HW,S,2005}$ to obtain the area that accumulated C during the Reference Period, i.e., the area that was neither planted nor harvested during the Reference Period,

$$A_{HW,GR} = A_{HW,S,2005} - \sum_{T} A_{HW,PL,t} \qquad (59)$$

Where;

$A_{HW,GR}$= stocking area in Hardwood Plantations that was planted before 2006 and was not harvested until the end of the Reference Period; ha
$A_{HW,S,2005}$ = stocking area in Hardwood Plantations in 2005; ha
$A_{HW,LG,t}$ = area logged in Hardwood Plantations in year t; ha

The average annual C gain on hardwood plantation was estimated by:

$$\Delta C_{HW,GR} = A_{HW,GR} \times MAIC_{HW} \qquad (60)$$

Where;

$\Delta C_{HW,GR}$ = average annual carbon gain on areas that were planted before 2006 and were not harvested until the end of the Reference Period; tC yr^{-1}
$A_{HW,GR}$= stocking area in hardwood plantations that was planted before 2006 and not harvested during the Reference Period; ha
$MAIC_{HW}$ = mean annual C increment in hardwood plantations; tC ha^{-1} yr^{-1}

Carbon also accumulated on plantation compartments that were harvested during the FRL Reference Period. For example, a plantation compartment that was harvested in 2010 accumulated C in 2006, 2007, 2008, 2009 and half of 2010. When the compartment is harvested in 2010 all carbon stored in the compartment is emitted to the atmosphere. This includes the C that was sequestered during the years 2006 to mid of 2010. However, since the C was sequestered during the Reference Period, these removals have to be accounted for. Average annual removals on compartments that were harvested during the Reference Period were estimated as follows:

$$\Delta C_{HW,GRH} = \mathrm{T}^{-1}\left[\sum_{T} \acute{\delta}_t \times A_{HW,LG,t} \times MAIC_{HW}\right] \qquad (61)$$

Where;
$\Delta C_{HW,GRH}$ = average annual C gain on areas that were planted before 2006 and harvested during the Reference Period; tC yr^{-1}
$\acute{\delta}_t$ = the time a compartment logged in year t grew during the Reference Period, δ′ t = t−2016 + 10.5, i.e., the reversal of δt; yrs
$A_{HW,LG,t}$ = area logged in Hardwood Plantations in year t; ha
$MAIC_{HW}$ = mean annual C increment in Hardwood Plantations; tC ha^{-1} yr^{-1}
T = duration of the Reference Period (i.e. 11 years); yrs

Total average annual C gain, including gains on areas planted during the Reference Period, areas harvested during the Reference Period and areas that were planted before 2006 and were not harvested until the end of the Reference Period, was computed by:

$$\Delta C_{HW,G} = \left[\mathrm{T}^{-1} \sum_{T} \Delta C_{HW,G,t}\right] + \Delta C_{HW,GRH} + \Delta C_{HW,GR} \qquad (62)$$

Where;
$\Delta C_{HW,G}$ = total average annual C gains including gains from areas that were planted in Hardwood Plantations during the Reference Period, areas that were harvested during the Reference Period, and areas that were planted before 2006 and were not harvested until the end of the Reference Period; tC yr^{-1}
$\Delta C_{HW,G,t}$ = carbon gains for year t in Hardwood Plantations over the Reference Period; tC
$\Delta C_{HW,GRH}$ = average annual C gain on areas that were planted before 2006 and harvested during the Reference Period; tC yr^{-1}
$\Delta C_{HW,GR}$ = average annual C gain on areas that were planted before 2006 and were not harvested until the end of the Reference Period; tC yr^{-1}

Estimated total average annual carbon gains in hardwood plantations were converted to average annual removals by:

$$\widehat{\emptyset}_{ECHre} = \Delta C_{HW.G} \times \eta_{CC} \qquad (63)$$

Where;

$\widehat{\emptyset}_{ECHre}$ = average annual gross removals from hardwood plantations; tCO2e yr^{-1}
$\Delta C_{HW.G}$ = total average annual carbon gains including gains from areas that were planted before 2006 and were not harvested until the end of the Reference Period and areas that were planted in hardwood plantations during the Reference Period; tC yr^{-1}
η_{CC} = conversion factor C to CO_2e; (tCO_2 $(C)^{-1}$)

The net emissions from Hardwood Plantations were estimated to be:

Emissions/Removals from Hardwood Plantations	**Estimate** **(**tCO_2e yr^{-1}**)**	**Lower Confidence Interval** **(**tCO_2e yr^{-1}**)**	**Upper Confidence Interval** **(**tCO_2e yr^{-1}**)**
Emissions from Hardwood Plantations	154,194	127,106	181,684
Removals from Hardwood Plantations	- 864,898	-1,239,892	-541,863
Net	**-710,705**	**-1,086,703**	**-385,590**

Activity Data

<table>
<tr><td>Description of the variable including the time period covered:</td><td>$V_{HW,L}$ = wood volumes harvested in hardwood plantations in year <i>t</i>;</td></tr>
<tr><td>Explanation for which sources or sinks the variable is used:</td><td>Emissions from logging in hardwood plantations estimated from data on extracted volumes.</td></tr>
<tr><td>Data unit:</td><td>m^3</td></tr>
<tr><td>Value for the variable:</td><td>
<table>
<tr><td>Year</td><td>$V_{HW,L}$</td></tr>
<tr><td>2006</td><td>37,216</td></tr>
<tr><td>2007</td><td>5,0092</td></tr>
<tr><td>2008</td><td>79,869</td></tr>
<tr><td>2009</td><td>63,758</td></tr>
<tr><td>2010</td><td>92,283</td></tr>
<tr><td>2011</td><td>91,025</td></tr>
<tr><td>2012</td><td>53,737</td></tr>
<tr><td>2013</td><td>63,251</td></tr>
<tr><td>2014</td><td>58,542</td></tr>
<tr><td>2015</td><td>54,568</td></tr>
<tr><td>2016</td><td>39,854</td></tr>
</table>
</td></tr>
<tr><td>Source of data:</td><td>Data on recovered (extracted) volumes from hardwood plantations was provided by Fiji Hardwood Corporation Limited for the years of the FRL Reference Period.</td></tr>
<tr><td>Spatial level:</td><td>Sub-National; this data represents volumes extracted from hardwood plantations within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the total land area of the Fijian islands.</td></tr>
</table>

Discussion of key uncertainties for this variable:	Small source, not relevant; not included in the quantification of uncertainty. Note that the data are census data (i.e., no sampling error).
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	None

<table>
<tr><td>Description of the variable including the time period covered:</td><td>$A_{HW,PL,t}$ = area planted in hardwood plantations in year t</td></tr>
<tr><td>Explanation for which sources or sinks the variable is used:</td><td>Carbon gains on areas planted with hardwood plantations during the Reference Period</td></tr>
<tr><td>Data unit:</td><td>Ha</td></tr>
<tr><td>Value for the variable:</td><td>
<table>
<tr><td>Year</td><td>$A_{HW,PL}$</td></tr>
<tr><td>2006</td><td>305.03</td></tr>
<tr><td>2007</td><td>305.03</td></tr>
<tr><td>2008</td><td>305.03</td></tr>
<tr><td>2009</td><td>305.03</td></tr>
<tr><td>2010</td><td>305.03</td></tr>
<tr><td>2011</td><td>228.00</td></tr>
<tr><td>2012</td><td>1000.00</td></tr>
<tr><td>2013</td><td>0</td></tr>
<tr><td>2014</td><td>0</td></tr>
<tr><td>2015</td><td>0</td></tr>
<tr><td>2016</td><td>300.00</td></tr>
</table>
</td></tr>
<tr><td>Source of data:</td><td>Fiji Hardwood Corporation Limited did not report on the areas planted for each year between 2006 and 2010, only aggregated data for the time interval 2001 to 2010 were reported (3050.3 ha). For the years 2006 to 2010, the average, i.e., 3050.3 ha / 10 years = 305.03 ha yr-1, was used. For the years 2011 to 2016 FHCL reported on areas planted in each year.</td></tr>
<tr><td>Spatial level:</td><td>Sub-National; this data represents volumes extracted from hardwood plantations within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the total land area of the Fijian islands.</td></tr>
<tr><td>Discussion of key uncertainties for this variable:</td><td>Large source, highly relevant; included in the quantification of uncertainty. Note that $\mathrm{A}_{\mathrm{HW,PL}}$ was only considered highly uncertain for the years 2006-2010, i.e., the years for which the annual average of the time interval 2001 to 2010 was used. For the remaining years 2011 to 2016, the uncertainty was considered small (and was ignored).</td></tr>
<tr><td>Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:</td><td>To obtain random draws of the area planted in the years 2006 to 2010, z = 10 realizations were drawn from a Uniform distributions with lower bound a = 0 and upper bound b = 3050:3, where b is the entire area planted between 2001 and 2010.</td></tr>
</table>

<table>
<tr><td>Description of the variable including the time period covered:</td><td>$A_{HW,LG,t}$ = area logged in hardwood plantations in year t;</td></tr>
<tr><td>Explanation for which sources or sinks the variable is used:</td><td>Carbon gains on areas planted with hardwood plantations during the Reference Period</td></tr>
<tr><td>Data unit:</td><td>Ha</td></tr>
<tr><td>Value for the variable:</td><td>
<table>
<tr><td>Year</td><td>$A_{HW,LG}$</td></tr>
<tr><td>2006</td><td>212.40</td></tr>
<tr><td>2007</td><td>278.00</td></tr>
<tr><td>2008</td><td>736.30</td></tr>
<tr><td>2009</td><td>164.60</td></tr>
<tr><td>2010</td><td>432.30</td></tr>
<tr><td>2011</td><td>132.00</td></tr>
<tr><td>2012</td><td>110.00</td></tr>
<tr><td>2013</td><td>310.00</td></tr>
<tr><td>2014</td><td>394.00</td></tr>
<tr><td>2015</td><td>375.00</td></tr>
<tr><td>2016</td><td>172.00</td></tr>
</table>
</td></tr>
<tr><td>Source of data:</td><td>Fiji Hardwood Corporation Limited</td></tr>
<tr><td>Spatial level:</td><td>Sub-National; this data represents volumes extracted from hardwood plantations within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the total land area of the Fijian islands.</td></tr>
<tr><td>Discussion of key uncertainties for this variable:</td><td>The key areas of uncertainty related to the area harvested arise from random and systematic errors as a result of data collected by the Ministry of Forestry staff in their patrols of the harvested areas. As the staff are well trained, subjected to QA/QC checks and the data is linked to Ministry revenues the data is considered of high quality and low uncertainty.</td></tr>
<tr><td>Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:</td><td>Small source, relevant; considered a small source of uncertainty in the quantification of uncertainty. Note that the data for the areas logged are census data (i.e., no sampling error).</td></tr>
</table>

Emissions Factors

Description of the variable including the forest class if applicable:	$MAIC_{HW}$ = mean annual C increment in hardwood plantations
Data unit:	tC ha^{-1} yr^{-1}
Value for the variable:	1.50
Source of data or description of the assumptions, methods and results of any underlying studies that have been used to determine the variable:	Total carbon increment, including above- and belowground was estimated from mean annual increment values provided by Fiji Hardwood Corporation Limited (FHCL) as follows: $$MAIAGB_{HW} = \overline{MAIV}_{HW} \times BCEF_{HW,I}$$ Where; $MAIAGB_{HW}$ = mean annual AGB increment in hardwood plantations; tB ha^{-1} yr^{-1}

	$\overline{MAIV}_{HW}$ = average mean annual volume increment in hardwood plantations; m^3 ha^{-1} yr^{-1}; calculated as a weighted mean estimate as 6.44 m^3 ha^{-1} yr^{-1} $BCEF_{HW,I}$ = biomass conversion and expansion factor for increment for humid tropical natural forest; growing stock level 21-40 m^3 ha^{-1}; tB (m^3)$^{-1}$ Total carbon increment, including above- and belowground was estimated by: $MAIC_{HW} = [MAIAG_{HW} \times (1 + R_{wl})] \times \eta_{CF}$ Where; $MAIC_{HW}$ = mean annual carbon increment in hardwood plantations; tB ha^{-1} yr^{-1} $MAIAG_{HW}$ = mean annual increment tB ha^{-1} yr^{-1} R_{wl} = root-to-shoot ration for tropical rainforest taken from IPCC, 2006, Vol.4, Chap. 4, Tab. 4.4; dimensionless η_{CF} = biomass to carbon conversion factor; tC (tB)$^{-1}$
Spatial level:	Sub-National; this data represents volumes extracted from softwood plantations within the Fijian islands of Viti Levu, Vanua Levu and Taveuni. The land area of these three islands makes up approximately 90% of the total land area of the Fijian islands.
Discussion of key uncertainties for this variable:	The key variables applied in the estimation of this emissions factor had the following uncertainty ranking: η_{CF} = small source, not relevant; not included in the quantification of uncertainty. R_{wl}= large source, relevant; included in the quantification of uncertainty. $MAIAG_{HW}$ = large source, highly relevant; included in the quantification of uncertainty.
Estimation of accuracy, precision, and/or confidence level, as applicable and an explanation of assumptions/methodology in the estimation:	Refer to the probability density functions of the variables [η_{CF}, R_{wl} and $MAIAG_{HW}$ which were applied in the Monte Carlo simulations.

Average annual net emissions from hardwood plantations

Average annual net emissions from hardwood plantations were estimated by:

$$\widehat{\emptyset}_{ECH} = \widehat{\emptyset}_{ECH_{em}} + \widehat{\emptyset}_{ECH_{re}} \quad (64)$$

Where;

$\widehat{\emptyset}_{ECH}$ = average annual net emission from hardwood plantations; tCO$_2$e yr^{-1}
$\widehat{\emptyset}_{ECH_{em}}$ = average annual gross emissions from hardwood plantations; tCO$_2$e yr^{-1}
$\widehat{\emptyset}_{ECH_{re}}$ = average annual gross removals from hardwood plantations; tCO$_2$e yr^{-1}

Average annual removals are added to the average annual emissions because removals have a negative sign.

Average annual net emissions from plantations

Average annual gross emission from forest plantations were estimated by:

$$\widehat{\emptyset}_{ECHS_{em}} = \widehat{\emptyset}_{ECH_{em}} + \widehat{\emptyset}_{ECS_{em}} \qquad (65)$$

Where;

$\widehat{\emptyset}_{ECHS_{em}}$ = average annual gross emissions from forest plantations; $tCO_2e\ yr^{-1}$
$\widehat{\emptyset}_{ECH_{em}}$ = average annual gross emissions from hardwood plantations; $tCO_2e\ yr^{-1}$
$\widehat{\emptyset}_{ECS_{em}}$ = average annual gross emissions from softwood plantations; $tCO_2e\ yr^{-1}$

Average annual gross removals from forest plantations were estimated by:

$$\widehat{\emptyset}_{ECHS_{re}} = \widehat{\emptyset}_{ECH_{re}} + \widehat{\emptyset}_{ECS_{re}} \qquad (66)$$

Where;

$\widehat{\emptyset}_{ECHS_{re}}$ = average annual gross removals from forest plantations; $tCO_2e\ yr^{-1}$
$\widehat{\emptyset}_{ECH_{em}}$ = average annual gross removals from hardwood plantations; $tCO_2e\ yr^{-1}$
$\widehat{\emptyset}_{ECS_{em}}$ = average annual gross removals from softwood plantations; $tCO_2e\ yr^{-1}$

Average annual net emissions from forest plantations were estimated by:

$$\widehat{\emptyset}_{ECHS} = \widehat{\emptyset}_{ECH} + \widehat{\emptyset}_{ECS} \qquad (67)$$

Where;
$\widehat{\emptyset}_{ECHS}$ = average annual net emissions from forest plantations; $tCO_2e\ yr^{-1}$
$\widehat{\emptyset}_{ECH}$ = average annual net emissions from hardwood plantations; $tCO_2e\ yr^{-1}$
$\widehat{\emptyset}_{ECS}$ = average annual net emissions from softwood plantations; $tCO_2e\ yr^{-1}$

The net emissions from Forest Plantations were estimated to be:

Emissions/Removals from Forest Plantations	**Estimate** ($tCO_2e\ yr^{-1}$)	**Lower Confidence Interval** ($tCO_2e\ yr^{-1}$)	**Upper Confidence Interval** ($tCO_2e\ yr^{-1}$)
Emissions from Plantations	596,195	513,925	701,282
Removals from Plantations	-1,639,123	-2,034,655	-1,279,843
Net Total	**-1,042,928**	**-1,445,834**	**-656,927**

ANNEX 8-2: GENERATION OF ACTIVITY DATA (2000-2006)

Summary

A description of the workflow to produce spatially complete ('Wall to Wall') and spatially explicit (IPCC Approach 3) activity data is presented in this Annex. Whilst all forest cover transitions were mapped for the entire annual time series only activity data related to (a) annual areas of deforestation (forest loss) in natural forest; and (b) annual areas of reforestation (forest gain) in natural forest were extracted for use in the FRL estimation. Activity data related to forest degradation and enhancement of carbon stocks (plantations) were sourced from logging and replanting self-reported data. In the future Fiji hope to augment this self reported data within logged areas with the information collected from this dense time series.

The Products cover the islands of Viti Levu, Vanua Levu and Taveuni for a period of at least 10 years between 2006 - 2016. A multi-temporal approach using digital classification was used to generate the activity data. A multi-temporal approach using digital classification was used to generate the underlying map products upon which an accuracy assessment was conducted following the stratified random sampling methods and applying estimators provided in Oloffson et al 2014. The resulting error adjusted areas which were used as activity data inputs to the Monte Carlo simulation to generate estimates of emission and removals related to REDD+ activities of Deforestation and Enhancement of Carbon Stocks (A/R) with confidence intervals.

Approach: Digital multi-temporal classification

The multi-temporal approach adopted in Fiji was developed by CSIRO's Remote Sensing Image Integration Group (the 'CSIRO approach'). The CSIRO approach underlies Australia's national forest monitoring system for land-based carbon accounting and provides maps of forest cover and forest cover change. The approach has been implemented (with modifications) in Indonesia as INCAS (Indonesia National Carbon Accounting System Remote Sensing Program and recently in Kenya's SLEEK program (System for Land-based Emission Estimation in Kenya), with adaptation to Kenya's national requirements and taking advantage of technological developments. The CSIRO approach was adopted in Fiji because of its operational status, demonstration of successful application in large mountainous areas where cloud cover is frequent (e.g. Indonesia) and the availability of expertise to support training and operational processing.

Features of the approach are:

- Assembly of multi-year data series (e.g. annual time series)
- Classification of each image date using supervised classification methods
- Multi-temporal processing of the full time series of classifications in a joint temporal model; this has the effect of inferring classification for areas of missing data. The result, given appropriate inputs to the model, is to improve the accuracy and particularly to reduce error on mapped change. Figure 1 presents an example of image outputs from the approach.

The method overcomes a major limitation in mapping change (deforestation, reforestation) from 2 or more dates of imagery when any 'hard' classification scheme (manual or digital) is applied. When differencing 'hard classifications" 'errors add up'; that is, errors of omission or commission at any date are likely to introduce false areas of change, usually in two periods. Since areas of change are usually a small proportion of the forest area, the result is (typically) large error rates on derived change products.

The time series applied in this approach results in processing the full times series jointly; uncertainty is recognised and resolved using inferences from the sequence of classification probabilities. As a simple example, an agricultural land pixel may appear spectrally similar to forest at one date because of its particular crop at that time, and be classified (with a high probability but incorrectly) as forest on that date. If it is (correctly) classified as non-forest in the surrounding years, we would infer from our knowledge of landcover transitions that the forest label is incorrect. The joint time series processing uses mathematical models to resolve time series forest probabilities in this way. Figures 1 illustrates the process. For a formal description see Caccetta et al (2012).

