



# Solomon Islands National Forest Reference Level

Submission for the UNFCCC Technical Assessment 2019

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## List of Acronyms

AD:	Activity Data
AFOLU:	Agriculture, Forestry and Land Use
AGB:	Above-Ground Biomass
BGB:	Below-Ground Biomass
BUR:	Biannual Update Report
CBSI:	Central Bank of the Solomon Islands
CE:	Collect Earth
CSO:	Civil Society Organization
COP:	Conference of Parties
EF:	Emission Factor
FAO:	United Nations Food and Agriculture Organization
FREL/FRL:	Forest Reference Emission Level/ Forest Reference Level
FRA:	Forest Resources Assessment
GDP:	Gross Domestic Product
GEF:	Global Environmental Facility
GEZ:	Global Ecological Zone
GHG:	Green House Gases
GIZ:	Gesellschaft fuer Internationale Zusammenarbeit
HFLD:	High Forest Cover Low Deforestation
IPCC:	Intergovernmental Panel on Climate Change
LDC:	Least-developed Country
LLEE:	Live and Learn Environmental Education
LULUCF:	Land use, Land use change and Forestry
LU:	Land Use
MALD:	Ministry of Agriculture and Livestock Development
MECDM:	Ministry of Environment, Climate Change, Disaster Management and Meteorology
MOFR:	Ministry of Forestry and Research
NAPA:	National Adaptation Programme of Action
NDC:	Nationally determined Contributions
NDS:	National Development Strategy 2016-2035
NFI:	National Forest Inventory
NGO:	Non Governmental Organization
RF:	Removal Factor
REDD+:	Reducing Emissions from Deforestation and Forest Degradation
RIU:	REDD+ Implementation Unit under the Ministry of Forestry and Research
QA/QC:	Quality Control and Quality Assurance
SIDS:	Small Island Developing State
SI:	Solomon Islands
SIG:	Solomon Islands Government
SPC:	Pacific Community
t. d.m:	Tons of Dry Matter
UNDP:	United Nations Development Programme
UNFCCC:	United Nations Framework Convention on Climate Change

# 1 Introduction

## 1.1 Overview of the Solomon Islands

Located between latitude 7 and 12 degrees south and longitude 156 and 170 degrees east, enclosed within the



Exclusive Economic Zone (EEZ) of 1.34 million square kilometers, Solomon Islands is a country of oceanic island archipelago in the south western Pacific. It is made up of 990 islands of which six are main islands, smaller islands, islets and low-lying atolls. Together the land mass covers approximately 28,000 square kilometers, the main islands are from volcanic origin and characterized by mountainous and rugged terrain. Mt Makarakomburu in Guadalcanal is Solomon Island's highest peak at 2,447 meters above

sea level.

Figure 1: Map of the Solomon Islands

With a population of 598,860 (SIG, 2015), Solomon Islands has a population density of 21 people per square kilometers, mostly settled along the coastal belts. The population growth rate is 2.7% p.a. (CBSI, 2017). More than 90% of the land is held under customary ownership with only a small portion in the provincial headquarters, Honiara city and other areas belonging to the state. The capital and largest city is Honiara, with nine provincial headquarters in the nine constitute provinces.

With a narrow economic base primarily on natural resources mainly forestry, fisheries, agriculture and mining, and very limited inshore industrial processing, most of the country's revenue derives from exports of raw materials. Consequently, employment opportunities are limited and most of the country's population depends on subsistence activities for income. More than 80% of the population is based in the rural areas and their livelihood depends entirely on natural resources. In 2017, the country's GDP stands at SBD 4,908 million with 3.7% growth (CBSI, 2017).

## 1.2 Overview over the Solomon Islands Forest Sector

In 2016 and 2017, around 65% of the county's export earnings came from forestry, mainly through sale of round logs, which accounts for 20% of the state revenue (CBSI, 2017). The economic dependency on log exports already spans over the last two decades as an effect of no significant contributions from the other sectors. In 2017, log exports reached an all-time high of more than 3.4 million cubic meters, an increase of about 21% from the previous year, and following a trend that persists since year 2000. Records of round log export was already above 1 million cubic meters in 2005 (SIG, 2018a), which is more than four times the sustainable rate estimated at

250,000 cubic meters per annum. At the current harvesting rate, timber resources are expected to last only 1-2 more decades before exhaustion (RAMSI, 2012). On a positive note, logging activities in the rural areas give rise to employment opportunities, royalties and spin-off benefits to resource owners and surrounding communities that improve rural livelihood at least during the lifetime of the logging developments. On the other hand, the social and the environmental repercussions including GHG emissions are significant and may persist over a long period of time. Observing the historical and current trend of the logging industry, increased growth in commercial agriculture, mining and hydro electricity generation as per sector ministries' plans and expected expansion of gardening areas and settlements due to population growth, it can be expected that deforestation and forest degradation activities will continue to increase in the short and mid-term.