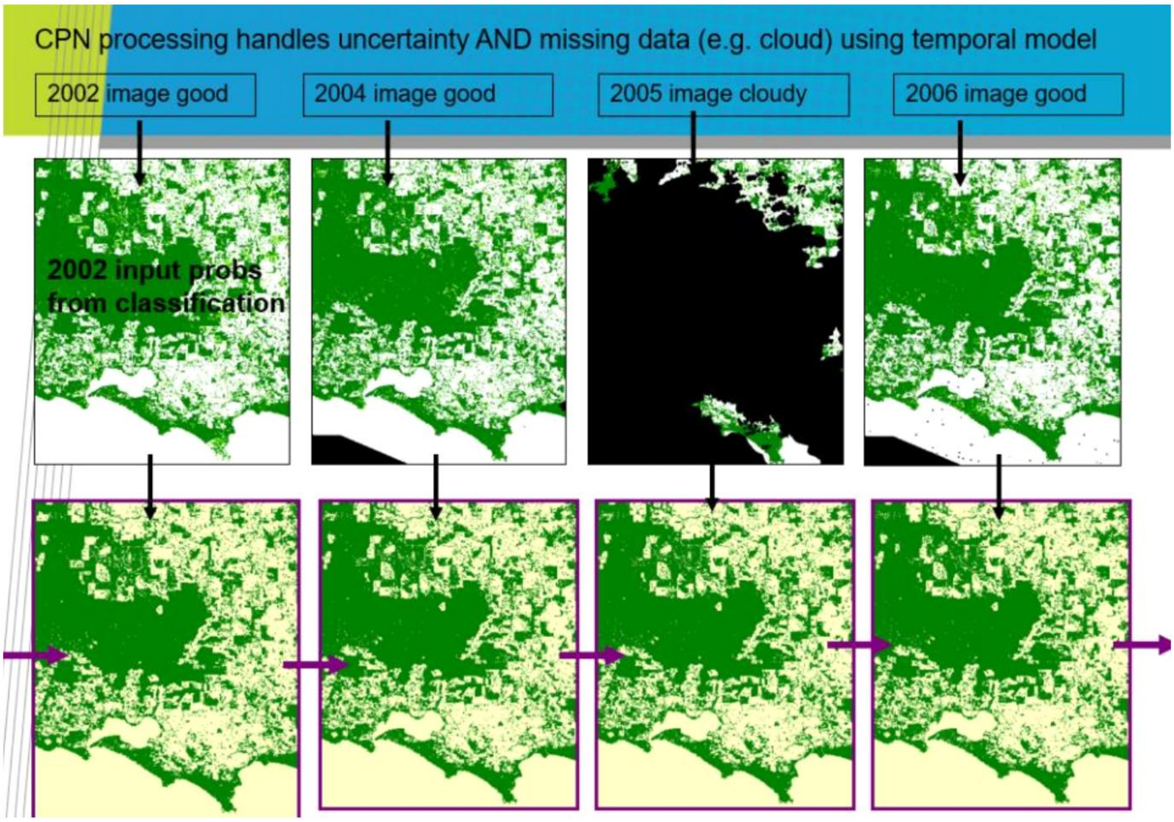


Figure 1. Example of input and output to multi-temporal forest classification. The top row shows the individual year classifications from 4 time periods (Forest in dark green; light green colours in top row indicate uncertainty in forest classifications). The 2005 map has large areas of missing data due to cloud. The bottom row shows the output forest maps after multi-temporal processing. Source: CSIRO.

A further advantage of the approach is that it is adaptable to different sources of image data. For ongoing monitoring using Landsat, the approach can be immediately applied to produce updates.

Figure 2 below shows a high-level flow chart of the steps in the approach. QA checks are conducted at all stages to ensure data and results are as accurate as possible. Failure of QA triggers a repeat of the processing step. The final stage ‘Attribution’ is conducted in GIS to attach labels or to remove particular errors which cannot be resolved by spectral signatures.

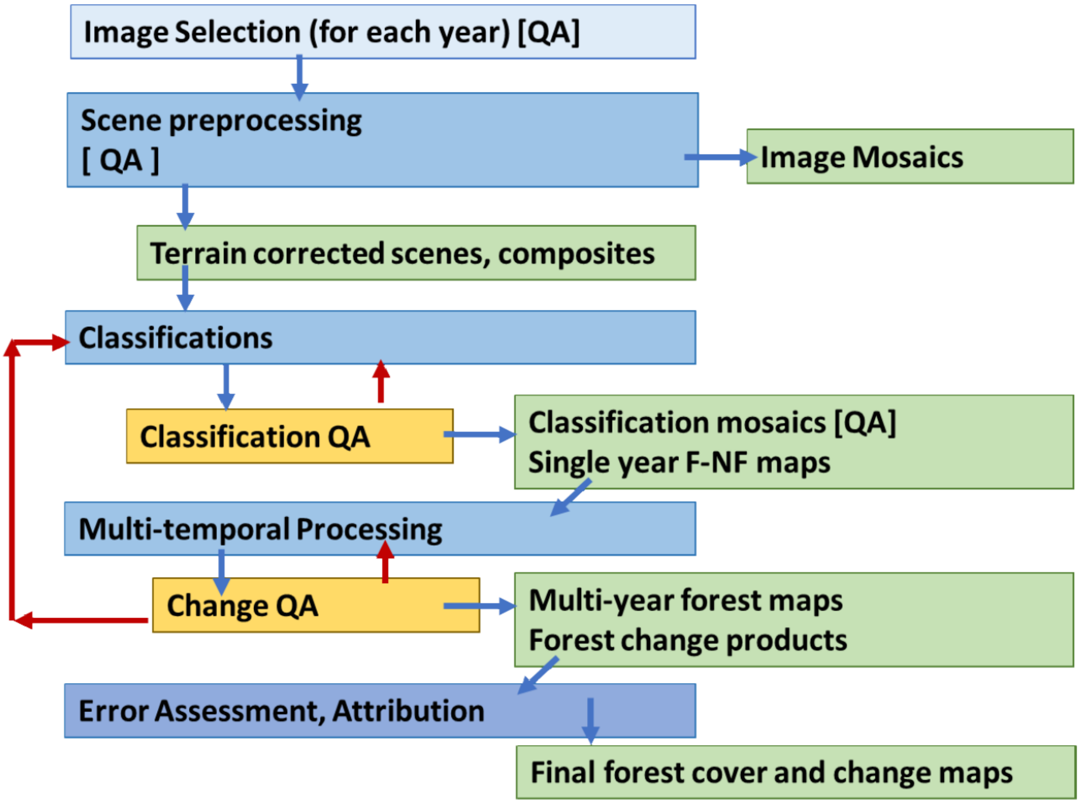


Figure2: High level schematic diagram of the multitemporal classification workflow. Outputs are shown in green boxes. Figure adapted from SLEEK (Kenya) LCC processing manual. The red arrows indicate iterative refinement processes following assessment of map and change products.

Image coverage and sources

Historic imagery of the Fiji Islands is limited. Over the reference period, the data collected from the US Landsat satellite series supplies the only consistent source of data. The Landsat satellites collect data from repeat orbits every 16 days: Landsat 7 imagery was collected over the entire period; Landsat 8 commenced routine acquisition in early 2013. Both systems collect similar optical information (visible and infrared) at 30m pixel resolution. Landsat 8 records an additional band in the short blue wavelengths, and its sensors have improved dynamic range. Landsat images are collected on a ‘path/row’ grid and identified by the path/row numbers and date of acquisition. Figure 3 shows the path/row coverage of the Fiji islands which are included in the forest reference data.

The archive of Landsat imagery for the world has been made freely available for download by the USGS and can be accessed via the GLOVIS or Earth Explorer web portals. The imagery is processed to a high standard by USGS – its ‘Level 1’ imagery is rectified to UTM coordinates (at 30m resolution). In recent years, USGS has made available a ‘Level 2’ product which is calibrated to reflectance. The Level 2 data also includes an automatically generated cloud mask, and a data quality band. The calibrated image data is stored as 16-bit integers, values equal to 100 times the calculated reflectance (%). This Level 2 data has been downloaded for Fiji for both Landsat 7 and Landsat 8.

Cloud is a major limitation for mapping land cover from imagery in Fiji with almost all images covering Fiji having some cloud, and many images are completely cloud covered. The chances of finding cloud free imagery increase with the number of images available.

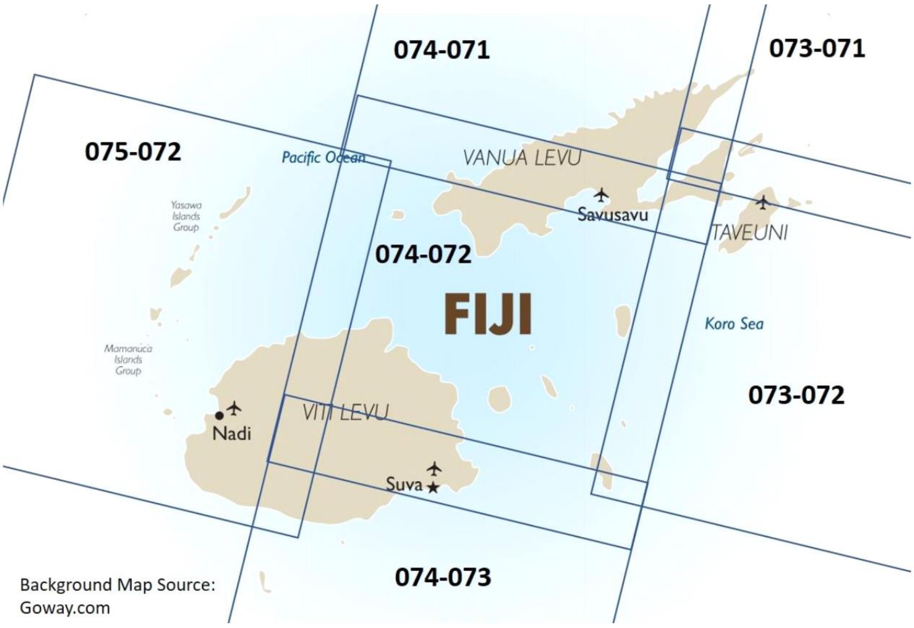


Figure 3: Landsat Path/Row extents overlaid on Fiji reference area. Five Landsat scenes cover (almost) the complete area – a sixth (073/071) may be required depending on scene boundaries at chosen dates

Since May 2013, the complete Landsat 8 acquisitions have been archived (22 or 23 per year). Prior to this, only Landsat 7 imagery is available, and due to limitations of onboard storage, less images were recorded. Landsat 7 imagery in this period is also affected by the 'SLC-off' problem: this results in regular wedges of missing data on both sides of the images. Nonetheless adequate imagery was found to exist in nearly every year to run the multi-temporal processing method as the model can accommodate missing data for some years in succession.

Image selection and download

Image selection (and QA) is the first step in the process. The aim of image selection is to acquire cloud-free images over the land areas for all years in the sequence. Multiple images with 'complementary' cloud-free areas can be used to create composites with minimal cloud. For Landsat 7, the SLC-off problem means that even cloud free images will have missing data 'wedges'. At least two LS-7 images are required to achieve cloud-free coverage. In practice, over Fiji, some cloud-affected or missing data exists in each year even with selection of multiple images.

Images were selected and downloaded for the years 2005-2017. The full list of the images used are provided in Table 1- Viti Levu & Table 2 – Vanua Levu/Taveuni.

The process used to select images involved viewing all the archived images for each path/row for each year (using Earth Explorer), selection and download of images with minimal cloud, or those with large cloud-free areas. Where one good image was found, the priority was to find others with complementary cloud free areas. The results of the search for each year are recorded in documents as tables. 'Quicklook' images were downloaded for QA and review. The tables and 'Quicklook' images were stored in a file as a record of the image selection process. The filename of this record file is (e.g.) ***LandsatData_Search_07572_2008.docx;*** indicating the path/row, year(2008). QA includes a check that the selected images have been downloaded and archived.

Terrain Illumination Correction, cloud masking and compositing

Terrain Illumination Correction

The signal received by the satellite sensor is affected by slope and aspect relative to the incoming sunlight – forest on the sunlit slope will appear brighter than the same forest cover on a slope facing away from the sun. It is essential to correct for these terrain effects before attempting to apply a numerical classification to imagery from mountainous areas. Terrain correction uses a digital elevation model (DEM) to calculate slopes for each pixel, and information from the satellite image header files to calculate the solar position and sun angles. The CSIRO terrain illumination software was used to apply the terrain corrections (Wu et al., 2004). The SRTM 30m DEM was downloaded and mosaics were made for Fiji. An example is shown in Figure 4 below. As the solar angle is different for every image, terrain correction must be run for each image. Testing was conducted and a semi-automated methods developed for applying the terrain corrections.

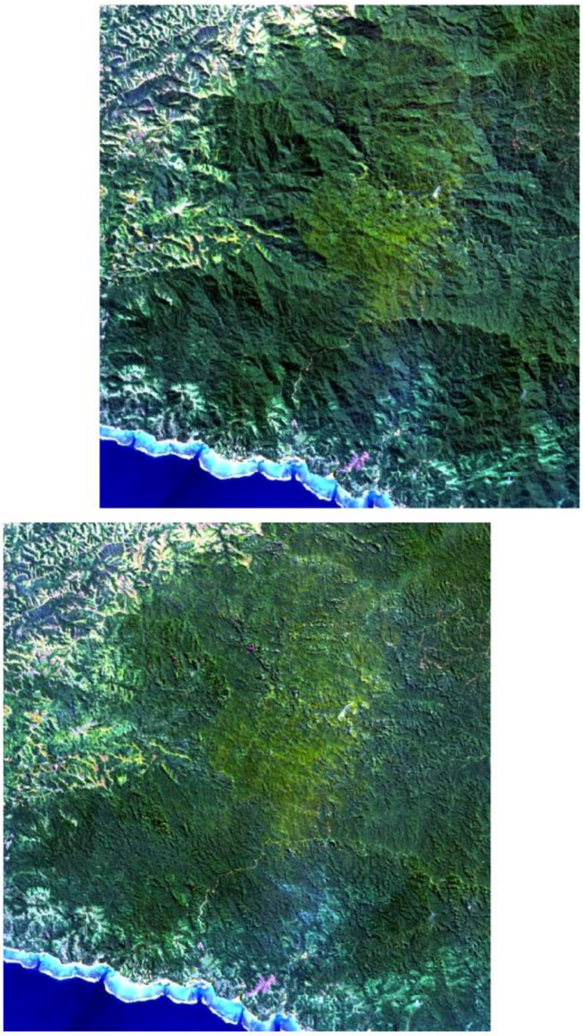


Figure 4: Left: Landsat image (detail) of southern Viti Levu from 6 July 2016; note the shadowing effects caused by the mountainous terrain. Right: The same image after terrain illumination correction

Cloud Masking

Cloud and cloud shadow must be removed before any digital classification of landcover. Masked areas are replaced with 'null values'. After cloud masking, two or more images may be composited to maximise the area of cloud-free imagery for visual display or classification.

In producing its Level 2 imagery, USGS also produces and supplies a 'cloud mask' band which is automatically generated to indicate areas of cloud. While in many cases the cloud mask is quite accurate, it is rarely complete in masking all cloud, haze and cloud shadow. As a result, some human intervention and QA processes are required to correct the cloud and shadow mask and to produce composite images free of cloud.

Image Composites

If cloud is adequately masked, compositing of images can be done automatically, but this is not ideal for classification purposes. It is preferred to select a 'date window' and a primary (mostly clear image) so that seasonal variation in the composite is not too great. CSIRO has developed efficient approaches which worked well when guided by Fijian knowledge of ground cover and seasonal changes. As a result of the cloud masking and compositing processes, composite images for each scene for each year with minimal missing data were generated. An example of this is shown in Figure 5 and Figure 6.

Figure 5: Cloud is a major problem over Vanua Levu and Taveuni. The south of Vanua Levu and all of Taveuni have very frequent cloud. A number of 'best available' images were selected each year and mosaics were made to maximise the cloud-free observations. This image is the 2009 Mosaic of Vanua Levu and Taveuni. Bands 321 in RGB. Missing data due to cloud and LS7 'strips; is shown in grey colour.

Figure 6: 2016 Landsat 8 mosaic. As above.

Further manual checking and digitizing of all mosaics was required to remove cloud, haze and bad data. The effect of the cloud/missing gaps on the products needs to be understood. The CPN technology will 'fill' the cloud gaps in the products, using inference from the 'neighbouring' years' classifications. In effect 'error' or uncertainty in multiple years is effectively removed or reduced. Where cloud is frequent, there may be gaps of two or more years with no observations. This leads to some consequences.

- First, the timing of detected changes is decided by the CPN rules and data, but may be uncertain within the period. The extent and change data for the first and last dates/periods is considered unreliable as there is only one neighbouring *image* – that is why the years 2005 and 2017 were added to the timeseries to get 2006-2016 maps
- Second, the result is more affected by any errors in the sparse dates
- Third, there are some areas where hazy data has been retained in some years which may affect accuracy. The south of Taveuni is one such area.

Classification and multi-temporal classification

The classification method applied was a supervised non-parametric method known as 'random forests' (Brieman, 2001). The approach is widely used and described in scientific literature. A version of random forests classifier which stores the label and a measure of classification confidence for each pixel was applied. The approach requires training areas to be selected by the operators as vector polygons on the imagery. Ground knowledge of different land covers greatly assisted in the selection of suitable training areas and the assessment of results. After classification, results were carefully assessed in a QA process again drawing on local ground knowledge. The process was re-run where necessary with targeted additional training areas following QA. Testing was conducted to establish whether the classifier is best run on composite images or on individual images.

The multitemporal classification approach was run once all the individual year classifications were complete for the designated area. The output products from the classification is complete forest-nonforest maps for each year as raster maps, and raster change maps for each year interval.

Timing of detected changes

The mosaics comprise of images within the calendar year. The change layers are nominally labelled (e.g. Forest Loss 2005-06). By reason of mixed dates in each mosaic, the annual gap is somewhat uncertain and may be more or less than 12 months in different places. The 'missing data' problem described above adds to this uncertainty in timing. Further, clearing and revegetation are continuous processes – some parts of the change area may be detected over two or more years. The changes in neighbouring periods may need to be viewed or added to summarise particular periods or change events. This has implications for accuracy assessment of change.

National data and information

Local knowledge, maps and interpretation along with Google Earth high resolution imagery were important for training classifiers and conducting iterative improvements. Existing GIS vector data of forest or land cover historic forest maps, and landcover maps of plantation and mangrove areas and spatial data on logging or reforestation areas were used.

Fiji's main forest cover is wet/humid tropical forest. The definition adopted for the FRL is the same as that reported to the FAO; 10% canopy cover, min 0.5ha and min 5m height. Initial work conducted to generate activity data from remote sensing images relied solely on manual digitization of Landsat images by multiple interpreters. This process was found to be quite inaccurate and inconsistencies between interpreters lead to high levels of uncertainty in the forest cover and forest cover change estimates. A more reliable and consistent method was needed to generate change data on a regular basis. Semi-automated methods were adopted to achieve a higher quality data set and consistent methodology. The algorithms used in the semi-automated process were trained using google earth samples and local knowledge of forest and non-forest cover. One limitation of this training process was the limited areas of forest with canopy cover of 10% in Fiji. It is probable that the algorithm is effectively detecting change at 20%. At this stage no quantitative work has been conducted to determine if the algorithm is distinguishing 10% canopy cover from 20-30% canopy cover. This will be considered in future step wise continuous improvements. Nonetheless this new methodology does enable consistency in detection of forest/nonforest and therefore the results (after CPN) are temporally consistent tuned to the lower cover limit of the training samples.

The Ministry is working on step-wise improvements to its data inputs to the NFMS including enhancing the capabilities of reporting open and closed forests. This includes improvements to the NFI sampling frame and enhanced sophistication of its land cover classification algorithms. These improvements will be made in a phased approach in line with the NFMS improvement plan and budget cycles.

Post-Processing

Spatial Filtering

Spatial filtering was applied to remove small areas of change for two main reasons.

Fiji's forest definition implies a minimum mapping unit of 0.5 ha for forest and change. A single Landsat pixel in the Fiji mosaics is 30m by 30m (0.9 ha). Five pixels makes an area of 0.45ha.

The classified images contain numerous labelled areas smaller than this. Many of these classified pixels are 'mixed' or 'edge' pixels along rivers or roads. The change images similarly contain multiple small pixels, even after the CPN has been applied to 'good' classification maps. Many of these small change areas are 'errors' or noise which should be removed from the data – else both clearing and reforestation areas will be exaggerated.

A filtering program has been written by CSIRO and applied to the data; this program has been designed to remove small and error areas, but uses the multi-temporal data to retain small areas of change if they expand when considering the next year's change.

The program is flexible in a number of parameters. In this version of the products, the following decisions have been applied to the change data:

- Minimum area to be retained**: 5 pixels** (0.45ha)
- Number of neighbouring years to check: **1** (i.e. +1 and -1 yrs; if a group of 3 pixels in 2006-07 adjoins a group of 2 pixels in 2007-08, both small areas will be retained)
- Gap spacing allowed: **0** [i.e. Where a group of 3 pixels and 2 pixels (subject to above temporal check) are separated by a gap of 1 pixel, they are considered separate – both will be deleted)
- Note that 2 pixels which are connected only at a corner are considered 'joined' for the purposes of the pixel count – so that narrow continuous 'diagonal' change features will be retained.

The program has been supplied by CSIRO to the Fiji team as executable code.

Attribution

Attribution describes GIS processes which are applied to the change and extent layers after they are produced. The archived data for Attribution consists of a set of GIS vectors and rules applied to these vectors. This set of data becomes a 'library' which can be improved over time and applied to new images or products as appropriate.

Attribution is applied for various reasons.

The first is to label extent and change data within specified areas differently for accounting purposes. Vector boundaries and rules need to be defined and recorded; these rules and vectors may apply to a particular time period but are generally physically based.

> *e.g. mangrove areas are excluded from forests for the purpose of ER program.*
> *A 'mangrove boundary' vector exists for the entire country.*
> *a rule may be applied such as 'forest and change within this area will be labelled 'mangrove'*

The second purpose of attribution is to relabel 'transient events' which may be excluded or down weighted in the accounting. For the purpose, event vectors must be created. The current example in Fiji is cyclone damage to forest, which may affect the label for one or more years within a visible area, and result in defined areas of change.

> An example might be
> *Within vector 'affected by Cyclone Winston in 2016'; for 2016 & 2017 time periods, relabel forest extent to 2015 and ignore forest loss for accounting purposes. In previous years, and from 2018 on, forest loss will be treated as clearing.*

The third reason for attribution is persistent error in classification due to spectral overlap and physical ground cover or bad data.

> The relevant bad data here are mostly caused by 'errors' in the terrain correction; (1) due to extremely steep varying terrain (peaks, ridgetops) where slight misregistration causes small bright and dark faults; and (2) areas where the SRTM DEM was missing or missing and

replaced with coarser 90m data. These areas are small and in the same locations year after year – the recommended approach is to build a GIS library of such areas and relabel to the know cover (e.g. in central Taveuni, these ridge effects are forest).

Spectral overlap causing false change can occur in special lands – e.g. grassy wetlands where water and vegetation changes give false forest and change signals.

The change data sets for deforestation and reforestation in Natural Forest areas were generated by masking out areas of mangroves, softwood and hardwood plantations, and areas subject to harvest in Natural Forest. The remaining area was then stratified into Upland and Lowland Forest Classes using the digital elevation model to distinguish change above (Upland) and below (Lowland) 600m a.s.l.[6]

Results

Below are some interesting results from the classification process.

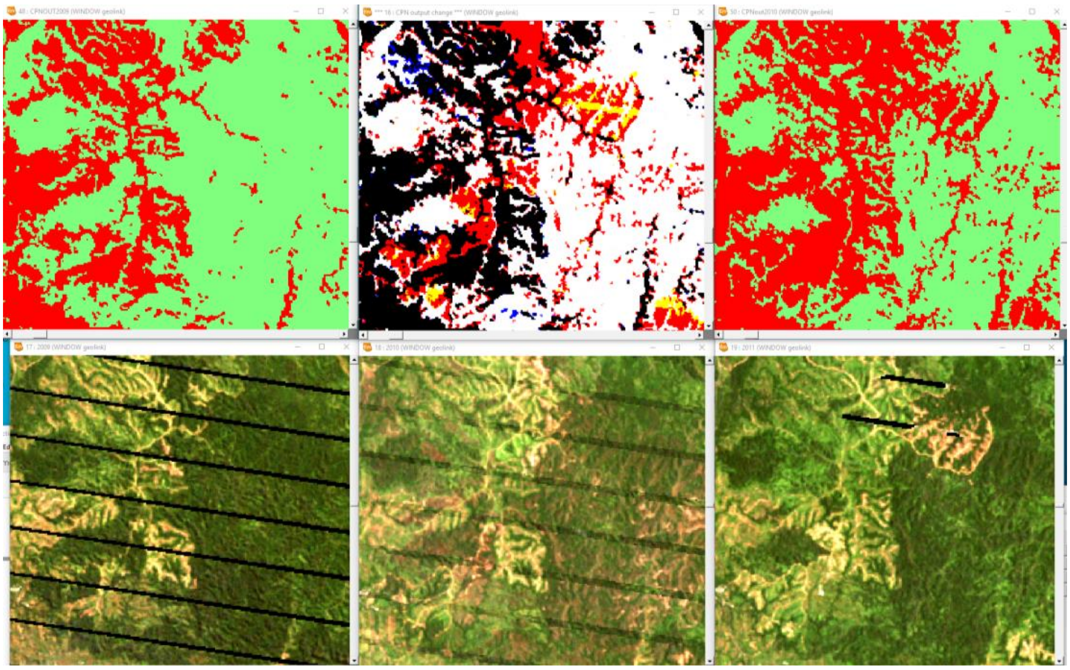


Figure 6: Illustration of CPN output and derived forest changes for three successive years in Viti Levu. *Bottom:* images from 2009, 2010, 2011. Top Left and Right: CPN Forest Non-forest maps for the same area from 2009 and 2011 respectively (Green:Forest, Red: NonForest). *Centre top:* 3-year change map: [Colour Key: White=Forest in all three years; Black=NonF; other colours represent change: Red=forest loss 2009-10, Yellow=forest loss 2010-11, Blue=forest gain 2010-11]

---

[6] Upland and Lowland forest were found to have a significant difference in carbon stocks (See Annex 8.2). A decision to investigate these strata was made based on findings by Mueller-Dombois & Fosberg [1998], who identified significant changes in structural and floristic characteristics in forests in Fiji below and above approximately 600 m a.s.l. Above 600 m a.s.l. Fijian forests tend to show characteristics typical for mountain forests systems, whereas forest located below 600 m a.s.l. show characteristics of either tropical rain forests or tropical moist deciduous forests.

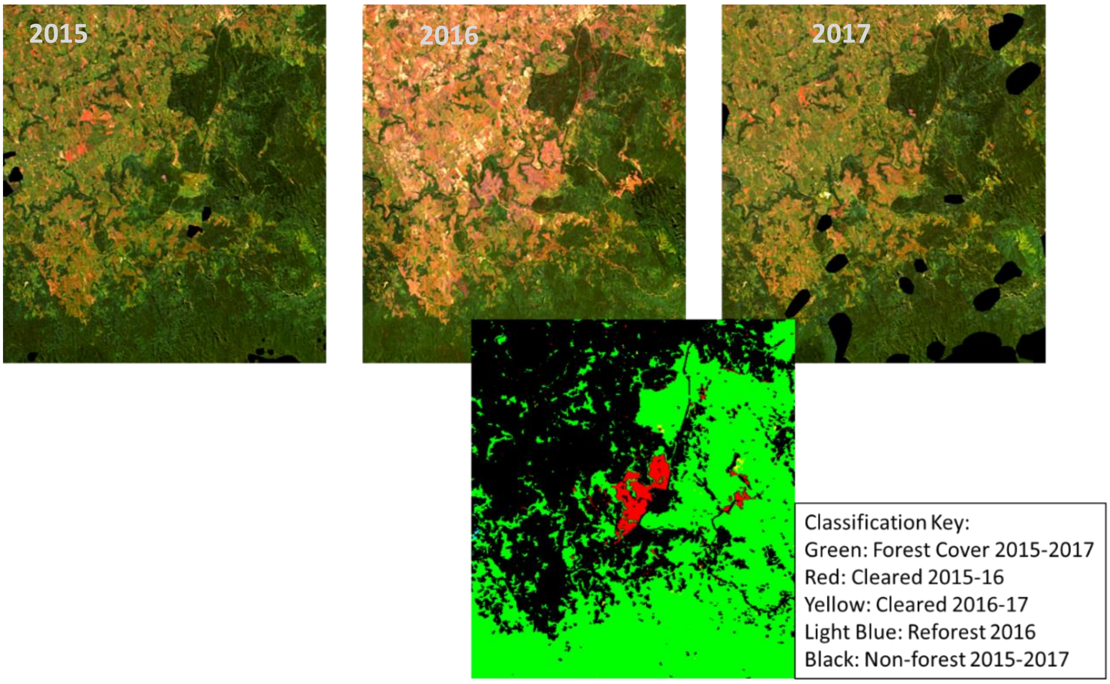


Figure 7: Forest extent and change example from Vanua Levu. 3 dates of image mosaics and forest extent and change product. Area shown is 13.5km by 15km. Top Left Coordinate 719000E, 8173000N (SUTM60). Post CPN pre-s patial filter data shown.

The predicted annual area of deforestation and reforestation is presented in the two tables below.

Predicted Deforestation annual timeseries data

Deforestation	Lowland	Upland	Total
			[ha]
2005 - 2006	4,873	594	5,467
2006 – 2007	5,013	2,265	7,278
2007 – 2008	2,745	2,010	4,754
2008 – 2009	4,721	1,102	5,823
2009 – 2010	9,351	2,163	11,514
2010 – 2011	8,580	1,874	10,454
2011 – 2012	5,270	2,680	7,951
2012 – 2013	13,240	1,982	15,222
2013 – 2014	13,224	1,388	14,613
2014 – 2015	8,491	1,425	9,916
2015 – 2016	10,526	4,954	15,480
2016 – 2017	6,905	2,194	9,099

Predicted Reforestation annual timeseries data

A/R	Lowland	Upland	Total
			[ha]

2005 - 2006	7,120	1,573	8,693
2006 - 2007	8,280	3,697	11,976
2007 - 2008	10,277	3,419	13,695
2008 - 2009	7,719	1,018	8,737
2009 - 2010	3,678	576	4,254
2010 - 2011	2,353	624	2,977
2011 - 2012	5,201	879	6,080
2012 - 2013	3,855	372	4,227
2013 - 2014	6,612	568	7,180
2014 - 2015	7,130	1,139	8,270
2015 - 2016	5,382	680	6,062
2016 - 2017	2,605	258	2,863

Accuracy Assessment

An accuracy assessment was conducted following the stratified random sampling methods outlined in Olofsson et al 2014 for the annual LULC change maps used to derive Fiji's FRLs. The stratification of the land cover and change classes were: lowland and upland native forests; lowland and upland cleared land; lowland and upland forest to cleared, lowland and upland cleared to forest.

The framework of assessment included development of a sampling strategy to acquire the required validation data, and the production of an accuracy assessment. The accuracy assessment was conducted fully independently of the generation of the LULC change maps being truthed.

Sampling Frame

The sampling frame was extended by considering each change map separately as annual LULC change was of interest. The change maps were synthesised from the starting forest LULC map and the forest-to-non-forest (F-C) and non-forest-to forest (C-F) changes maps for 2006-2007 through to 2015-2016.

Sampling strategy

The general sampling strategy follows Olofsson et al. (2014) who recommend that stratified simple random sampling be applied to the different land change classes. In this instance the mapped classes served as strata. The advantage of stratified random sampling is that it enables repeated rounds of sampling without loss of validity in the conclusions drawn from the augmented samples, thereby enabling accuracy estimation of less frequent change events, so long as a sub-sample is drawn from each stratum value through simple random sampling (without replacement). Olofsson et al. (2014) also recommend to *"use sample size and optimal allocation planning calculations as a guide to decisions on total sample size and sample allocation.".* This approach allowed a first round of sampling to guide future sampling through conducting a sample size calculation. A second (or further) round(s) of sampling and planning was then applied to achieve desired accuracy targets. Predicted transitions between forest and non-forest were rare. Clearly, a proportional allocation would not generate a sample size sufficient to represent accurately the user's and producer's accuracy for these minority strata values. Hence, oversampling was applied (Oloffson et al. 2014).

Response design

Due to a lack of cloud free high resolution imagery covering Fiji over the historical time series, Landsat data was used to truth the generated sample of data. A logical TRUE value was then assigned to those sample points where the truthed and the predicted LULC change were equal, and FALSE elsewhere. The number of observations within the seven mapped classes are shown below.

Code	111	112	171	172	711	712	777
No. Observations	248	244	233	254	253	236	480

```
## Class codes
# 111 = Forest (1) remaining Forest (1); lowland (1)
# 112 = Forest (1) remaining Forest (1); upland (2)
# 171 = Forest (1) converted to Non-Forest (7); lowland (1)
# 172 = Forest (1) converted to Non-Forest (7); upland (2)
# 711 = Non-Forest (7) converted to Forest (1); lowland (1)
# 712 = Non-Forest (7) converted to Forest (1); upland (2)
# 777 = Non-Forest (7) remaining Non-Forest (7); low- and upland (7)
```

Accuracy calculations

The accuracy calculations of Olofsson et al. (2014) enables area and other quantities derived from the LULC change maps to be corrected for errors of omission and commission. This error correction is designed to produce unbiased estimates of the LULC changes, and some measure of uncertainty associated with each of the estimates. Both the accuracy and sample size planning calculations are derived from the error matrix, as constructed from the remotely sensed LULC change predictions and the LULC change classes truthed observations.

From the sample data an error (or confusion) matrix was obtained. The error matrix is shown below. The sample counts in mapped classes are given in rows. Sample counts in the “true” (reference) classes are given in columns.

Code	111	112	171	172	711	712	777
111	218	0	14	0	8	0	8
112	0	232	0	7	0	3	2
171	68	0	137	0	6	0	22
172	0	77	0	141	0	8	28
711	81	0	7	0	144	0	21
712	0	88	0	9	0	121	18
777	13	21	12	14	7	7	406

Sample counts were converted to area proportions. In order to do that, the total areas mapped in the seven classes were used, i.e., the total area (in hectares) mapped over the entire time–series.

Code	111	112	171	172	711	712	777
Predicted Area (ha)	670,300	229,098	54,406	9,834	33,742	3,489	502,344

The confusion (error) matrix showing area proportions is provided below.

Code	111	112	171	172	711	712	777
111	0.3920	0.0000	0.0252	0.0000	0.0144	0.0000	0.0144
112	0.0000	0.1449	0.0000	0.0044	0.0000	0.0019	0.0012
171	0.0106	0.0000	0.0213	0.0000	0.0009	0.0000	0.0034
172	0.0000	0.0020	0.0000	0.0036	0.0000	0.0002	0.0007
711	0.0072	0.0000	0.0006	0.0000	0.0128	0.0000	0.0019
712	0.0000	0.0009	0.0000	0.0001	0.0000	0.0012	0.0002
777	0.0091	0.0146	0.0084	0.0097	0.0049	0.0049	0.2827

Estimators provided in Olofsson et al. (2014) were used to derive bias-adjusted area estimates of the seven classes. The total area in hectares of mapped stable and change classes (area) is provided in the Table below. The column titled ‘Adjusted Area’ gives the bias-adjusted estimated areas (in hectares; rounded to the nearest integer). Confidence bounds were obtained from the non-parametric bootstrap (Q(:05)– and Q(:95)– percentiles):

Code	Predicted Area	Adjusted Area	Lower CI	Upper CI

	(ha)	(ha)	Adjusted Area (ha)	Adjusted Area (ha)
111	670,300	629,501	605,576	652,802
112	229,098	244,090	234,927	253,562
171	54,406	83,321	66,371	101,243
172	9,834	26,816	19,520	34,663
711	33,742	49,555	36,941	63,471
712	3,489	12,241	7,210	17,774
777	502,344	457,687	439,254	476,618

From these data the average annual area of deforestation (in hectares per year) in lowand upland forest was estimated. To obtain the annual average, estimates were divided by the length of the time interval from mid 2006 to mid 2016, i.e., 10 years. Upper and lower 90% confidence intervals were derived from the Q(:05)– and Q(:95)–percentiles of a nonparametric bootstrap distribution.

The area estimates provided below were used as input for activity data (AD) to estimate emissions from deforestation.

Code	Stratum	Area Loss (ha/yr)	Lower CI Area Loss (ha/yr)	Upper CI Area Loss (ha/yr)
171	Lowland	8,332	5,531	8,437
172	Upland	2,681	1,627	2,889

The area estimates provided below were used as input for activity data (AD) to estimate emissions from afforestation/reforestation. For the estimation of removals from afforestation / reforestation (AR), there is no differentiation between low-and upland Natural Forest.

Code	Area Gain (ha/yr)	Lower CI Area Gain (ha/yr)	Upper CI Area Gain (ha/yr)
711/712	6,180	4,415	8,124

User, Producer and Overall Accuracy

Users, producers and overall accuracy of the map products are presented in the following tables.

Code	Users Accuracy	Users Accuracy Standard Error	Users Accuracy Lower CI	Users Accuracy Upper CI
111	0.879	0.021	0.838	0.920
112	0.951	0.014	0.924	0.978
171	0.588	0.032	0.525	0.651
172	0.555	0.031	0.494	0.616
711	0.569	0.031	0.508	0.630
712	0.513	0.033	0.449	0.577
777	0.846	0.016	0.813	0.878

Code	Producers Accuracy	Producers Accuracy Standard Error	Producers Accuracy Lower CI	Producers Accuracy Upper CI
111	0.936	0.022	0.892	0.98
112	0.892	0.012	0.869	0.916
171	0.384	0.02	0.345	0.423
172	0.204	0.025	0.155	0.252
711	0.388	0.019	0.35	0.425
712	0.146	0.028	0.092	0.201
777	0.928	0.018	0.892	0.964

Overall Accuracy	Overall Accuracy Standard Error	Overall Accuracy Lower CI	Overall Accuracy Upper CI
0.858	0.011	0.837	0.88

List of Landsat Images Used

Table 4: List of Landsat Images

PATH	ROW	DATE	USGS NAME of Image
075	072	2005-05-29	LE07_L1TP_075072_20050529_20170114_01_T1
075	072	2005-02-06	LE07_L1TP_075072_20050206_20170116_01_T1
075	072	2005-08-01	LE07_L1TP_075072_20050801_20170113_01_T1
075	072	2005-07-16	LE07_L1TP_075072_20050716_20170115_01_T1
075	072	2005-06-14	LE07_L1TP_075072_20050614_20170114_01_T1
074	072	2005-12-16	LE07_L1TP_074072_20051216_20170112_01_T1
074	073	2005-12-16	LE07_L1TP_074073_20051216_20170112_01_T1
074	072	2005-10-13	LE07_L1TP_074072_20051013_20170113_01_T1
074	073	2005-10-13	LE07_L1TP_074073_20051013_20170113_01_T1
074	072	2005-07-09	LE07_L1TP_074072_20050709_20170115_01_T1
074	073	2005-07-09	LE07_L1TP_074073_20050709_20170115_01_T1
074	071	2005-01-14	LE07_L1TP_074071_20050114_20170117_01_T1
074	071	2005-02-15	LE07_L1TP_074071_20050215_20170116_01_T1
074	071	2005-07-09	LE07_L1TP_074071_20050709_20170113_01_T1
074	071	2005-10-13	LE07_L1TP_074071_20051013_20170113_01_T1
73	71	2005-01-23	LE07_L1TP_073071_20050123_ddddddd_nn_Tn
73	72	2005-01-23	LE07_L1TP_073072_20050123_ddddddd_nn_Tn
73	72	2005-09-20	LE07_L1TP_073072_20050920_ddddddd_nn_Tn
73	72	2005-10-22	LE07_L1TP_073072_20051022_ddddddd_nn_Tn
74	71	2005-01-14	LE07_L1TP_074071_20050114_ddddddd_nn_Tn
74	71	2005-02-15	LE07_L1TP_074071_20050215_ddddddd_nn_Tn
74	71	2005-07-09	LE07_L1TP_074071_20050709_ddddddd_nn_Tn
74	71	2005-10-13	LE07_L1TP_074071_20051013_ddddddd_nn_Tn
74	72	2005-07-09	LE07_L1TP_074072_20050709_ddddddd_nn_Tn
74	72	2005-10-13	LE07_L1TP_074072_20051013_ddddddd_nn_Tn
74	72	2005-12-16	LE07_L1TP_074072_20051216_ddddddd_nn_Tn
075	072	2006-03-29	LE07_L1TP_075072_20060329_20170110_01_T1
075	072	2006-04-30	LE07_L1TP_075072_20060430_20170110_01_T1
075	072	2006-08-04	LE07_L1TP_075072_20060804_20170107_01_T1
075	072	2006-08-20	LE07_L1TP_075072_20060820_20170109_01_T1
075	072	2006-09-21	LE07_L1TP_075072_20060921_20170107_01_T1
075	072	2006-04-14	LE07_L1TP_075072_20060414_20170110_01_T1
074	073	2006-02-18	LE07_L1TP_074073_20060218_20170111_01_T1
074	072	2006-03-06	LE07_L1TP_074072_20060306_20170111_01_T1
074	073	2006-04-23	LE07_L1TP_074073_20060423_20170109_01_T1
074	072	2006-04-23	LE07_L1TP_074072_20060423_20170110_01_T1
074	072	2006-10-16	LE07_L1TP_074072_20061016_20170107_01_T1
074	072	2006-08-29	LE07_L1TP_074072_20060829_20170107_01_T1
074	072	2006-04-07	LE07_L1TP_074072_20060407_20170110_01_T1
074	073	2006-04-07	LE07_L1TP_074073_20060407_20170110_01_T1