### 1.3 Effects of Climate Change in the Solomon Islands

The Inter-governmental Panel Climate Change (IPCC) fourth report has shown that Green House Gases (GHG) will continue to increase to affect our climate (SIG, 2017). Solomon Islands as a Small Island Developing State (SIDS) is only marginally responsible for but among the most vulnerable countries to the adverse impacts of climate change (GFDRR, 2011). This is due to the circumstance that the majority of the population lives along coastlines, which agglomerates economic and infrastructure activities in these locations. The most likely impacts for this location will derive from sea-level rise, which affect crops and fresh water sources, especially in the low lying islands. Severe weather patterns such as cyclones and heavy rains that result in flash floods and soil erosion (landslides) affect crop production, infrastructure and community livelihood on the coast and further inland. This will cause adverse effects on the country's food security, economy, human health, natural resources and physical infrastructure. It is expected that the economic losses as results of climate change for Solomon Islands will amount to 4.7% of the annual GDP by 2100 (SIG, 2014). Climate change related impacts are already experienced all across the Solomon Islands and affect the development in all economic sectors.

For this reason, the Solomon Islands Government (SIG) through the Ministry of Environment, Climate Change, Disaster Management and Meteorology (MECDM) has joined the international community to address climate change through adaptation and mitigation measures. In response to adaptation measures, a National Adaptation Programme of Action (NAPA) was developed to prioritize specific measures of urgent attention, consistent with UNFCCC (SIG, 2008). Likewise, responding to mitigation measures SIG is encouraging countries with higher emissions to legally agree on reducing GHG during negotiations at UNFCCC COP meetings. SIG is also focusing on the energy sector to encourage the ample use of renewable energy sources (SIG, 2017). Similarly, the forestry sector through Ministry of Forest and Research (MoFR) is developing a national REDD+ program since 2010 to reduce forest emission through encouraging forest conservation and sustainable management. The impacts of climate change on development are furthermore addressed by SIG through its National Climate Change policy and National Development Strategy 2016-2035. Government agencies will need to work together with communities, CSO's and the private sector to develop responses to minimize the causes and impacts of climate change on the people, economy and environment of Solomon Islands (SIG, 2012).

### 1.4 Solomon Islands National REDD+ Programme and Readiness Progress

SIG has ratified the Paris Agreement under the UNFCCC to contribute towards carbon off setting mechanisms through REDD+ Actions. Accordingly, SIG has mandated MECDM as the focal point for reporting to UNFCCC and

MoFR as the coordination and implementing agency of the National REDD+ Programme. The four elements for countries to participate in a REDD+ mechanism, as required by the UNFCCC (FAO, 2012) are:

1. A national REDD+ Strategy or Action plan;
2. A national Forest Reference Emission Level and/or Forest Reference Level (FREL/FRL);
3. A robust and transparent national Forest Monitoring System for the monitoring and reporting of the REDD+ activities;
4. A system for providing information on how REDD+ safeguards are being addressed and respected throughout the implementation of the REDD+ activities.

In line with UNFCCC COP agreements, Solomon Islands is currently developing its national REDD+ Program and associated elements. For this purpose, a national REDD+ Roadmap was formulated and endorsed by the cabinet in November 2015 to guide the process for participation in the REDD+ mechanisms and enable Solomon Islands to access result-based payments through reducing forest emission in the future.

The Solomon Islands national REDD+ Readiness process follows a phased approach (see Figure 2).

Phase 1: Preparation: Development of necessary capacities and institutions to implement REDD+ at national level, through development of strategies, action plans, awareness raising and capacity building;

Phase 2: Demonstration and Piloting of Policies and Measures: Field testing of practical measures and strategies may be conducted through demonstration activities, in addition to continuous capacity building and development of new policies and legislation;

Phase 3: Full national implementation of REDD+ activities: A national performance-based system with an operational national forest monitoring system, safeguards information system, and a national forest reference emission level and/or reference level (FREL/FRL).