PATH	ROW	DATE	USGS NAME of Image
73	71	2006-11-26	LE07_L1TP_073071_20061126_ddddddd_nn_Tn
73	72	2006-03-31	LE07_L1TP_073072_20060331_ddddddd_nn_Tn
73	72	2006-11-26	LE07_L1TP_073072_20061126_ddddddd_nn_Tn
74	71	2006-04-07	LE07_L1TP_074071_20060407_ddddddd_nn_Tn
74	71	2006-04-23	LE07_L1TP_074071_20060423_ddddddd_nn_Tn
74	71	2006-08-29	LE07_L1TP_074071_20060829_ddddddd_nn_Tn
74	71	2006-10-16	LE07_L1TP_074071_20061016_ddddddd_nn_Tn
74	72	2006-03-06	LE07_L1TP_074072_20060306_ddddddd_nn_Tn
74	72	2006-04-07	LE07_L1TP_074072_20060407_ddddddd_nn_Tn
74	72	2006-04-23	LE07_L1TP_074072_20060423_ddddddd_nn_Tn
74	72	2006-08-29	LE07_L1TP_074072_20060829_ddddddd_nn_Tn
075	072	2007-10-10	LE07_L1TP_075072_20071010_20170102_01_T1
075	072	2007-07-06	LE07_L1TP_075072_20070706_20170102_01_T1
075	072	2007-06-20	LE07_L1TP_075072_20070620_20170102_01_T1
075	072	2007-10-26	LE07_L1TP_075072_20071026_20170102_01_T1
074	072	2007-11-04	LE07_L1TP_074072_20071104_20161231_01_T1
074	072	2007-05-12	LE07_L1TP_074072_20070512_20170103_01_T1
074	073	2007-04-10	LE07_L1TP_074073_20070410_20170104_01_T1
074	072	2007-04-10	LE07_L1TP_074072_20070410_20170104_01_T1
074	071	2007-04-10	LE07_L1TP_074071_20070410_20170104_01_T1
074	072	2007-04-10	LE07_L1TP_074072_20070410_20170104_01_T1
074	071	2007-05-12	LE07_L1TP_074071_20070512_20170103_01_T1
073	071	2007-05-21	LE07_L1TP_073071_20070521_20170103_01_T1
073	072	2007-05-21	LE07_L1TP_073072_20070521_20170103_01_T1
073	071	2007-06-06	LE07_L1TP_073071_20070606_20170103_01_T1
073	072	2007-06-06	LE07_L1TP_073072_20070606_20170103_01_T1
073	072	2007-06-22	LE07_L1TP_073072_20070622_20170102_01_T1
075	072	2008-10-12	LE07_L1TP_075072_20081012_20161225_01_T1
075	072	2008-08-09	LE07_L1TP_075072_20080809_20161225_01_T1
075	072	2008-07-24	LE07_L1TP_075072_20080724_20161228_01_T1
075	072	2008-06-06	LE07_L1TP_075072_20080606_20161228_01_T1
075	072	2008-03-02	LE07_L1TP_075072_20080302_20161230_01_T1
074	072	2008-09-19	LE07_L1TP_074072_20080919_20161224_01_T1
074	072	2008-06-15	LE07_L1TP_074072_20080615_20161228_01_T1
074	073	2008-06-15	LE07_L1TP_074073_20080615_20161228_01_T1
074	072	2008-02-08	LE07_L1TP_074072_20080208_20161230_01_T1
074	073	2008-02-08	LE07_L1TP_074073_20080208_20161231_01_T1
074	071	2008-01-23	LE07_L1TP_074071_20080123_20161230_01_T1
074	072	2008-02-08	LE07_L1TP_074072_20080208_20161230_01_T1
073	071	2008-03-04	LE07_L1TP_073071_20080304_20161230_01_T1
073	072	2008-03-04	LE07_L1TP_073072_20080304_20161230_01_T1
073	071	2008-04-21	LE07_L1TP_073071_20080421_20161229_01_T1

PATH	**ROW**	**DATE**	**USGS NAME of Image**
073	072	2008-04-21	LE07_L1TP_073072_20080421_20161229_01_T1
074	071	2008-07-01	LE07_L1TP_074071_20080701_20161228_01_T1
074	072	2008-07-01	LE07_L1GS_074072_20080701_20161228_01_T2
074	072	2008-08-02	LE07_L1GS_074072_20080802_20161226_01_T2
075	072	2009-07-27	LE07_L1TP_075072_20090727_20161218_01_T1
075	072	2009-06-09	LE07_L1TP_075072_20090609_20161219_01_T1
074	072	2009-05-01	LE07_L1TP_074072_20090501_20161220_01_T1
074	073	2009-05-01	LE07_L1TP_074073_20090501_20161222_01_T1
074	072	2009-04-15	LE07_L1TP_074072_20090415_20161220_01_T1
074	073	2009-04-15	LE07_L1TP_074073_20090415_20161222_01_T1
074	073	2009-05-17	LE07_L1TP_074073_20090517_20161222_01_T1
074	072	2009-05-17	LE07_L1TP_074072_20090517_20161222_01_T1
074	071	2009-02-26	LE07_L1TP_074071_20090226_20161222_01_T1
073	071	2009-03-23	LE07_L1TP_073071_20090323_20161221_01_T1
073	072	2009-03-23	LE07_L1TP_073072_20090323_20161221_01_T1
073	072	2009-04-08	LE07_L1TP_073072_20090408_20161220_01_T1
074	071	2009-05-01	LE07_L1TP_074071_20090501_20161222_01_T1
074	072	2009-05-01	LE07_L1TP_074072_20090501_20161220_01_T1
073	071	2009-06-11	LE07_L1TP_073071_20090611_20161219_01_T1
074	071	2009-10-08	LE07_L1TP_074071_20091008_20161217_01_T1
074	072	2009-10-24	LE07_L1TP_074072_20091024_20161217_01_T1
075	072	2010-05-27	LE07_L1TP_075072_20100527_20161214_01_T1
075	072	2010-05-11	LE07_L1TP_075072_20100511_20161215_01_T1
075	072	2010-04-09	LE07_L1TP_075072_20100409_20161214_01_T1
075	072	2010-03-08	LE07_L1TP_075072_20100308_20161216_01_T1
074	072	2010-07-07	LE07_L1GS_074072_20100707_20161214_01_T2
074	072	2010-08-24	LE07_L1GS_074072_20100824_20161213_01_T2
074	073	2010-01-12	LE07_L1TP_074073_20100112_20161216_01_T1
074	071	2010-01-12	LE07_L1TP_074071_20100112_20161217_01_T1
074	072	2010-01-12	LE07_L1TP_074072_20100112_20161217_01_T1
073	072	2010-01-21	LE07_L1TP_073072_20100121_20161217_01_T1
073	072	2010-03-10	LE07_L1TP_073072_20100310_20161216_01_T1
073	072	2010-05-13	LE07_L1TP_073072_20100513_20161215_01_T1
073	071	2010-06-30	LE07_L1TP_073071_20100630_20161213_01_T1
073	072	2010-06-30	LE07_L1TP_073072_20100630_20161214_01_T1
074	072	2010-07-07	LE07_L1GS_074072_20100707_20161214_01_T2
074	071	2010-07-23	LE07_L1TP_074071_20100723_20161213_01_T1
074	072	2010-07-23	LE07_L1GS_074072_20100723_20161213_01_T2
074	071	2010-08-24	LE07_L1TP_074071_20100824_20161213_01_T1
074	072	2010-08-24	LE07_L1GS_074072_20100824_20161213_01_T2
075	072	2011-02-07	LE07_L1TP_075072_20110207_20161210_01_T1

PATH	ROW	DATE	USGS NAME of Image
075	072	2011-03-11	LE07_L1TP_075072_20110311_20161210_01_T1
074	072	2011-08-11	LE07_L1TP_074072_20110811_20161206_01_T1
074	073	2011-08-11	LE07_L1TP_074073_20110811_20161206_01_T1
074	072	2011-09-12	LE07_L1GS_074072_20110912_20161206_01_T2
074	073	2011-09-12	LE07_L1TP_074073_20110912_20161206_01_T1
073	072	2011-02-25	LE07_L1TP_073072_20110225_20161210_01_T1
074	071	2011-08-11	LE07_L1TP_074071_20110811_20161206_01_T1
074	072	2011-08-11	LE07_L1TP_074072_20110811_20161206_01_T1
073	072	2011-09-21	LE07_L1TP_073072_20110921_20161206_01_T1
075	072	2012-07-19	LE07_L1TP_075072_20120719_20161130_01_T1
075	072	2012-07-03	LE07_L1TP_075072_20120703_20161201_01_T1
074	072	2012-05-09	LE07_L1TP_074072_20120509_20161202_01_T1
074	073	2012-04-07	LE07_L1TP_074073_20120407_20161202_01_T1
074	072	2012-05-25	LE07_L1TP_074072_20120525_20161201_01_T2
074	073	2012-05-25	LE07_L1TP_074073_20120525_20161202_01_T1
074	072	2012-08-13	LE07_L1GS_074072_20120813_20161129_01_T2
073	072	2012-02-12	LE07_L1TP_073072_20120212_20161203_01_T1
074	072	2012-04-07	LE07_L1GS_074072_20120407_20161202_01_T2
074	072	2012-05-09	LE07_L1TP_074072_20120509_20161202_01_T1
074	071	2012-08-13	LE07_L1TP_074071_20120813_20161130_01_T1
074	072	2012-08-13	LE07_L1GS_074072_20120813_20161129_01_T2
074	072	2012-09-14	LE07_L1GS_074072_20120914_20161205_01_T2
073	072	2012-10-09	LE07_L1TP_073072_20121009_20161128_01_T1
074	071	2012-11-01	LE07_L1TP_074071_20121101_20161127_01_T1
074	072	2012-11-01	LE07_L1GS_074072_20121101_20161127_01_T2
075	072	2013-09-08	LE07_L1TP_075072_20130908_20161121_01_T1
075	072	2013-07-06	LE07_L1TP_075072_20130706_20161123_01_T1
075	072	2013-02-12	LE07_L1TP_075072_20130212_20161125_01_T1
075	072	2013-10-02	LC08_L1TP_075072_20131002_20170502_01_T1
075	072	2013-12-21	LC08_L1TP_075072_20131221_20170427_01_T1
074	073	2013-10-11	LC08_L1TP_074073_20131011_20170429_01_T1
074	072	2013-10-11	LC08_L1TP_074072_20131011_20170429_01_T1
074	072	2013-12-14	LC08_L1TP_074072_20131214_20180202_01_T1
074	073	2013-12-14	LC08_L1TP_074073_20131214_20180202_01_T1
074	072	2013-07-31	LE07_L1TP_074072_20130731_20161122_01_T1
075	072	2014-09-19	LC08_L1TP_075072_20140919_20170419_01_T1
075	072	2014-09-03	LC08_L1TP_075072_20140903_20170420_01_T1
074	072	2014-06-24	LC08_L1TP_074072_20140624_20170421_01_T1
074	073	2014-06-24	LC08_L1TP_074073_20140624_20170421_01_T1
074	072	2014-05-23	LC08_L1TP_074072_20140523_20180202_01_T1
074	073	2014-05-23	LC08_L1TP_074073_20140523_20180202_01_T1

PATH	ROW	DATE	USGS NAME of Image
074	072	2014-01-31	LC08_L1TP_074072_20140131_20170426_01_T1
074	073	2014-01-31	LC08_L1TP_074073_20140131_20170426_01_T1
075	072	2015-08-05	LC08_L1TP_075072_20150805_20170406_01_T1
075	072	2015-10-24	LC08_L1TP_075072_20151024_20170402_01_T1
075	072	2015-03-30	LC08_L1TP_075072_20150330_20170411_01_T1
074	072	2015-05-10	LC08_L1TP_074072_20150510_20170409_01_T1
074	072	2015-04-08	LC08_L1TP_074072_20150408_20170410_01_T1
074	073	2015-04-08	LC08_L1TP_074073_20150408_20170410_01_T1
074	072	2015-03-23	LC08_L1TP_074072_20150323_20170411_01_T1
074	072	2015-11-18	LC08_L1TP_074072_20151118_20170401_01_T1
074	073	2015-11-18	LC08_L1TP_074073_20151118_20170401_01_T1
075	072	2016-09-24	LC08_L1TP_075072_20160924_20170320_01_T1
074	072	2016-06-13	LC08_L1TP_074072_20160613_20170324_01_T1
074	073	2016-06-13	LC08_L1TP_074073_20160613_20170324_01_T1
074	072	2016-05-28	LC08_L1TP_074072_20160528_20170324_01_T1
074	072	2016-06-13	LC08_L1TP_074072_20160613_20170324_01_T1
074	073	2016-06-13	LC08_L1TP_074073_20160613_20170324_01_T1
074	072	2016-05-28	LC08_L1TP_074072_20160528_20170324_01_T1
074	072	2016-12-22	LC08_L1TP_074072_20161222_20170316_01_T1
074	073	2016-12-22	LC08_L1TP_074073_20161222_20170316_01_T1
074	072	2016-10-03	LC08_L1TP_074072_20161003_20170320_01_T1
075	072	2017-08-26	LC08_L1TP_075072_20170826_20170913_01_T1
075	072	2017-04-04	LC08_L1TP_075072_20170404_20170414_01_T1
074	072	2017-08-03	LC08_L1TP_074072_20170803_20170812_01_T1
074	073	2017-08-03	LC08_L1TP_074073_20170803_20170812_01_T1
074	072	2017-05-31	LC08_L1TP_074072_20170531_20170615_01_T1
074	073	2017-05-31	LC08_L1TP_074073_20170531_20170615_01_T1
074	072	2017-01-23	LC08_L1TP_074072_20170123_20170311_01_T1
074	073	2017-01-23	LC08_L1TP_074073_20170123_20170311_01_T1
074	071	2013-08-16	LE07_L1TP_074071_20130816_20161122_01_T1
074	072	2013-07-31	LE07_L1TP_074072_20130731_20161122_01_T1
074	071	2013-10-11	LC08_L1TP_074071_20131011_20170429_01_T1
074	072	2013-10-11	LC08_L1TP_074072_20131011_20170429_01_T1
074	071	2013-07-07	LC08_L1TP_074071_20130707_20180202_01_T1
073	071	2013-11-21	LC08_L1TP_073071_20131121_20170428_01_T1
073	072	2013-11-21	LC08_L1TP_073072_20131121_20170428_01_T1
073	071	2014-08-20	LC08_L1TP_073071_20140820_20170420_01_T1
073	072	2014-08-20	LC08_L1TP_073072_20140820_20170420_01_T1
073	071	2014-04-14	LC08_L1TP_073071_20140414_20170423_01_T1

PATH	ROW	DATE	USGS NAME of Image
073	072	2014-04-14	LC08_L1TP_073072_20140414_20170423_01_T1
074	071	2014-06-24	LC08_L1TP_074071_20140624_20170421_01_T1
074	072	2014-06-24	LC08_L1TP_074072_20140624_20170421_01_T1
074	071	2014-11-15	LC08_L1TP_074071_20141115_20170417_01_T1
074	072	2014-11-15	LC08_L1TP_074072_20141115_20170417_01_T1
073	071	2015-05-19	LC08_L1TP_073071_20150519_20170408_01_T1
073	072	2015-05-19	LC08_L1TP_073072_20150519_20170408_01_T1
074	071	2015-05-10	LC08_L1TP_074071_20150510_20170409_01_T1
074	072	2015-05-10	LC08_L1TP_074072_20150510_20170409_01_T1
074	071	2015-04-08	LC08_L1TP_074071_20150408_20170410_01_T1
074	072	2015-04-08	LC08_L1TP_074072_20150408_20170410_01_T1
073	071	2016-07-08	LC08_L1TP_073071_20160708_20170323_01_T1
073	072	2016-07-08	LC08_L1TP_073072_20160708_20170323_01_T1
074	071	2016-10-03	LC08_L1TP_074071_20161003_20170320_01_T1
074	071	2016-06-13	LC08_L1TP_074071_20160613_20170324_01_T1
073	071	2016-07-08	LC08_L1TP_073071_20160708_20170323_01_T1
073	072	2016-07-08	LC08_L1TP_073072_20160708_20170323_01_T1
074	071	2017-12-09	LC08_L1TP_074071_20171209_20180202_01_T1
074	072	2017-12-09	LC08_L1TP_074072_20171209_20180202_01_T1
074	071	2017-05-31	LC08_L1TP_074071_20170531_20170615_01_T1
074	071	2017-04-13	LC08_L1TP_074071_20170413_20170501_01_T1
074	072	2017-04-13	LC08_L1TP_074072_20170413_20170501_01_T1
073	071	2017-06-09	LC08_L1TP_073071_20170609_20170616_01_T1
073	072	2017-06-09	LC08_L1TP_073072_20170609_20170616_01_T1
073	072	2017-07-27	LC08_L1TP_073072_20170727_20170810_01_T1
073	071	2017-07-27	LC08_L1TP_073071_20170727_20170810_01_T1

Summary Activity Data for Reference Period

Table 5: Summary of Deforestation

Changes	Lowland	Upland	Total
			[ha]
2005 - 2006	4,873	594	5,467
2006 - 2007	5,014	2,265	7,279
2007 - 2008	2,745	2,010	4,754
2008 - 2009	4,721	1,102	5,823
2009 - 2010	9,351	2,163	11,514
2010 - 2011	8,580	1,874	10,454
2011 - 2012	5,270	2,680	7,951
2012 - 2013	13,240	1,982	15,222
2013 - 2014	13,225	1,388	14,614
2014 - 2015	8,492	1,426	9,918
2015 - 2016	10,527	4,954	15,481
2016 - 2017	6,905	2,194	9,099

Table 6: Summary of Reforestation

Changes	Lowland	Upland	Total
			[ha]
2005 - 2006	7,122	1,573	8,695
2006 - 2007	8,282	3,697	11,978
2007 - 2008	10,281	3,419	13,699
2008 - 2009	7,721	1,018	8,739
2009 - 2010	3,680	576	4,256
2010 - 2011	2,353	624	2,977
2011 - 2012	5,201	879	6,080
2012 - 2013	3,855	372	4,227
2013 - 2014	6,612	568	7,180
2014 - 2015	7,130	1,139	8,270
2015 - 2016	5,382	680	6,062
2016 - 2017	2,605	258	2,863

References

Breiman, L. (2001). Random forests. Machine Learning, 45, 5–32.

Caccetta, P., Furby, S., Richards, G., Wallace, J., Waterworth, R., Wu, X., 2012. *Long-term monitoring of Australian landcover change using Landsat data: development, implementation and operation.* 2012. In Global Forest Monitoring from Earth Observation, Editors: Frédéric Achard & Matt Hansen. CRC Press.

Lehmann E., Wallace J.F., Caccetta P.A., S. Furby S.L., and Zdunic K. 2013. Forest cover trends from time series Landsat data for the Australian continent. *International Journal of Applied Earth Observation and Geoinformation,* 21:453–462.

Mueller-Dombois, D. & Fosberg, F.R., 1998. *Vegetation of the tropical Pacific islands.* Ecological Studies. Springer Science, New York, USA.

Wu, X., Furby, S. and Wallace, J.F. 2004. An approach for terrain illumination correction. In: Proceedings of the 12th Australasian Photogrammetry and Remote Sensing Conference. Fremantle Western Australia.

.

ANNEX 8-3: ESTIMATION OF EMISSION AND REMOVAL FACTORS

The procedures followed for generating the emission and removal factors for estimation of the forest reference level of Fiji is elaborated below.

A8.2.1 Emission Factors for Natural Forests

The emissions factors for above- and below ground biomass of natural forests were generated using two datasets - the National Forest Inventory and the Permanent Sample Plot Inventory.

National Forest Inventory

The population of interest for Fiji's NFI 2006 was defined by a forest cover map produced in 2001 by the Fiji South Pacific Applied Geoscience Commission (SOPAC). The area mapped as Natural Forest in 2001 defined the study population. Forest plantations (i.e., Hardwood and Softwood Plantations managed by FHCL and FPL, respectively) were excluded and were not assessed during the NFI 2006.

The 2001 map showing the area of Natural Forest depicted two forest classes within Natural Forest, namely **closed forest** and **open forest**. To differentiate between closed and open forest, unsupervised classification techniques were used. No documentation is available that details how the unsupervised classification was conducted. Moreover, no map accuracy assessment was conducted to quantify the quality of the forest cover map. The NFI 2006 covered the islands of Viti Levu, Vuanua Levu, Tavauni, Kadavu, Gau, Koro and Ovalau. Stratified simple random sampling was used for the NFI 2006, where the mapped classes closed and open forest served as strata. The number of observations in the strata closed and open forest were $n_{closed} = 731$ and $n_{open} = 292$, respectively. The total sample size was n = 1023. Sample plot locations were randomly placed within the strata in a geographic information system (GIS).

Cluster plots with five nested circular cluster sub-plots were used for the NFI 2006 (Figure 1). On the large sub-plot circle with radius r1 = 11:28 m (Ar1 = 400 m^2), the diameter at breast height (DBH; the tree bole diameter at 1.3 m above ground recorded in cm using a diameter tape) and species was recorded for all living trees with 20 cm DBH. On the circle with radius r2 = 5:64 m (Ar2 = 100 m^2), the DBH and species were recorded on all trees between 5 cm and < 20 cm DBH. In the smallest circle with radius r3 = 1:78, trees > 1:3 m height were counted and the DBH was not recorded. Data were collected by field teams between 2006-04-03 and 2007-12-11.

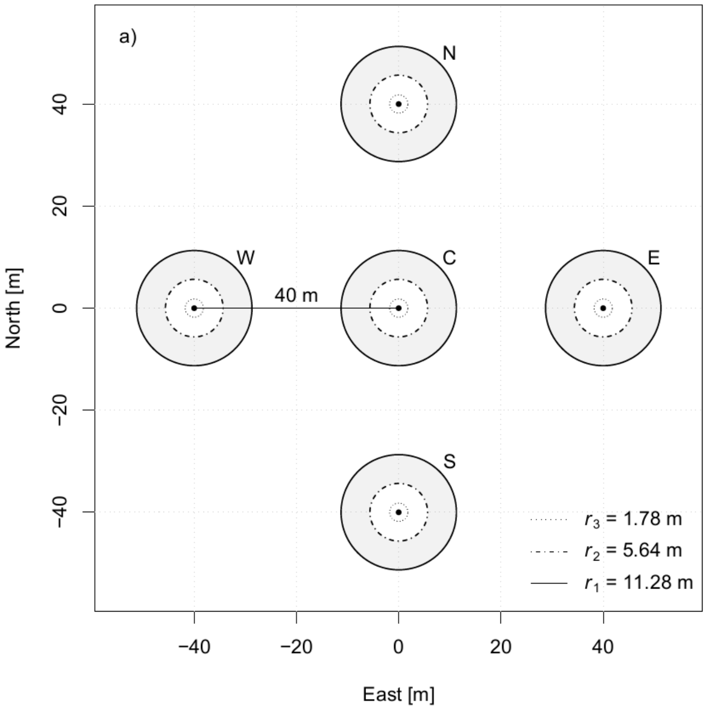


Figure 1.: Sample plot design used for the NFI 2006

Fiji's Permanent Sample Plot Inventory
Fiji's PSP program overlaps the entire ER Program Accounting Area (systematic sample plot location over the three islands Viti Levu, Vanua Levu and Taveuni). The grid size (i.e., the distance between adjacent sample plots) differs between the islands. On Viti Levu, for example, the grid size is 12x12 km, and on Taveuni 15x15 km. The attributes of trees have been recorded on nP SP = 86 plots in 2010, 2012, 2014, 2016 and 2018.

Fiji's Permanent Sample Plot (PSP) program started in 2010. The primary purpose of initiating the program was to obtain estimates of timber growth in Natural Forest to derive annual allowable cuts. It is intended that the program be continued for the next at least 25 years.

The PSP plot design is shown in Figure 2. On the large square 50x50 m, the DBH [cm], total tree height [m] and species was recorded on all living trees with DBH 25 cm. On the two 20x20 m subplots the DBH [cm], total tree height [m] and species was recorded on all living trees between 5 cm and < 25 cm DBH. The number of PSP tree records in the first measurement round of the PSP program (2010) was m_{PSP} = 5331.

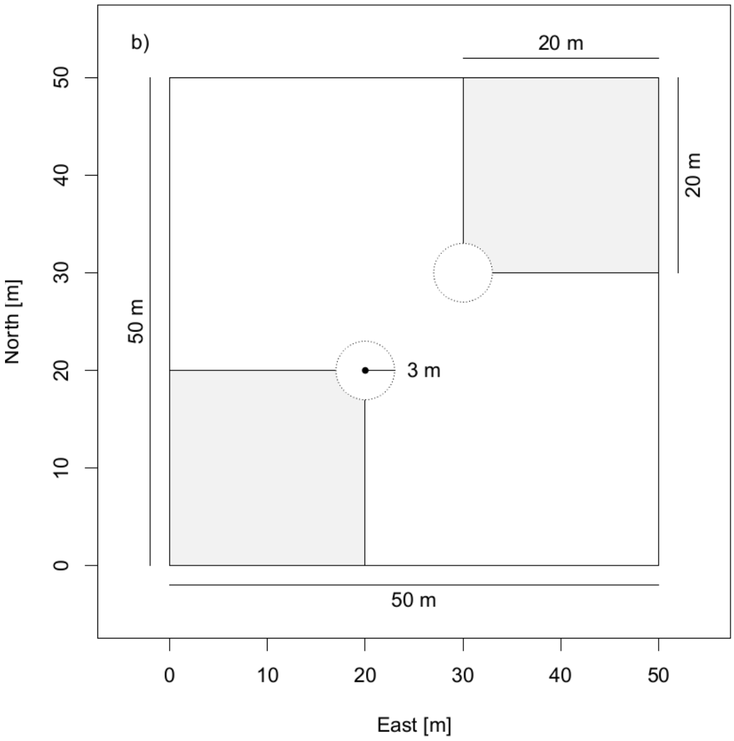


Figure 2: Sample plot design used for Fiji's Permanent Sample Plot (PSP) program

Carbon stocks in closed / open forest compared to upland / lowland forest
For the NFI 2006, stratified sampling was used. The two strata applied to the sampling design were closed and open forest. Although these two strata are reported in FAO FRA statistics, these were not retained for the FRL estimation as the activity data to differentiate closed and open forest were not available through the available remote sensing imagery.

The mean carbon stock [tC ha^{-1}] in closed and open forest were computed by simply taking the average tC ha^{-1} of plots in each stratum:

$$\bar{C}_h = n_h^{-1} \sum_{S_h} C_i \qquad \text{(A)}$$

Where;
$\bar{C}_h$ = average [t ha^{-1}] in stratum h,
n_h = sample size in stratum h,
S_h = set of sample plots in stratum h and Ci is the predicted C [t ha^{-1}] of the i^{th} NFI plot.

Note that for the strata closed and open forest the subscript h is used.

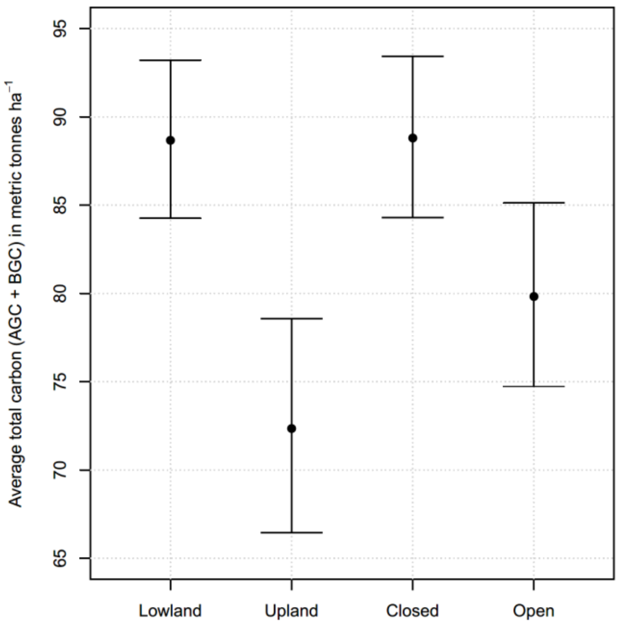


Figure 3: Estimated average total carbon stocks (TC = AGC + BGC) in t ha^{-1} in Lowand Upland Natural Forest and closed and open forest. Vertical bars give 90%-confidence intervals obtained from MC simulations.

Figure 3 shows the estimated average carbon stocks (TC = AGC + BGC) in the two NFI 2006 strata closed and open forest, as well as for Low-and Upland Natural Forest. The average C stock in closed forest was estimated at 88.01 (84.29; 93.44) tC ha^{-1} and at 78.97 (74.73; 85.12) tC ha^{-1} in open forest.

The decision to investigate any significant difference between Upland and Lowland forest was made based on findings by Mueller-Dombois & Fosberg [1998], who identified significant changes in structural and floristic characteristics in forests in Fiji below and above approximately 600 m a.s.l. Above 600 m a.s.l. Fijian forests tend to show characteristics typical for mountain forests systems, whereas forest located below 600 m a.s.l. show characteristics of either tropical rain forests or tropical moist deciduous forests.

For the analysis of the NFI 2006 data, the two “strata” Low-and Upland Natural Forest were treated as domains that cut across the two NFI strata closed and open forest (note that Low-and Upland Natural Forest were not considered as strata in the NFI 2006 design). Moreover, only NFI 2006 plots that were located within the FRL Accounting Area were considered for the estimation of C stocks, i.e., the domains were Lowland Natural Forest and Upland Natural Forest within the ER Program Accounting Area.

To estimate the average C stock [t ha^{-1}] for the two domains, the estimator for the domain mean for stratified sampling was used [Särndal et al., 1992, page 349]

$$\bar{C}_d = \sum_{h=1}^{H} \frac{N_h}{n_h} \sum_{S_{dh}} C_i \times \left[\sum_{h=1}^{H} \frac{N_h}{n_h} n_{S_{dh}} \right]^{-1} \qquad \text{(B)}$$

Where;
$\bar{C}_d$ = average C [t ha^{-1}] in the dth domain (Low-or Upland Natural Forest within the FRL Accounting Area),
H = the set of strata (closed and open forest),
N_h = strata size (Aclosed and Aopen),
n_h = sample size in stratum h,
S_{dh} = intersection of the sample plots in the dth domain and the sample plots drawn in stratum h
ns_{dh} = the random size of this intersection
C_i = the C [t ha^{-1}] on the ith NFI plot

The sample sizes in the domains Low-and Upland Natural Forest were $n_{Lowland}$ = 903 and n_{Upland} = 120. The average C stock in Lowland Natural Forest was estimated at 87.86 (84.25; 93.22) tC ha^{-1} and at 71.57 (66.45; 78.58) tC ha^{-1}in Upland Natural Forest. They were found to be significantly different.

Additional investigation work is planned to improve the NFI design and data analysis with the aim of determining Open and Closed Forest carbon stocks. This work will be conducted in conjunction with the step-wise approach to incorporating direct measurement and estimation of forest degradation in Fiji's National Forest Monitoring System.

Carbon Stocks in Upland and Lowland Forest

Carbon stocks in Natural Forest were estimated based on data collected during Fiji's National Forest Inventory (NFI) 2006. The methods used to derive estimates of C stocks in Low-and Upland Natural Forest and associated estimates of precision from this data set are described in the following sections.

Aboveground Biomass

To predict the aboveground biomass (AGB) of individual trees captured in the NFI 2006, a biomass model (allometric equation) published in Chave et al. [2014][7] was used in the absence of a country specific allometric model in Fiji. The selection of the allometric equation followed a process of assessing several candidate models selected from the literature (e.g., models found in Chave et al. [2005] and Chave et al. [2014]).

Initially, Equation 7 in Chave et al. [2014] was selected as the most promising candidate model because it does not rely on measures of tree height. Total tree height was not measured during the NFI 2006 field campaigns. Equation 7 instead applies a substitute for tree height (i.e., a so-called environmental stress factor).

A suitability test was conducted using Fiji's PSP data set which provides data on DBH and total tree height. This data set enabled a comparison between Equation 4 and 7 from Chave et al. [2014]. This suitability test found that predicted tree aboveground biomass was much higher when using Equation 7 with the environmental stress factor (as a substitute for trees height) compared to using the measured heights in Equation 4. It was found that the environmental stress factor assumes much taller trees in Fiji compared to the heights measured during the PSP. The same holds true for Eq. II.5 Wet in Chave et al. [2005].

In the latter, tree height is not used as an input (only DBH and the wood density are used as inputs) but an inherent relationship between DBH, total tree height and AGB is assumed. It was, therefore, decided to use the PSP data to derive a height model, predict the heights of NFI 2006 trees using the fitted model and then use Equation 4 in Chave et al. [2014] to predict the AGB of NFI 2006 trees.

Equation 4 in Chave et al. [2014] takes the following form:

$$AGB_k = \beta_0(\rho_k h_k d_k^2)^{\beta_1} + \epsilon_k \qquad \text{(C)}$$

where
AGB_k = the biomass in kilograms of the kth tree
ρ_k= wood density (defined as the oven-dry mass divided by green volume; g cm^{-3}),
h_k = total tree height [m],
d_k = diameter at breast height (DBH) [cm],
β_0 and β_1 = model parameters, where $\widehat{\beta_0}$ = 0.0643 and $\widehat{\beta_1}$ = 0.979
ϵk is the residual error term.

The data that were used by Chave et al. [2014] to derive the parameter estimates for Eq. 4 are publicly available on the web (see Pan-tropical tree harvest database [PTHD]). The PTHD dataset was downloaded and the model (Equation A) was refitted to the data using non-linear generalized least squares (including a power variance function structure for the input variable DBH). The parameter estimates obtained slightly differ from those reported by Chave et al. [2014]: where $\hat{\beta}_0'$ = 0.0632 and $\hat{\beta}_1'$ = 0.979.

---

[7] Specifically, Equation 4 listed in this publication was used.

The reason for refitting Chave et al. [2014] Equation 4 was that the AGB model (Equation A) was refitted several times during the Monte Carlo (MC) simulations using bootstrap samples from PTHD. To ensure that the parameter estimates $\hat{\beta}_0'$ and $\hat{\beta}_1'$ and the parameter estimates from the MC simulations are asymptotically equivalent, the parameter estimates from the refitted model were used to predict the AGB of individual NFI 2006 trees.

Missing tree heights of NFI 2006 trees were predicted using the PSP height model. The number of sample plots that were used to fit the PSP height model was n_{PSP}'= 86. As only a single pine tree was recorded during the NFI, pine trees were removed from the PSP dataset before the height model was fitted to the data.

After removing pine trees from the PSP dataset, the number of PSP plots reduced to n_{PSP}'= 82. The number of PSP tree records in the first measurement round of the PSP program (2010) was m_{PSP} = 5331. These data were used to fit the PSP height model which took the following simple form:

$$h_k = \beta_0 + \ln(d_k)\beta_1 + \epsilon_k \tag{D}$$

Model parameters were estimated as: $\hat{\beta}_0$ = -4.682 and $\hat{\beta}_1$ = 5.372.

The fit was poor with an R^2 = 0:44. This lack of fit was accounted for in the uncertainty analysis. Using Equation (B), the height of all m = 76968 NFI 2006 trees recorded was predicted.

Wood density for use in Equation A, was extracted from a wood density database published by Chave et al. [2009] and Zanne et al. [2009]. If the density of a tree species recorded during the NFI 2006 was not available in the database, the average density of the genus was taken. If the genus was not in the database, the average wood density of the family was used and if the family was not in the database, the average wood density of all NFI 2006 trees for which the species, genus or family was available formed the input.

The AGB of individual NFI 2006 trees was finally predicted using:

$$\widehat{AGB}_k = 1000^{-1}\left[\hat{\beta}_0'\left(\hat{\rho}_k \hat{h}_k d_k^2\right)^{\hat{\beta}_1'}\right] \tag{E}$$

Where;
$\widehat{AGB}_k$ = predicted AGB [t] of the k^{th} NFI 2006 tree,
$\hat{\rho}_k$= estimated wood density [g cm^{-3}]
$\hat{h}_k$ = predicted tree height [m]
d_k = measured DBH [cm]

The AGB for an NFI 2006 plot was predicted by first aggregating the AGB of individual trees at the different circle sizes:

$$AGB_{i,r_c}' = \sum_{k=1}^{m_{i,rc}} A\hat{G}B_k \tag{F}$$

Where;

AGB_{i,r_c}' = the aggregated AGB [t] on the i^{th} cluster plot on circles with radius r_c, with c = {1, 2}
m_{i,r_c}= the number of trees on the i^{th} plot on circles with radius r_c
$A\hat{G}B_k$ is given in Equation (C).

The plot AGB was expanded to the hectare using the expansion factors:

$$EF_{r1} = [5 \times a_{r1}]^{-1} \times 10000 = 5 \tag{G}$$
$$EF_{r2} = [2 \times a_{r2}]^{-1} \times 10000 = 20 \tag{H}$$

Where;
a_{r1}= 400 m^2
a_{r2} = 100 m^2

10000 is the area of one hectare in m^2.

The AGB ha^{-1} for circles with radius r_c for the ith NFI plot was computed by:

$$AGB_{i,r_c} = AGB'_{i,r_c} \times EF_{r_c} \qquad \text{(I)}$$

Total AGB [t ha^{-1}] (i.e., from the large and small circle) was computed for each plot by

$$AGB_i = \sum_i AGB_{i,c} \qquad \text{(J)}$$

Belowground Biomass

Below-ground biomass (BGB) was estimated for each cluster plot using default values of root-to-shoot ratios R from IPCC [2006, Vol. 4, Chap. 4, Tab. 4.4]. The value of R used for an NFI 2006 cluster plot depended on the location of the central cluster sub-plot.

According to IPCC [2006, Vol. 4, Chap. 3, Fig. 3.A.5.1], Fiji lies entirely within the tropical wet climatic zone. However, because of the southeast trade winds combined with the mountainous topography of Fiji, a pronounced windward-leeward effect can be observed in precipitation patterns. The southeastern side of the main islands receive about 3000 mm of rainfall per year, whereas leeward sides receive about 2000 mm per year or less [Mueller-Dombois & Fosberg, 1998]. The boundary between tropical rain forest and tropical most deciduous forest was first defined by the mean annual precipitation IPCC [2006, Vol. 4, Chap. 3, Fig. 3.A.5.2]. However, to allow for an even finer climatic zonation, the Aridity Index (AI; see Zomer et al. [2008]) was used to distinguish between areas of tropical rain forest and tropical most deciduous forest (Figure 1). Table 1 provides an overview on climatic and altitudinal zonation, as well as the values of R used for the different zones.

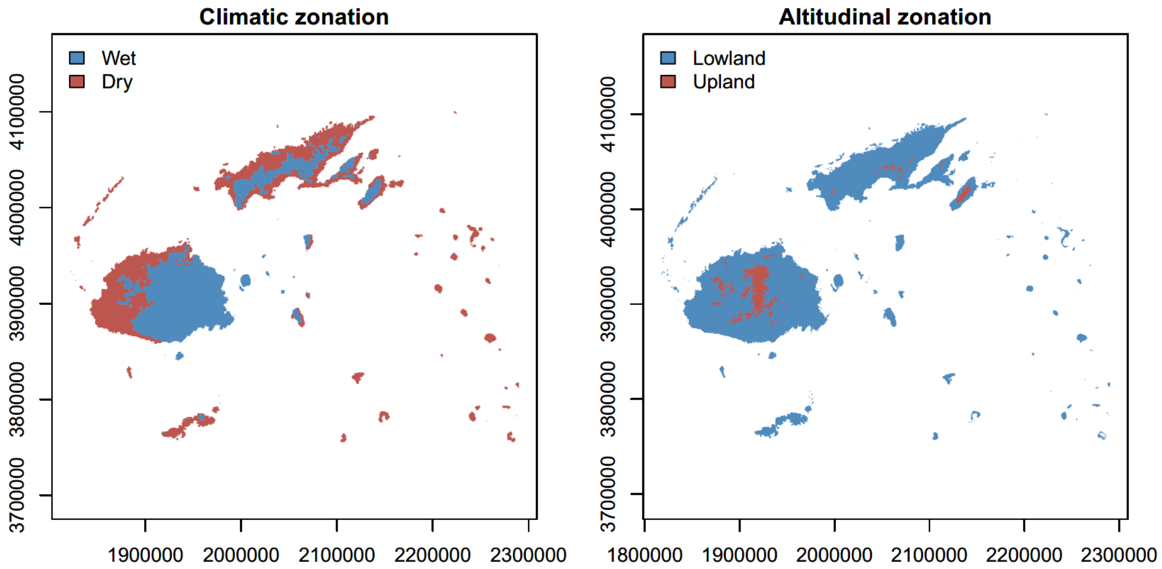


Figure 4: Climatic and altitudinal zonation used to select root-to-shoot ratios from IPCC [2006, Vol.4, Chap. 4, Tab. 4.4].

Table 1.: Root-to-shoot ratios, R, used to compute below-ground biomass (BGB) from above-ground biomass (AGB) [IPCC, 2006, Vol. 4; Chap. 4; Tab. 4.4].

IPCC Ecological zone	Climate[a]	Alt.[b]	Zonation[c]	AGB [t ha^{-1}]	R^d	Notation
Tropical rainforest	Wet	Lowland	WL		.37	R_{wl}
Tropical moist deciduous forest	Dry	Lowland	DL	< 125	.20	R_{dll}
	Dry	Lowland	DL	≥ 125	.24	R_{dlh}
Tropical mountain systems	Dry	Upland	DU		.27	R_u
	Wet	Upland	WU		.27	R_u

[a] Climatic zonation: Wet = Aridity Index (AI) ≥ 2, Dry = AI < 2

[b] Altitudinal zonation; Lowland < 600 m a.s.l., Upland ≥ 600 m a.s.l.

[c] WL = Wet Lowland, DL = Dry Lowland, DU = Dry Upland, WU = Wet Upland

[d] R = root-to-shoot ratio

Total Biomass

Total biomass was obtained by:

$$TB_i = AGB_i \times (1 + R_i) \quad \text{(J)}$$

Where;

TB_i = the total biomass [t ha^{-1}]

AGB_i is given in Equation G,

R_ii depends on where a cluster plot is located and is selected based on the zonation given in Table 1

To compute total carbon for each NFI 2006 cluster plot, C_i [t ha^{-1}], TB_i was multiplied by the IPCC default value CF = 0:47 [IPCC, 2006, Vol. 4, Chap. 4,Tab. 4.3].

A8.2.2 Removal Factors for Natural Forests, Afforestation and Reforestation and Plantations

Removals factors within Fiji are in the early stages of investigation and were difficult to find for the FRL calculations. Below presents a description of the process to select/generate removal factors with national relevance from available data. A more detailed description of the calculation methods and applied uncertainty to these factors can be found in Annex 8.3 and 12.1 respectively.

Removal factors for natural forests

Removals occur on areas that have been logged. In logged Natural Forest carbon stock gains are assumed to be slightly higher than carbon stock losses and it is assumed that carbon stocks will not fully recover until the next harvest.

Data on net carbon stock gains after logging in Natural Forest within Fiji have not yet been assessed nationally. For the FRL, data were taken from a limited data set available from the REDD+ pilot site at Nakavu.

The estimated net carbon gain (AGB and BGB) was reported as 0.99 tC ha^{-1} yr^{-1} (Mussong; personal communication; unpublished data). These data currently represent the only data on carbon growth in logged Natural Forest currently available in Fiji. Estimates of variance for carbon stock gains in logged Natural Forest are not available and therefore the uncertainty applied to this emissions factor was set as large in the Monte Carlo simulations (refer to Annex 12.1).