### Solomon Islands Current REDD+ Readiness Progress

Figure 2: Illustration of the phased REDD+ Readiness approach and current progress in the Solomon Islands

SI national REDD+ program has taken momentum in achieving key requirements of the preparation phase. Its activities were focused on institutional arrangements, stakeholder awareness raising, preparation and submissions of a National REDD+ Forest Reference Level and piloting of REDD+ activities. As for Institutional arrangements, a REDD+ Implementation Unit (RIU) under the MoFR has been mandated to coordinate the



national REDD+ Programme and a National REDD+ Committee has been operationalized as the National REDD+ advisory body. Next, MoFR's RIU team organized two, multi-sectoral REDD+ awareness raising campaigns at national, provincial and community level. Between 2017 and 2018, an annual historical land use and forest cover change assessment was carried out with FAO support for the preparation of the national REDD+FRL submission to the UNFCCC. Whilst developing these components, piloting of project-level REDD+ activities has been carried out under the CSO LLEE (Nakau Program) in Choiseul Province and in Temotu Province with support from the CSO Ocean Watch and funded by New Zealand Government. The establishment of a national REDD+ pilot site is currently underway, and SIG has allocated SBD 2 Million for project development between 2018-2021, these funds have yet to be released, however. The abovementioned components are expected to provide key outcomes for SI REDD+ Readiness. The implementation of these activities is supported by development cooperation projects as UNREDD-FAO, UNDP-CB2, SPC/GIZ REDD+ II and GEF5-FAO IFM.

## 1.5 National and International Policy Environment

Based on socio-economic development and in relation to its heavy reliance on natural resources for development and livelihood, Solomon Islands is considered a small island developing state (SIDS) and a least developed country (LDC) as per United Nations definition. As a result, Solomon Islands remains one of the most vulnerable countries to the anticipated impacts of climate change. In the face of these development challenges and threats, Solomon Islands has joined the international community and ratified the Rio Conventions, the Kyoto protocol and the Paris Agreement to protect its biodiversity, maintain ecosystem functions as well as implement related programs and activities.

MECDM is the responsible government agency for implementing climate change programs in the country. Program Funding and technical support occurred through international cooperation with GEF, UNDP and FAO with supports from related government agencies, NGOs, civil society, private sector and resource owners. The Ministry of Forestry and Research (MoFR) and Ministry of Agriculture and Livestock Development (MALD) are the two main agencies governing the AFOLU sectors.

The present FRL submission for Solomon Islands' is in line with its Nationally Determined Contribution (NDC). The intended Nationally Determined Contribution (INDC) was submitted to the UNFCCC in September 2015 before the ratification of the Paris Agreement in December and was formally registered on the 21<sup>st</sup> of March 2016 as its Nationally Determined Contribution (NDC) under the Paris Agreement, referring to the National Climate Action Plan. The Solomon Islands' National Climate Action Plan has identified the AFOLU and particularly the forest sector as the main potential to reduce national emissions but no targets for emission reductions in the AFOLU sector have been set yet due to lack of data. Therefore, the Solomon Islands' Second National Communications (SNC) to the UNFCCC submitted in September 2017 does not include targets for emission reduction from the forest sector. Hence, both the NDC 2015 and the SNC 2017 may only set out mitigation actions derived from the National Policies: The National Development Strategy (NDS) 2016-2035 and the Medium-Term Development Plan (MTDP) 2016-2020.

The NDS 2016-2035 proclaims the vision of "Improving the Social and Economic Livelihoods of all Solomon Islanders". For climate change mitigation and adaptations, this is translated into two key objectives: (a) to

improve programs to effectively develop and manage the environment sustainably and in the longer term, and (b) to increase support for climate change mitigation.