In the future, assessments of regrowth following logging should also be derived for other parts of the REDD+ Accounting Area, e.g., Vanua Levu and Taveuni. The Nakavu site is located in the lower wet area of Viti Levu and increments may be different in more drier areas and areas not located in lowland forest (i.e., 600 m above sea level [a.s.l.]). The PSP data (see Appendix B.1) could not be used for the estimation of C stock gains in Natural Forest due to limitations in data procurement procedures.

Removal Factors for afforestation and reforestation

Mean annual carbon increments on areas of afforestation/reforestation (A/R) of natural forest species have not yet been rigorously assessed in Fiji. For the FRL, data on the mean annual increment (MAI) provided by Fiji Harwood Corporation Limited (FHCL) were used.

FHCL reported the MAI for individual tree species, as well as for mixed hardwood stands. The estimates of the MAI used in the FRL were assessed in plantations established in FHCL's lease area, noting that the MAI provided by FHCL refers to volume increments, i.e., MAIV , and not to C increments.

As the species planted (or naturally regenerated) historically was not known on these identified A/R lands, selection of an appropriate MAIC was challenging. To avoid the risk of underestimating removals from AR for the FRL, the average MAIV over all species reported by FHCL was computed; excluding the MAI from mixed hardwood stands. The value of MAIV used for the FRL was 3.71 m^3 ha^{-1} yr^{-1}.

Combining this MAIV with a biomass expansion factor of 1.1 (from Table 4.5 in IPCC 2006 Vol. 4, Chap. 4) a root shoot ratio of 0.37 (IPCC, 2006, Vol. 4; Chap. 4; Tab. 4.4) and carbon fraction of 0.47, the mean annual increment in carbon was calculated to be 2.63 tC ha^{-1} yr^{-1}.

Removal factors for plantations

Removals from Forest Plantations were estimated based on the MAI reported for Hard-and Softwood Plantations.

Hardwood Plantations

Annual increments of wood volume in Hardwood Plantations were estimated based on data on mean annual volume increments, $MAIV_{HW}$. Removals were estimated based on data on areas planted during the Reference Period and growth on areas that were planted before 2006 and were either harvested or not harvested before the end of the Reference Period.

Table 2 lists increments of tree species managed by FHCL. As FHCL did not report areas planted by species and year, a weighted average of the $MAIV_{HW}$ was calculated using the data from Table 2 Weights were computed by dividing the stocking of a species, A_{HW} in Table 2, by the total of A_{HW}. The average $MAIV_{HW}$ was found to be 5.85 m^3 $ha^{-1}yr^{-1}$. Growth functions that would allow to derive current annual increments, CAIV , or the MAIV at different plantation ages were not available from FHCL. Volume increments were converted to increments of AGB by multiplying the volume by a biomass conversion and expansion factor for increment (BCEFI) of 1.1 tB (m^3). The value was taken from IPCC [2006, Vol. 4, Chap. 4, Tab. 4.5; humid tropical natural forests; growing stock level 21-40 m3 ha-

^{1} yr^{-1}] and the root:shoot ratio from IPCC, 2006, Vol.4, Chap. 4, Tab. 4.4 then to carbon my multiplying by biomass:carbon default conversion factor (0.47). The resulting mean annual carbon increment was calculated, as outlined below, to be 4.14 tC ha^{-1} yr^{-1}

Total carbon increment, including above- and belowground was estimated from mean annual increment values provided by Fiji Hardwood Corporation Limited (FHCL) as follows:

$$MAIAGB_{HW} = \overline{MAIV}_{HW} \times BCEF_{HW,I} = 5.85 \times 1.1 = 6.435$$

Where;

$MAIAGB_{HW}$ = mean annual AGB increment in hardwood plantations; tB ha^{-1} yr^{-1}

$\overline{MAIV}_{HW}$ = average mean annual volume increment in hardwood plantations; m^{3} ha^{-1} yr^{-1}; calculated as a weighted mean estimate as 5.85 m^{3} ha^{-1} yr^{-1}

$BCEF_{HW,I}$ = biomass conversion and expansion factor for increment for humid tropical natural forest; growing stock level 21-40 m^{3} ha^{-1}; tB (m^{3})$^{-1}$

Total carbon increment, including above- and belowground was estimated by:

$$MAIC_{HW} = [MAIAG_{HW} \times (1 + R_{wl})] \times \eta_{CF} = [6.435 \times 1.37 \times 0.47] = 4.14$$

Where;

$MAIC_{HW}$ = mean annual carbon increment in hardwood plantations; tB ha^{-1} yr^{-1}

$MAIAG_{HW}$ = mean annual increment tB ha^{-1} yr^{-1}

R_{wl} = root-to-shoot ration for tropical rainforest taken from IPCC, 2006, Vol.4, Chap. 4, Tab. 4.4; dimensionless

η_{CF} = biomass to carbon conversion factor; tC (tB)$^{-1}$

Table 2: Estimated mean annual volume increments in Hardwood Plantations expected cut volumes, and stocking area in 2017. The data were provided by the Fiji Hardwood Corporation Limited (FHCL). CC: cutting cycle length (rotation) in years.

Species	$MAIV_{HW}$ [m^{3} ha^{-1} yr^{-1}]	CC [yrs]	Cut volume [m^{3} ha^{-1}]	A_{HW} [ha]
Mahogany	6.30	37	220	48801
Mixed hardwoods	2.00	35	70	3634
Cadamba	5.00	35	180	1263
Cordia	1.40	35	50	940
Maesopsis	2.90	35	100	912
Pine	7.10	27	180	532
Dakua Makadre	3.00	60	180	241
Eucalyptus	7.50	25	150	161
Yemini	4.00	60	100	46
Kauvula	1.70	50	100	33
Teak	4.00	30	120	2

Softwood Plantations

The mean annual biomass increment in softwood plantations, $MAIB_{SW}$ was taken from Waterloo [1994]) which reported mean annual biomass increment for pine plantations in Fiji to be 10 tB ha^{-1}yr^{-1} which includes both above- and belowground biomass. This was converted to carbon increment, MAIC, by a simple multiplication of the default biomass:carbon conversation factor (0.47).The resulting mean annual carbon increment was calculation to be: 4.7 tC ha^{-1} yr^{-1}.

References

Chave, J., Andalo, C., Brown, S., Cairns, M., Chambers, J., Eamus, D., Fölster, H., Fromard, F., Higuchi, N., Kira, T. *et al.,* 2005. Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia,* 145(1):87–99.

Chave, J., Coomes, D., Jansen, S., Lewis, S.L., Swenson, N.G. & Zanne, A.E., 2009. Towards a worldwide wood economics spectrum. *Ecology Letters,* 12(4):351–366.

Chave, J., Réjou-Méchain, M., Búrquez, A., Chidumayo, E., Colgan, M.S., Delitti, W.B., Duque, A., Eid, T., Fearnside, P.M., Goodman, R.C. *et al.,* 2014. Improved allometric models to estimate the aboveground biomass of tropical trees. *Global Change Biology,* 20(10):3177–3190.

IPCC, 2006. IPCC Guidelines for National Greenhouse Gas Inventories. The Intergovernmental Panel on Climate Change (IPCC), IGES, Hayama, Japan.

Mueller-Dombois, D. & Fosberg, F.R., 1998. *Vegetation of the tropical Pacific islands.* Ecological Studies. Springer Science, New York, USA.

Särndal, C.E., Swensson, B. & Wretman, J., 1992. *Model Assisted Survey Sampling.* Springer Series in Statistics. Springer, New York, 2 edition.

Zanne, A., Lopez-Gonzalez, G., Coomes, D., Ilic, J., Jansen, S., Lewis, S., Miller, R., Swenson, N., Wiemann, M. & Chave, J., 2009. Data from: Towards a worldwide wood economics spectrum. Dryad Digital Repository.

Zomer, R.J., Trabucco, A., Bossio, D.A. & Verchot, L.V., 2008. Climate change mitigation: A spatial analysis of global land suitability for clean development mechanism afforestation and reforestation. *Agriculture, ecosystems & environment,* 126(1):67–80.

ANNEX 8-4: ESTIMATION OF EMISSION FROM FIRE AND FUELWOOD

The procedures followed for assessing emission from Fire and Fuelwood and assessing significance are elaborated below.

Emissions from Fire

The approach to assessing the greenhouse gas impact of fire within forest lands in Fiji during the Forest Reference Level Period (i.e. 2006-2016) is outlined below.

Fiji has very limited national data to enable the quantification of the extent of fire in all forest lands. To fill this gap global data sets were considered however, unlike other countries, the MODIS Burned Area Product does not cover Fiji. Points from the MODIS Active Fire Product are available and were downloaded. The majority of hotspots (85%) were detected in non-forest lands. The remaining 15% were found in Plantations (6%) and Natural Forest (9%).

Fire is typically used in Fiji as a tool to manage grasslands for agriculture production, particularly in the Districts where sugar cane is the predominate crop. Sometimes these fires ‘get away’ into forest areas bordering the sugar cane plantations. These forests are typically Pine plantations that have been established by Fiji Pine limited on previously degraded lands.

A random sample of points were check against available higher resolution Google Earth imagery to determine if there was a detectable fire scar associated with the Active Fire Points from MODIS. This investigation determined that fire scars could not be associated with MODIS points in natural forest or hardwood plantations. Fire points were associated with fire scars in Pine Plantations. The findings of the random sample analysis are consistent with the known patterns and use of fire in Fiji as a cropland management tool. Fire is not typically used in Fiji to clear native forest areas.

Further investigation into the incidence and extent of fire in Natural Forest is a priority (see Fijis REDD+ Improvement Plan; Section 9.4). Based on additional data and evidence on the significance of fire emissions in natural forests, emissions from fire from natural forests will be included in a step-wise approach.

Data availability

- Burned areas are available for fires that occurred in Fiji Pine Limited plantation areas. No spatial data from which area impacted can be derived is available on fires in Natural Forest or in Hardwood plantations, which represent a very small proportion of Fijis forest estate.
- The MODIS Burned Area Product does not cover Fiji (see Figure 1). The MODIS Active Fire Product (C6) and the VIIRS 375 m cover Fiji. MODIS data (1 km spatial resolution) was used due to its temporal coverage.

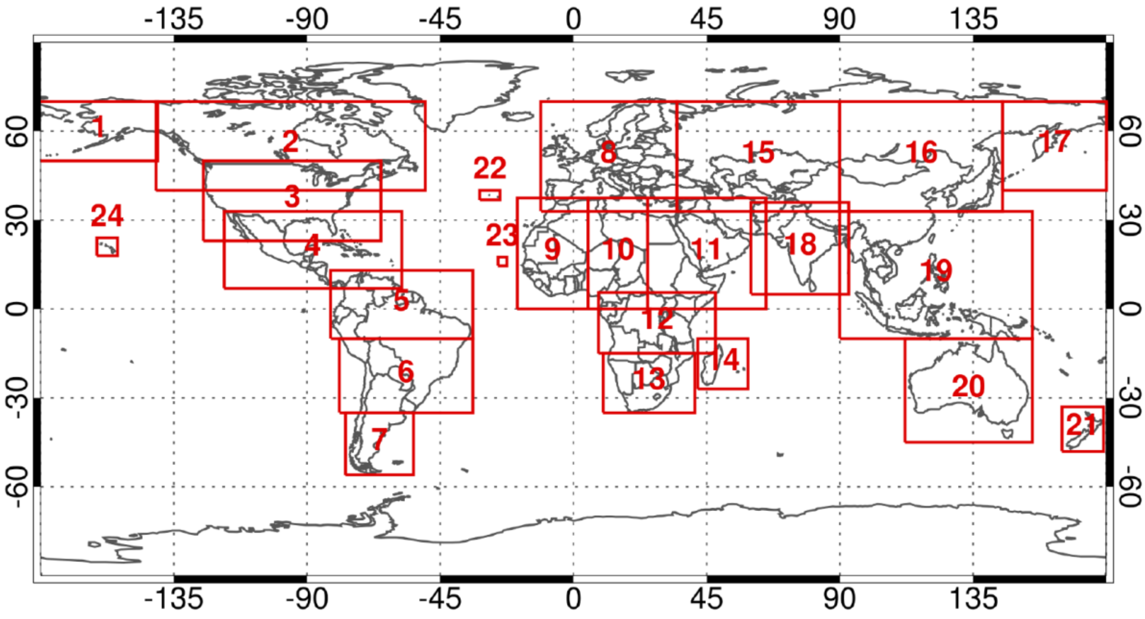


Figure 1: Coverage of the MODIS Burned Area Product.

MODIS Active Fire Product

- The MODIS Active Fire Product (AFP) was downloaded from the web (start date 2006-01-01 and end date 2016-12-31).
- A sub-set of the hotspot dataset was overlaid on the annual forest cover change maps and the incidence of the hotspot falling in Softwood Plantation, Hardwood Plantation and Natural Forest within the ER Programme area is presented in Table 1.
- The majority of hotspots (85%) were detected in non-forest lands. The remaining 15% were found in Plantations (6%) and Natural Forest (9%).
- The number of hotspots in Hardwood Plantations was very low.

Table 7: Number of MODIS Hotspots recorded in Plantation and Natural Forest between 2012 and 2016.

Year	**Softwood Plantations**	**Hardwood Plantations**	**Native Forest**
	MODIS Hot Spots	MODIS Hot Spots	MODIS Hot Spots
2012	83	3	165
2013	196	4	247
2014	350	6	858
2015	437	9	470
2016	186	6	456

Spatial Data

- Spatial data of area burnt to correspond to the MODIS hotspots is only available for Softwood Plantations in Fiji for the years 2015-2018. Fiji Pine collects this data and made it available to the Ministry of Forests on request. A sample of the data collected is listed in Table 2.

Table 8: Sample of data collected on burnt areas in softwood plantations.

COUPE_ID	PlantingYear_YEAR	AREABURNT	YEARBURN	AGE
LOL-010-27	2012	4.9	2015	7
LOL-001-11	2014	8.1	2015	5
LOL-001-01	2015	25.93	2015	4
LOL-001-22	2015	9.7	2015	4
LOL-005-09	1994	7.8	2015	25
LOL-007-07	2002	15	2015	17
LOL-011-22	2001	6.2	2015	18
LOL-006-07	1991	47.8	2015	28
LOL-010-07	2015	2.4	2015	4
LOL-010-01	2014	3.9	2015	5
LOL-004-15	2012	5.5	2015	7

- Spatial data to verify the MODIS hotspots and to quantify GHG emissions from fire were not available for Natural Forests.
- The MODIS hotspots were overlaid in higher resolution google maps to determine if the points correlated with fire scars.
- A number of points in natural forest and softwood plantations were checked.
- Most points in natural forest did not correlate with a fire scar, in fact only a single fire scar was seen in natural forest after checking more than 30 points in this forest class over the 2015 – 2018 time period (Figure 1).
- Where hot spots corresponded to grasslands or plantations, fire scars were regularly found (Figure 1 and Figure 2).
- Spatial data and plantation age class of softwood plantations affected by fire between 2015 -2108 was provided by Fiji Pine Limited. This data was used to estimate fire emissions from this forest class and to include in the FRL.
- No data was provided by Fiji Hardwood Corporation Limited to include this forest class in the FRL at this time.

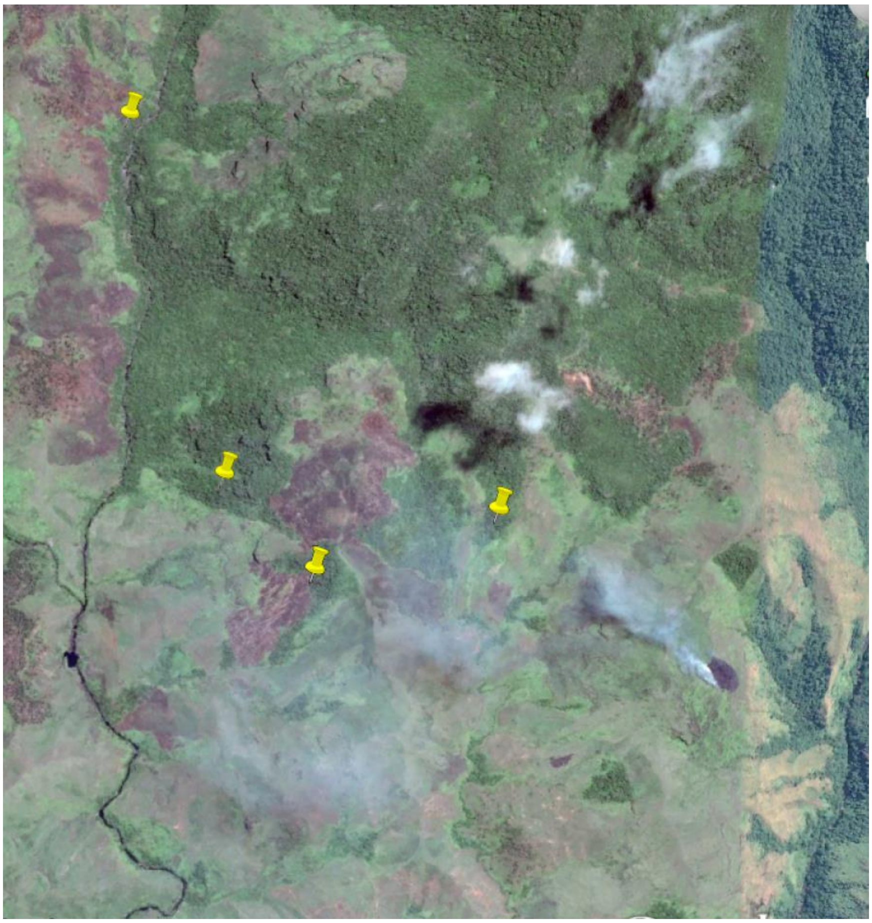


Figure 1: MODIS points in grasslands with fire scars and 2 points in natural forest with no fire scars visible.

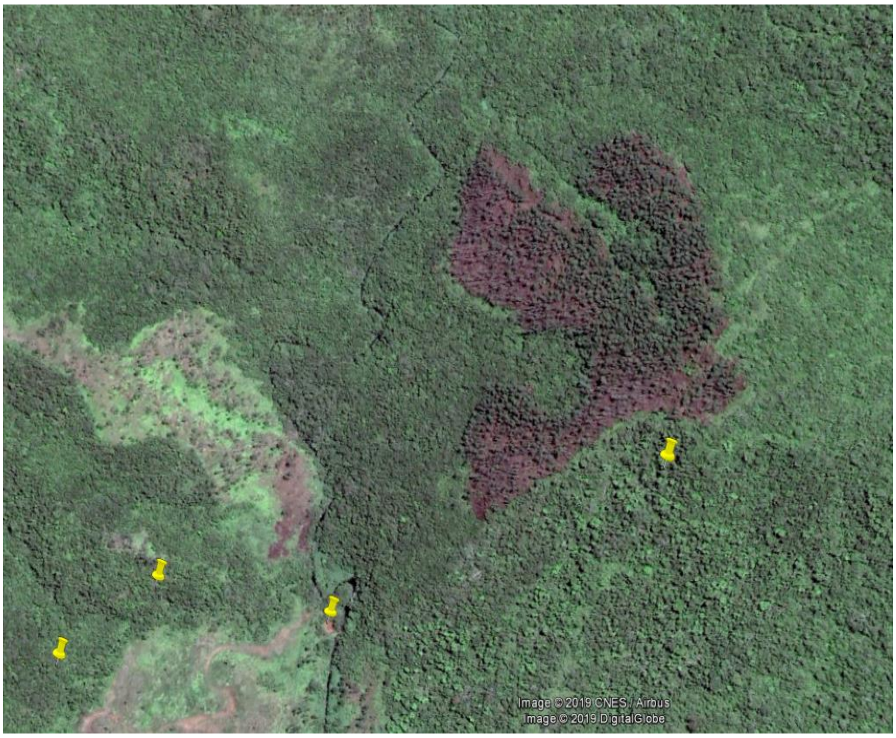


Figure 2: MODIS point adjacent to softwood plantation fire, one in the centre bottom on grassland and 2 in natural forest with no sign of fire scar.

Estimation of Emissions from Fire

- The area of fire within Pine plantations was not estimated from a sample.
- Area burnt data provided by Fiji Pine between 2015 – 2018 was used to estimate an annual average area burnt to include emissions from fire in softwood plantation in the FRL.
- IPCC GPG 2006 Tier 1 default methods and factors in combination with National spatial data was used to provide an initial estimate of emissions from fire in softwood plantations.
- It is noted that the quantified emissions represent approximately 40% of the hot spots within Forest Lands.
- No quantification of emission on Natural Forest was possible due to a lack of spatial data and a lack of evidence that the MODIS hotspots correspond to a fire in this forest class.
- Emissions from fire were estimated using the IPCC default equation:
-

$$\mathrm{E}_{\mathrm{BiomassBurn,i,t}} = \sum_{g=1}^{G} \left(\left(\left(\mathrm{A}_{\mathrm{burn,i,t}} \times \mathrm{B}_{\mathrm{i,t}} \times \mathrm{COMF}_{\mathrm{i}} \times \mathrm{G}_{\mathrm{g,i}} \right) \times 10^{-3} \right) \times \mathrm{GWP}_{\mathrm{g}} \right)$$

Where;

$E_{BiomassBurn,t}$	Greenhouse emissions due to biomass burning activities in stratum i in year t; tCO_2-e of each GHG (CO_2, CH_4, N_2O)
$A_{burn,i,t}$	Area burnt for stratum i at time t; ha
$B_{i,t}$	Average aboveground biomass stock before burning stratum i, time t; tonnes d.m. ha- 1
$COMF_i$	Combustion factor for stratum i; dimensionless (see Volume 4, chapter 2, Table 2.6 of IPCC, 2006)
$G_{g,i}$	Emission factor for stratum i for gas g; kg t^{-1} dry matter burnt (default values as derived from Volume 4, Chapter 2, Table 2.5 of IPCC, 2006)
GWP_g	Global warming potential for gas g; t CO_2/t gas g (default values from IPCC SAR: CO_2 = 1; CH_4 = 21; N_2O = 310)

- The aboveground biomass was calculated based on the age of the plantation at the time of the burn (provided by Fiji Pine) multiplied by the average carbon increment value provided by Fiji Pine and used in the estimation of removals from regrowth in the FRL calculations.
- The average annual emissions are estimated in the FRL and are presented in Chapter 8.

Emissions from Fuelwood

The approach to estimating the significance of emissions from fuelwood collection during the reference period (i.e. 2006-2016) is outlined below. Fuelwood has traditionally been a major source of energy in Fiji, particularly as a fuel for cooking in rural areas. However, Fiji has experienced rapid shift to modern fuels for cooking in the last decade and fuelwood use is on the decline.

Data on fuelwood consumption was taken from the National Energy Demand/Supply Database as and population demographics from National census data from 2007 and 2017.
Based on the estimation presented here it appears that fuelwood emissions are on the decline during the reference period.

Based on the available data from the reference period, fuelwood use for cooking as a driver of forest degradation is expected to have a declining trend during the program period as the adoption of modern fuels increases. Migration of families to urban areas in search of employment, increase the use of modern fuels such as electricity, liquid petroleum gas (LPG), kerosene, and spread of electrification to rural reflects the move to other fuels. Therefore, exclusion of fuelwood emissions as source of forest degradation emissions from the FRL is conservative.

Data availability

- Data for the estimation of emissions from fuelwood was gathered from:

- the National Energy Demand/Supply Database Manual [8], and
- A rural energy survey: A survey of domestic rural energy use and potential[9]
- National Population Census 2007 and 2017

Estimation of Emissions from Fuelwood Collection

- Emissions from fuelwood consumption were estimated based on National census data which reports population distribution between urban and rural areas and household sizes.
- The fuelwood use per household was sourced from National Energy Demand/Supply Database.
- A conservative assumption was made that household consumption rate remain same over the time period.
- The emissions were estimated by assuming the kg of fuelwood consumed was on a dry weight basis, multiplying by the carbon content and converting C to CO_2e.
- The contribution to the annual FRL emissions was determined by dividing the emissions from fuelwood by the total estimated FRL emissions.
- The contribution of household emission to the total FRL emissions was determined to be 15%

Table 9: Emissions from Fuelwood Consumption

	2007		**2017**		**Reference**
Indicator	**Urban**	**Rural***	**Urban**	**Rural**	
Population of Fiji	424, 861	412, 410	494, 252	390, 635	Fiji Bureau of Statistics
Average household sizes areas	4.8	4.7	4.6	4.6	
Number of households using fuel wood	12,829	60,850	6,718	35,210	
HH consumption rate (kg/HH/Year)*	378	927	378	927	(SOPAC, 2000)
Total fuel wood consumption (kg/year)	4,849,362	56,407,950	2,539,404	32,639,670	Calculated
Total fuel wood consumption (kg/year)	61,257,312		35,179,074		Calculated
t/year	61,257.31		35,179.07		Calculated
tC/year	28,790.94		16,534.16		Calculated
tCO_2-e	105,566.77		60,625.27		Calculated
% of total FRL emission from fuel wood					Calculated
Average % Emissions from Fuel wood					Calculated

Note: the carbon conversion factor (0.47) and CO_2e conversion factor (3.667) were sourced from the IPCC 2006.

The fuelwood emissions estimated in Table 3 above indicate the declining trend in fuelwood emissions and insignificant at the end of reference of period. Therefore, exclusion of emissions form fuelwood from the FRL is conservative.

Data constraints and priorities for step-wise approach to improve data on fuelwood

- Data on fuelwood use during reference period is limited
- This data has national value in reporting a number of indicators including those related to National greenhouse gas emissions

---

[8] http://prdrse4all.spc.int/system/files/MR0381.pdf

[9] https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/5000/IDL-5000.pdf?sequence=1

- Designing and implementing a systematic fuelwood collection protocol and process is a priority
- Fuelwood consumption is anticipated to decrease in comparison to the Reference Period as many Fijians are moving to urban areas in search of work opportunities, shifting to modern fuels such as LPG and kerosene and electrification of villages is expanding. These combined changes are expected to result in lower fuel wood consumption. These changes are happening despite the REDD+ interventions.
- Collecting data on fuelwood use to demonstrate the declining trend in fuelwood use could be part of the step-wise approach.

References:

SOPAC, 2000. THE NATIONAL ENERGY DEMAND/SUPPLY DATABASE MANUAL :(Access on 13 March 2019, Fiji National Energy Demand/Supply Database Manual [http://prdrse4all.spc.int/system/files/MR0381.pd

ANNEX 14-1: FEEDBACK GRIEVANCE AND REDRESS MECHANISM

Annex 14-1: Feedback Grievance and Redress Mechanism

ANNEX 15-1: TYPES OF BENEFIT SHARING MODELS IN FIJI

The SESA study has identified 5 types of benefit sharing models that exist in the country. A brief overview of the five benefit sharing models is explained in the following sections.

i. ***The iTaukei Lands Trust Board (the Board) Model:*** The TLTB is responsible to protect and manage land ownership rights assigned to iTaukei landowners and to facilitate the commercial transactions that revolve around its use through a process of leasing and licenses. Under the iTaukei Lands Trust Act (TLTA - see Section 4.5), the control of iTaukei land is vested in the Board and administered by the Board for the benefit of the iTaukei owners. TLTB collects the premiums, lease rentals and other fees derived from land resource transactions. Lease rental money is distributed according to the provisions of section 14 of the TLTA and the iTaukei Land Trust (Leases and Licenses) (Amendment) Regulations 2010. All benefit payments to TLTB are expressly stated in the terms and conditions of the lease agreement, clearly stating the amount to be paid. Usually, lessees are expected to make two payments in a financial year. These are received and distributed to the landowning units by TLTB. Upon receipt of rental payments and after deduction of poundage on leases (administration fee), TLTB is legally mandated to remit the payments to all individual members' bank accounts (above 18 years) in equal parts. The register of all living members from the record of the VKB (register of all living members), housed at the offices of the iTaukei Lands and Fisheries Commission, is cross-referenced to ensure currency of members. Member deaths and births are recorded through periodic updates.

ii. ***The Land Bank model:*** The Land Use Decree (See Section 4.5) offered iTaukei owners the option to have their lands administered by government through a system commonly referred to as the Land Bank. Despite the provisions of the Land Use Decree, the iTaukei lands that remain in the control of the TLTB continue to be administered under the provisions of the TLTA. Under this model land-owning units (LOUs) are required to elect up to five qualifying members who, after approval by the Prime Minister, are to act as trustees for their respective LOU. Trustees receive lease rental payments and are then responsible for their distribution according to specifications as articulated in the deed of trust. Unlike the TLTB model, the Land Bank Model distributes 100% payment of lease rentals to the LOUs. The state guarantees the payment and the methodology of the distribution of lease monies amongst members of the LOUs.

iii. ***Charitable trusts:*** The Charitable Trusts Act makes particular provision for charities. Significantly, it also makes provision for the incorporation of charitable trusts. For the operation of the system, it is important that a charitable purpose is being fulfilled by the trust. In addition to the four traditional purposes of charity – relief of poverty, advancement of education, advancement of religion, and other similar purposes of a public nature; the Act provides for the application of the Act to other purposes declared charitable by the Attorney-General. Many attempts have been made to make this trust operational, but none has been for environmental purposes, although international practice has, in many cases, extended charity to cover environmental purposes. In the case of its use for REDD+ benefit distribution purposes, Attorney-General should accede to a request to declare an environmentally oriented trust charitable.

iv. ***Companies benefit sharing mechanism:*** A company limited by guarantee is incorporated under the Companies Act 2015 and may provide a suitable option for non-profit organization. Instead of shareholders (company limited by shares), there are members who agree to subscribe a certain (typically nominal) amount in the event of the company being wound up. Registering a company limited by guarantee provides an alternative company registration process and, once registered; the company can apply to FRCA for not-for-profit-status, giving it the same tax exemptions as would normally be associated with a charitable trust.

v. ***Benefit-sharing mechanisms – incorporation as a co-operative:*** The Co-operatives Act 1996 provides that a co-operative is an association of persons who have voluntarily joined together to achieve a common end through the formation of a democratically controlled organization which makes equitable contributions to the capital required and accepting a fair share of the risks and benefits of the undertaking. Members of the co-operative actively participate in the running of the co-operative, which is provisionally or fully registered under the Co-operative Act. A co-operative aims at promoting the economic and social interests of its members by providing effective services that the members need and can make use of. The Co-operative may function as a primary or secondary cooperative, apex organization or the National Co-operative Federation registered according to the provisions of the Act. Often, the main purpose of a co-operative is to maximize profit, ensure inclusivity and to ensure long-term sustenance of business operations. The co-operative must operate according to sound business principles. A registered co-operative is also a body corporate and, once registered, it may apply for a tax holiday for up to eight years. Co-operatives have by-laws or internal regulations and must hold an annual general meeting once every financial year. It is run by a board of directors, and delivers a dividend and bonus, being a share of the surplus.

Table: Relevance of the types of Benefit Sharing Mechanism in Fiji to ER-P Implementation

BSM	Strengths for REDD+ benefit sharing	Challenges for REDD+ benefit sharing
Sovi Basin	• Provides a model for monetary benefits (cash) to landowners combined with non-monetary benefits to entire communities to create incentives for all people in the surrounding communities to participate in conservation. This approach recognizes rights and opportunity costs. •	• The transaction costs for annual negotiation and disbursement for the non-monetary benefits are high. The Sovi Basin Trust Fund covers salaries for 2 staff but also needs significant time and support from the National Trust Director and CI staff whose time is not covered. • A portion of landowners think that non-monetary funds should be allocated to each village based on the proportion of land owned, which would give their village a larger share. However, this will defeat the purpose of the community fund aimed at equitable share to all community members including those with no land in the Protected Area. • Costs of reforestation and labour to remove African tulips are currently not covered.
Drawa	• Monetary benefits include lease payments and equal share of the remainder between 8 LOU and to 2 associations • Plan Vivo documentation is detailed and transparent with independent verification • Cooperative is flexible so LOU can join or leave	• Only 60% of the carbon revenues go to local stakeholders • The reference level and MRV will need to be aligned with national approach – which will change the ERs generated and the methodology used. It will no longer be possible to use Plan Vivo methodologies and sell Plan Vivo credits. ERs generated and exported from Fiji will need to be cancelled from the national account in the future.

BSM	Strengths for REDD+ benefit sharing	Challenges for REDD+ benefit sharing
Nakauvadra	• The local communities received significant benefits as they were paid to plant trees and they received in-kind benefits. • Upfront payments paid for the costs and labour for tree planting. • A lot of benefits flowed to the community from the work they carried which led to good behavioural changes to protect the forests in some communities	• No further carbon finance will be received. Fiji Water paid up front for the planting costs and other in-kind benefits in exchange for all ERRs generated over 30 years from 2009. No further funds will be transferred. No funds are available for maintenance of the trees after 2019. • ERRs generated must be cancelled from the national account to avoid double payment for the same ERRs. • No lease arrangements so no ongoing cash payments to landowners but they did receive 4x normal planting rate. • Upfront payment does not cover opportunity cost for next generation. • Low transparency on the funding received and how it was distributed within the community. Though a lot of benefits flowed to the community, it was not clear who received what and this is quite common in the community setting. The benefits flow in for the work that was done and not for the behavioural changes in the community over time.
Emalu	• One landowning unit in one village - makes it simple • Non landowners have received benefits through a training program as well as livelihood projects that were developed for the village	• Does not consider beneficiaries from other villages in the same District. • Benefits are not performance based, as there is no conservation agreement for the non-monetary community benefits and there is no formal arrangement with the communities.
TLTB	• Proven track record since 1940 • Clear process and benefits to landowners • Premiums are upfront payments • Landowners can be fined for breach of conditions in the lease agreements (eg, if trees are cut) • Already accommodates special lease type for REDD+/conservation • Affords long-term certainty and limits conflicts, given TLTB's vast historical data bank for all landowning units (LOUs) in Fiji • Interface of LOU data with external institutions systems such as banks and makes direct payments to members easy while removing imperceptible practices associated with manual distribution • Has dispute and grievances provisions for the landowners. • Equal dividend payment to individual members of the landowning unit. • Allows for flexible payments systems towards commercial and social projects under an assignment as collectively preferred by landowning units. • Funds are invested for landowners under 18 years old until they become adults. • Has the systems and reach to landowners all over Fiji. • Considers the future land needs of the landowners.	• Only deals with iTaukei landowners • Relies on initiative of landowners to allocate funds for alternative livelihoods • All benefit-sharing arrangements may be restricted within the allowable ambit of leases and licences regulations • Subject to limitation of laws and regulations • There are two types of land market in Fiji, one is regulated, and the other is market based. All agricultural leases are governed by ALTA where rent us regulated at 6% of Unimproved Capital Value (UCV). TLTB charges a new lease consideration or premium based on land classifications • Open market is applied to all leases (non-agricultural leases) under a willing seller/ willing buyer basis • Lack of capacity to assign value to customary rights and interests on land such as intangible value. (This a challenge not only for TLTB, but for Fiji) • Administration fee, which is a charge of 10% on monies received on behalf of landowning units.

BSM	Strengths for REDD+ benefit sharing	Challenges for REDD+ benefit sharing
Land Bank	• iTaukei land is deposited by voluntary consensus of no less than 60% of signatories is mandatory • Analysis of land availability is carried out to ensure sufficient land is available for LOU future sustenance before any land parcel is deposited in the land bank. If land availability ratio is below average, then LOU are advised not to deposit land • No-monetary benefits are negotiated before and lease process is concluded as part of the lease condition and is captured under the special condition clause of the lease document. • Regular consultation through Ministry of Lands /Land Bank with LOU from expression of interest to the final process of leading endorsement where LOU input is significant • Issues cadastral leases and instrument of title when lease is issue • Lease rentals valued at market price • Direct payments of lease monies to LOU Trustees the • LOU are at liberty and mandated to select their trustees through their Annual General Meeting endorsed by more than 60% of members • 100% payment of lease rentals to the LOUs with no administrative costs paid to the Ministry of Land /Land Bank • Administrative procedures are all managed by the Ministry of Land /Land Bank on behalf of the landowners • Longer tenure of leases for commercial and agricultural purposes • Land Use Act allows exit for any land parcel deposited where it is regulated that LOU may apply cessation of designation five years after land is deposited and leasing is not secured.	• Being a new instrument, the main challenge is to convince LOU to deposit land into Land Bank. • Long turn-around time for lease because it is a legislated requirement that any lease issued under the land bank should be surveyed. • Affordability of long-term leases over large parcels of land as lease rentals are valued at market price under the Land Use Act • Lack of capacity to value cultural rights, biodiversity, and intangible values as there is no legislated requirement to incorporate above factors to form part of land value. • No legal redress mechanism in place to address disputes amongst the LOU when lease monies are released to trustees. • Risk of landowning units changing stance and not honouring their own decisions when trustees are selected. •

BSM	Strengths for REDD+ benefit sharing	Challenges for REDD+ benefit sharing
Charitable trust	• Landowners empowered to manage their financial resources from lease rental • They are free from taxation • Trust is governed by the trust deed act. • For charitable purposes only. • Non - profit organisations.	• Lack of transparency and oversight leads to lack of trust in financial management • Registration formality under the act is limited. • Benefit is shared to the public and not only the targeted community. • The purpose is limited to relief of poverty, advancement of education, advancement of religion, and other similar purposes of a public nature. • Public accountability is limited. • Non profit entity.
Cooperative	• Flexible and less onerous to create and manage • Can include non-landowners • Oversight by Ministry of Industry, Trade and Tourism/Department of Cooperatives • Ownership usually rests with members, i.e. landowning unit or community • Primary purpose is to serve the needs of the members • Administered by the board and delivers a dividend and bonus as share of the surplus every year. • Equal sharing of benefits to all members. • Opportunities to other groups and new members to join • Tax holiday for up to eight years if registered.	• Some degree of lack of transparency leads to lack of trust in financial management • Driven by market forces • The returns are lower as its main purpose is to service members and not maximise profits. • Requires at least eighty per cent (80%) of members to be permanent full-time employees
Company	• A company limited by guarantee and incorporated under the Companies Act 2015. • Separate entity that can support long-term sustainability of the targeted community initiatives	• Driven by market forces • More sophisticated set-up (administrative costs, risks and complexities). • More capital upfront • Can incur investment losses • A legal or accountancy firm engaged to meet all the regulatory requirements. • To apply for a not-for-profit / tax exemption status, the articles of association to indicate how the assets will be distributed if company ceases operations. •
Mineral Royalties	• Fair Share of Mineral Royalties Act (2018) • Royalty from minerals shared in the following manner— (a) 20% of the royalty to the State; and (b) 80% of the royalty to the owner of the land and Qoliqoli areas (beach, lagoon and reef).	• Carbon is not considered a mineral by definition of the Mining Act; nevertheless; ○ Based on information gathered at Divisional and National workshop, REDD+ Stakeholders prefer to maximise benefits given to beneficiaries ○ Recommended share for Government is 10% maximum (3% ideal), 5% buffer and balance (<85%) to beneficiaries.

Risk	Suitability	Advantages	Disadvantages
iTaukei Lands Trust Board (TLTB) Model			
• All benefit-sharing arrangements may be restricted within the allowable	• Affords long-term certainty and limits conflicts, given TLTB's vast historical data bank for all landowning units (LOUs) in Fiji • Interface of LOU data with external institutions systems	• Administration fee, which is a first charge on monies received on behalf of landowning units, are considered high. • Equal dividend payment to individual members of the landowning unit.	• Subject to limitation of laws and regulations • Current system predominantly advocate monetary benefits • TLTB considering non-monetary benefits as a policy option moving into the future

Risk	Suitability	Advantages	Disadvantages
ambit of leases and licences regulations • Not subject to or driven by market forces.	such as banks makes direct payments to members easy and removes imperceptible practices associated with manual distribution	• Although it allows for flexible payments systems towards commercial and social projects as collectively preferred by landowning units; current system is predominantly monetary benefits.	
Land Bank Model			
• Land Use Unit of the Ministry of Lands is mandated the benefit of the LOUs	• Direct payments of lease monies to LOU members' bank accounts. • Administrative procedures are all managed by the Land Use Unit.	• 100% payment of lease rentals to the LOUs with no administrative costs paid to the Land Use Unit. • Longer tenure of leases for commercial and agricultural purposes • Guarantee of payment by the state • Allows members of a LOU to determine how their wealth should be distributed and managed hence supports both monetary and non-monetary benefits.	• Political stability may affect appointment of trustees. The Prime Minister has the discretion to approve and appoint the elected members as trustees of the LOU or seek further names for appointment.
Private Initiatives and Trust Deeds			
• Informal trusts are not formally registered body which could be a risk in the long term.	• Community initiated and regulated and do not need to meet external standards.	• Minimal administrative requirements. • Community ownership- giving communities to utilise existing traditional structures.	• Communities are liable to the actions of the informal trust. • An initial source of funds/endowment revenue stream is required. • There are donor requirements, and these include the entity to be registered. • Can incur investment losses • Taxation- the informal trust would be liable to pay tax.
Charitable Trusts			
• Registration formality under the act is limited.	• Trust is governed by the trust deed act.	• They are free from taxation.	• Benefit is shared to the public and not only the targeted community. • The purpose is limited to relief of poverty, advancement of education, advancement of religion, and other similar purposes of a public nature. • Public accountability is limited.
Companies			
• Driven by market forces.	• A company limited by guarantee and incorporated under the	• Separate entity that can support long-term sustainability of the	• More sophisticated set-up (administrative costs, risks and complexities).

Risk	Suitability	Advantages	Disadvantages
	Companies Act 2015.	targeted community initiatives.	• More capital upfront • Can incur investment losses • A legal or accountancy firm engaged to meet all the regulatory requirements. • To apply for a not-for-profit / tax exemption status, the articles of association to indicate how the assets will be distributed if company ceases operations.
Incorporation as a Cooperative			
• Driven by market forces.	• Ownership usually rests with members, i.e. landowning unit or community • Primary purpose is to serve the needs of the members (landowning unit)	• Administered by the board and delivers a dividend and bonus as share of the surplus every year. • Equal sharing of benefits to all members. • Tax holiday for up to eight years if registered.	• The returns are quite less as its main purpose are to service members and not maximise profits. • Requires at least eighty per cent (80%) of members to be permanent full-time employees

Annex 15-2: Matrix on Definition of Beneficiaries and Types of Benefits

ANNEX 15-2: DEFINITION OF BENEFICIARIES AND TYPES OF BENEFITS

		•	•
		•	•
		•	•
		•	•
			•
		•	•

Carbon Enhancement: Community Based Planting – Table 1					
Actors	**Rights or influence**	**Roles and responsibilities**	**Beneficiary Group**	**Types of Benefits**	
				Non-carbon benefits	**Carbon Benefits**

iTaukei Landowning Units	Rights to manage own land, to plant and harvest trees	Landowners plant and harvest trees and crops, protect trees	Landowning Units that register to plant trees on their own land	+ Revenue from timber + Training on basic forest management principles (planting and maintenance) from MOF + Enhanced protection of woodlots	Monetary: Lease payment Monetary or Non Monetary: Incentives for tree planting (e.g. RDF model $244/ha)
Villages/communities that use the forest	Rights to basic needs; building materials, firewood, food. Threat to forest.	Protect trees from fire and illegal use of forest resources, monitor and enforce forest laws	Villages/communities that use the forest	+ Maintained supply of forest products, (e.g. timber, firewood) and ecosystem services etc.	Non-Monetary: Community development project

Forest Conservation

The intervention supports forest conservation and maintaining carbon sinks, the protection of watershed areas and ensuring clean water sources, the continuous supply of nutrients and soil fertility to maintain and enhance crop production. Forest conservation is related to long term management of forest resource with the aim of supporting areas that will remain forested into perpetuity. Without this intervention, important forest sites within Fiji will continue to face threats from degradation (logging) and deforestation (conversion).

Main Actors	Rights or influence related to the activity	Roles and responsibilities for ensuring success of the activity	Beneficiary Group	Types of Benefits	
				Non-carbon benefits (from other sources not CF)	Carbon Benefits (from CF)
Owners of land – iTaukei or other	Rights to lease land	Consent to lease for conservation	Owners of land who consent to a conservation lease	+ Lease payment from the conservation lease holder and compensation cost	
	Rights to manage forest on own land	Landowners protect the forest	Owners of land who register to adopt forest conservation on their forest lands	+ Income from ecotourism	Monetary: Lease payment and compensation cost
Private sector or NGO lease holder	Right to benefits from forest conservation	Protect the forest	Private sector or NGO lease holder	+ Income from ecotourism + Enhanced forest protection	

Villages/ communities that use the forest	Rights to basic needs; building materials, firewood, food. Threat to forest	Protect from fire, illegal use of forest resources, monitor and enforce forest laws	Village/communities that use the forest	+ Maintained supply of forest products, (e.g. timber, firewood) and ecosystem services etc.	Non-monetary: Community development project
Provincial Council/ Ministry of iTaukei Affairs	Governance Support	Facilitators, arbitrator, FGRM for iTaukei Lands			
District Council/ Ministry of Rural Development	Governance Support	Facilitators, arbitrator, FGRM for non iTaukei Lands			
Ministry of Forests	Technical Advice	monitoring and enforcement			
CSO	Technical Advice & Social Services	support facilitation and engagement			

Sustainable Management of Native Forest

This intervention aims to address the establishment of long-term Forest Management Licenses and the application of the revised FFHCOP that integrates RIL principles including application of diameter limit tables.

Specific activities include:

- Public/Private Partnership and dialogue to establish Forest Management Licenses
- Application of the new FFHCOP that incorporates Reduced Impact Logging and diameter treatment through close collaboration between private sector, statutory bodies and Government agencies
- Public/Private Partnership between communities and logging companies to co-manage native forest resources through implementation of the FFHCOP in all Forest Management License Areas
- Enable and support multi stakeholder dialogue and decision through the District and Provincial REDD+ Working Groups to support the Divisional REDD+ Working Groups

Main Actors	**Rights or influence related to the activity**	**Roles and responsibilities for ensuring success of the activity**	**Beneficiary Group**	**Types of Benefits**	
				Non-carbon benefits (from other sources not CF)	**Carbon Benefits (from CF)**
Owners of land – iTaukei or other	Rights to lease land	Consent to lease for sustainable management of forests or for plantation	Owners of land who consent to forest management or plantation lease	+ Lease payments, market premium, rent, stumpage paid by lease holder	
	Rights to manage own forest	Owners of land plant	Owners of land managing their	+Timber revenue	

		and harvest trees and crops, protect trees	own forests/plantation who register to adopt sustainable management of forests/plantation	+ Training on RIL principles and monitoring FFHCOP from MOF - Pay own lease payment + Enhanced protection of forest/plantation	
Larger private sector lease holders	Rights to use land to plant trees, harvest wood etc.	Developer – plant trees, harvest wood, protect trees, finance	Private Forestry Companies registered to do REDD+ activities	- Loss in timber revenue from adoption of Reduced Impact Logging + Increased security from longer term leases for 50 years + Training on RIL principles and monitoring FFHCOP from MOF + Enhanced protection of forest/plantation	
Villages/ communities that use the forest	Access Rights for traditional use meeting basic needs; building materials using naturally growing trees, firewood, food. May also pose threat to forest plantation	Protect from fire and illegal use of forest resources, monitor and enforce forest laws, paid labor	Villages/communities that use the forest	+ Maintained supply of forest products, (e.g. timber, firewood) and ecosystem services etc. + Training to use waste timber for revenue from MOF	Non-monetary: Community development project
Provincial Council	Governance Support	Facilitators, arbitrator, FGRM for iTaukei Lands			
District Council	Governance Support	Facilitators, arbitrator,			

		FGRM for non iTaukei Lands			
Ministry of Forests	Technical Support	Authorization for logging, monitoring and enforcement			
CSO	Technical and Social Support	support facilitation and engagement			

Carbon Enhancement Plantations - Private Plantations, Fiji Pine and Fiji Hardwood

Fiji Pine Ltd. and Fiji Hardwood Corp. are private Government owned companies that manage plantation estates in Fiji. Fiji Pine Ltd have an estate estimated at 76,171 ha while Fiji Hardwood Corp holds 58,978ha. This intervention aims to support establishment of plantation areas in logged over forest estates and the application of the FFHCOP. The following activities apply to Fiji Pine Ltd. and Fiji Hardwood Corps.

- Capacity building on the requirements of the FFHCOP
- Strengthening of monitoring and evaluation of planted areas.
- Implementation of the Fire Management Strategy

Main Actors	**Rights or influence related to the activity**	**Roles and responsibilities for ensuring success of the activity**	**Beneficiary Group**	**Types of Benefits**	
				Non-carbon benefits (from other sources not CF)	**Carbon Benefits (from CF)**
Owners of land – iTaukei or other	Rights to lease land	Consent to lease for sustainable management of forests or for plantation	Owners of land who consent to forest management or plantation lease	+ Lease payments, market premium, rent, stumpage paid by lease holder	
	Rights to manage own forest	Owners of land plant and harvest trees and crops, protect trees	Owners of land managing their own forests/plantation who register to adopt sustainable management of forests/plantation	+Timber revenue + Training on RIL principles and monitoring FFHCOP from MOF - Pay own lease payment + Enhanced protection of forest/plantation	
Larger private sector lease holders	Rights to use land to plant trees, harvest wood etc.	Developer – plant trees, harvest wood, protect trees, finance	Private Forestry Companies registered to do REDD+ activities	- Loss in timber revenue from adoption of Reduced Impact Logging + Increased security from longer term leases for 50 years	

				+ Training on RIL principles and monitoring FFHCOP from MOF + Enhanced protection of forest/plantation	
Villages/ communities that use the forest	Access Rights for traditional use meeting basic needs; building materials using naturally growing trees, firewood, food. May also pose threat to forest plantation	Protect from fire and illegal use of forest resources, monitor and enforce forest laws, paid labor	Villages/communities that use the forest	+ Maintained supply of forest products, (e.g. timber, firewood) and ecosystem services etc. + Training to use waste timber for revenue from MOF	Non-monetary: Community development project
Provincial Council/ Ministry of iTaukei Affairs	Governance support	Facilitators, arbitrator, FGRM for iTaukei Lands			
District Council/ Ministry of Rural Development	Governance support	Facilitators, arbitrator, FGRM for non iTaukei Lands			
Ministry of Forests	Technical Advice	Authorization for logging, monitoring and enforcement			

Carbon Enhancement Community Planting: Riparian planting – flood mitigation

Successful models for community forestry exist in Fiji such as the Fiji Pine Trust and the Nakauvadra Community Based Reforestation Project and Reforest Fiji. Fiji Pine Trust focuses on community development and expansion of Fiji Pine (*Pinus Caribbea* var. hondurensis) while the latter focused on mix planting of native species, mahogany and teak aimed at ecosystem restoration. Willingness of local landowning units to engage with tree planting and availability of idle and degraded lands makes this intervention promising.

Intervention will entail community agreement to undertake planting trees and a long-term commitment that all members of the clan will protect and support the maintenance and care of the planted trees to be protected from fire, indiscriminate cutting or alternative future land use – at the very least, for 30 years being the average timber cycle for native and introduced species in Fiji. With Fiji's rich cultural heritage, the approach will combine traditional modes of communication aligned to FPIC while guided by REDD+ Communications Plan.

The Fiji Government launched its 4 million tree initiative in February 2019. This initiative is supported by the community planting with areas planted well over the 4million trees to buffer expected survival rate of 70-80%.

Flood Mitigation

- Increase service and intervention by Ministry of Agriculture and Ministry of Forestry Extension Services through Agroforestry advice to local farmers and distribution of climate resilient crops varieties from the Koronivia Research Station;
- Public/Private Partnership and dialogue through field school exchange among farmers facilitated by the Ministry of Agriculture and Ministry of Forestry Extension Services;

Note: trees will be planted at 4mx5m along 400m x 50m on either side of the river bank with vetiver grass planted 3 rows at the edge using spacing of 0.5mx0.5m. the result is at least 4 ha of forest on either side of the river bank with

Main Actors	**Rights or influence related to the activity**	**Roles and responsibilities for ensuring success of the activity**	**Beneficiary Group**	**Types of Benefits**	
				Non-carbon benefits (from other sources not CF)	**Carbon Benefits (from CF)**
iTaukei Landowning Units	Rights to manage own land, to plant and harvest trees	Landowners plant and harvest trees and crops, protect trees	Landowning Units that register to plant trees on their own land	+ Revenue from timber + Training on basic forest management principles (planting and maintenance) from MOF + Enhanced protection of woodlots	Monetary: Lease payment Monetary or Non Monetary: Incentives for tree planting (e.g. RDF model $244/ha)
Villages/communities that use the forest	Rights to basic needs; building materials, firewood, food. Threat to forest.	Protect trees from fire and illegal use of forest resources, monitor and enforce forest laws	Villages/communities that use the forest	+ Maintained supply of forest products, (e.g. timber, firewood) and ecosystem services etc.	Non-Monetary: Community development project
Provincial Council/ Ministry of iTaukei Affairs	Governance support	Facilitators, arbitrator, FGRM for iTaukei Lands			
District Council/ Ministry of Rural Development	Governance support	Facilitators, arbitrator, FGRM for non iTaukei Lands			
Ministry of Forests	Technical Advice	Authorization for logging, monitoring and enforcement			

CSO	Technical Advice & Social Services	support facilitation and engagement			

Carbon Enhancement Community Planting: Agroforestry and Alternative Livelihood

Shade Grown Agriculture

- Establishment of kava, vanilla and other shade tolerant crops;
- Aimed at mid-slope and lower slope cultivation to avoid deforestation;
- Assume that alley cropping design may be relevant to maximize production by local farmers such that kava, vanilla and other share grown crops are intercropped in agroforestry system;
- The proportion of forest that will be retained in 1ha is estimated at 0.3ha to meet the definition of forest;
- At national level, intervention is aimed at 1000ha per year hence the area of avoided deforestation is 300ha per year.

Main Actors	**Rights or influence related to the activity**	**Roles and responsibilities for ensuring success of the activity**	**Beneficiary Group**	**Types of Benefits**	
				Non-carbon benefits (from other sources not CF)	**Carbon Benefits (from CF)**
Owners of land – iTaukei or other	Rights to lease land	Consent to lease for agroforestry	Owners of land who consent to an agriculture lease	+ Lease payments, market premium, rent, stumpage from the lease holder	
	Rights to manage own land in a sustainable manner	Owners of land plant and harvest trees and crops, protect trees, finance	Owners of land who register to adopt agroforestry on their land	+ Revenue from crops and timber + Training on forest management (planting and maintenance) from MOF and training on agroforestry from MOA - Pay own lease payment	
Larger private sector lease holders	Rights to use land for agriculture	Plants and harvests crops and trees, protects trees, provides finance	Private Companies registered for REDD+ activities	+ Improved yields from agroforestry + Training on forest management from MOF and agroforestry from MOA	

				+ Enhanced protection of trees	
Small farmer lease holders < 5 ha	Rights to use land to for agriculture	Developer – plan and harvest crops and trees, protect trees, finance	Small farmer lease holders < 5 ha	+ Training on forest management from MOF and agroforestry from MOA, possibly with subsidy + Enhanced protection of trees	Monetary or Non-monetary: Incentives (e.g. seedlings, materials)
Villages/ communities that use the forest	Use for basic needs; building materials, firewood, food. Threat to forest	Protect from fire and illegal use of forest resources, monitor and enforce forest laws	Village/ communities that use the agroforestry area	+ Maintained supply of forest products, (e.g. timber, firewood) and ecosystem services etc.	Non-monetary: Community development project
Provincial Council/ Ministry of iTaukei Affairs	Governance Support	Facilitators, arbitrator, FGRM for iTaukei Lands			
District Council/ Ministry of Rural Development	Governance Support	Facilitators, arbitrator, FGRM for non iTaukei Lands			
Ministry of Forests	Technical Advice	Authorization for logging, monitoring and enforcement			
Ministry of Agriculture	Technical Advice				
CSO	Technical and Social Services	support facilitation and engagement			

Carbon Enhancement Community Planting: Agroforestry and Alternative Livelihood

Alternative Livelihood activities

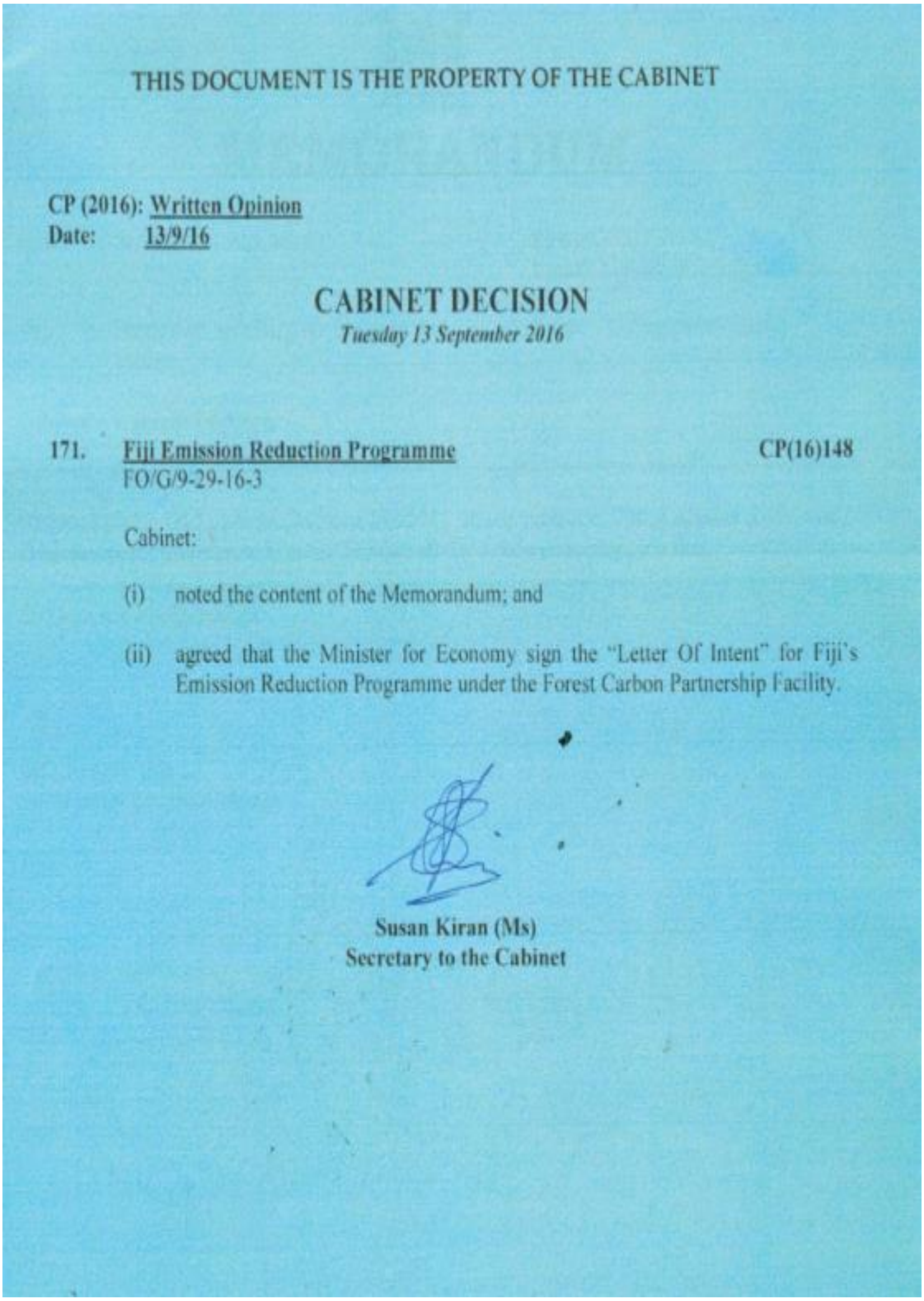
- Increase services and intervention by Ministry of Agriculture supporting vanilla, bee keeping, and supply of pawpaw, breadfruit, pineapple and seedlings of other tradeable commodities;
- Encourage and strengthen uptake of minimum tillage and shade grown agriculture including kava and vanilla among rural farmers at the fringe of forest areas to reduce deforestation.
- Public/Private Partnership and dialogue through field school exchange among farmers facilitated by the Ministry of Agriculture and Ministry of Forestry Extension Services

  Undertake value chain assessment of key commodities to support market access by rural communities while rationalising coordinated District level approach to agriculture production. This idea supports the "cluster" initiative and linked to the integrated land use plan. The aim is to develop target commodities per district. The commodity is dictated by the land capability. Participant farmers are than organised in clusters to produce "on-schedule" to avoid flooding the market with single commodity but to facilitate consistent supply of agriculture commodity all year around – sharing the proceeds in a consistent manner.

Main Actors	Rights or influence related to the activity	Roles and responsibilities for ensuring success of the activity	Beneficiary Group	Types of Benefits	
				Non-carbon benefits (from other sources not CF)	Carbon Benefits (from CF)
Owners of land – iTaukei or other	Rights to lease land	Consent to lease for agroforestry	Owners of land who consent to an agriculture lease	+ Lease payments, market premium, rent, stumpage from the lease holder	
	Rights to manage own land in a sustainable manner	Owners of land plant and harvest trees and crops, protect trees, finance	Owners of land who register to adopt agroforestry on their land	+ Revenue from crops and timber + Training on forest management (planting and maintenance) from MOF and training on agroforestry from MOA - Pay own lease payment	
Larger private sector lease holders	Rights to use land for agriculture	Plants and harvests crops and trees, protects trees, provides finance	Private Companies registered for REDD+ activities	+ Improved yields from agroforestry + Training on forest management from MOF and agroforestry from MOA + Enhanced protection of trees	
Small farmer lease holders < 5 ha	Rights to use land to for agriculture	Developer – plan and harvest crops and trees, protect trees, finance	Small farmer lease holders < 5 ha	+ Training on forest management from MOF and agroforestry from MOA, possibly with subsidy + Enhanced protection of trees	Monetary or Non-monetary: Incentives (e.g. seedlings, materials)
Villages/ communities that use the forest	Use for basic needs; building materials, firewood,	Protect from fire and illegal use of forest resources, monitor and enforce forest laws	Village/ communities that use the agroforestry area	+ Maintained supply of forest products, (e.g. timber, firewood) and	Non-monetary: Community development project

	food. Threat to forest			ecosystem services etc.	
Provincial Council/ Ministry of iTaukei Affairs	Governance Support	Facilitators, arbitrator, FGRM for iTaukei Lands			
District Council/ Ministry of Rural Development	Governance Support	Facilitators, arbitrator, FGRM for non iTaukei Lands			
Ministry of Forests	Technical Advice	Authorization for logging, monitoring and enforcement			

ANNEX 17-1: CABINET DECISION ENDORSING REDD+ AND SUPPORTING MINISTRY OF ECONOMY



THIS DOCUMENT IS THE PROPERTY OF THE CABINET

CP (2016): <u>Written Opinion</u>
Date: <u>13/9/16</u>

CABINET DECISION

Tuesday 13 September 2016

171. **<u>Fiji Emission Reduction Programme</u>** **CP(16)148**
FO/G/9-29-16-3

Cabinet:

(i) noted the content of the Memorandum; and

(ii) agreed that the Minister for Economy sign the "Letter Of Intent" for Fiji's Emission Reduction Programme under the Forest Carbon Partnership Facility.

Susan Kiran (Ms)
Secretary to the Cabinet