As a forestry sector policy, the MoFR Corporate Plan 2015-2018 (currently reviewed and updated for next phase 2019-2022) identifies key strategies and actions to address environment sustainability and climate change mitigation and adaptations. The new National Forestry Policy has just been finalized in 2018 (currently awaiting approval from the cabinet) and provides a long-term vision and strategies to promote and implement cross-sectoral actions towards forest sector economic, environmental and social sustainability. The recently launched and cabinet-endorsed Logging Sustainability Policy 2018 provides a set of measures that aim to prevent the depletion of timber resources. Most importantly, the outdated Forest Resources and Timber Utilization Act 1969 is currently at the final stages of review to provide legal footing and the vehicle to implement the relevant policies and programs in the forest sector. Furthermore, supporting legislations already exist and currently implemented by MECDM – the Protected Areas Act 2010, the Environment Act 1998 and the Wildlife Management Act, with relevant amendments and policies anticipated to provide strong backing towards the National Forest Policy and REDD+ program. Similarly, improved policies and legislations of the Agriculture and Land use sector would also be necessary to address deforestation and forest degradations, which would lead to reduced emissions in the forestry sector given the required commitment in terms of financial and technical support for implementation.

## 1.6 Objectives on Developing the National FRL

Solomon Islands has joined the UNFCCC and agreed in COP 15 decisions that implementing FREL/FRLs is important to assess each country's performance in implementing REDD+ activities (FAO, 2015). Hence, Solomon Islands is developing its national FRL for various different reasons at both national and international level:

- Domestic: To assess effectiveness of policies and measures and or meet national objectives to reduce GHG emission from the forest sector;
- Global Responsibility- To demonstrate national contributions to the mitigation of climate change;
- REDD+ Finance: Reducing emissions from deforestation and forest degradation below FRL through REDD+ actions and qualify for results-based payments.

## 2 Definitions

The following chapter defines the set of technical parameters, which form the base for the land use and forest cover change assessment and the construction of the FRL. All definitions were reviewed and validated by a broad group of stakeholders and technical experts during four consultative workshops held in 2017 and 2018.

### 2.1 Solomon Islands National Forest Definition

The definition of forest is an eligibility criterion for FRL submission to the UNFCCC. The choice of a forest definition will influence the extent and drivers of deforestation and forest degradation, and therefore, FRL estimates.

Solomon Islands chooses to adopt the FAO forest definition of:

***“Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use” (FAO, 2012).***

For the Solomon Islands, the adoption of the FAO forest definition has the advantage of maintaining consistency and comparability with past and future FAO Forest Resource Assessment (FRA) data and results.

The following table provides a technical overview of the forest definition parameters:

Table 1: Technical Parameters of the Solomon Islands National Forest Definition.

Definition Criteria	Threshold	Rationale
Minimum Area	≥ 0,5 ha	The Solomon Islands is a nation of six major and over 900 smaller islands, which harbor a heterogeneous array of vegetation types, land-uses and terrain conditions. In order to adequately represent small-scale forest cover changes, it is necessary to adopt a relatively low minimum forest area threshold.
Canopy Cover	≥ 10%	Canopy cover is the criteria which most strongly influences the assessment of forest cover loss. Setting a low canopy cover threshold increases the proportion of forest degradation, while a high canopy cover threshold increases deforestation. The results of the land use and forest cover change assessment show that forest degradation is the most important driver of forest cover loss in the Solomon Islands. Therefore, a low canopy cover threshold of 10% is considered appropriate to adequately assess forest cover loss. Young tree stands with a canopy cover below 10% are included as forest if they can be expected to attain the necessary thresholds in the future.
Tree Height	≥ 5m	The FAO threshold of 5 m is expected to adequately represent the great majority of forest types in the Solomon Islands. There are four exceptions of forest vegetation types which may fall below to the tree height threshold, but are classified as forests: <ol style="list-style-type: none"> <li>1. Mangroves (forest subjected to tidal influences);</li> <li>2. High altitude forests: May be less than 5 meters high but harbors high biodiversity, ecological, cultural and livelihood significance – e.g. water regulation. MoFR recognizes these services and strives to conserve these forest ecosystems.</li> <li>3. Young tree stands with a tree height below 5 m if they can be expected to attain or exceed 5 m in the future.</li> <li>4. Agroforestry systems (areas with mixed agriculture, trees and forestry activities) due to higher permanence, biodiversity and carbon stock as compared to cropland.</li> </ol>

## 2.2 Classification of Forest Types

The SI forest classification is based on the National Forest Resource Inventory (SOLFRIS) carried out from 1991-1994 (Ministry of Forests, Environment and Conservation, 1995). Information on forest types was circulated and reviewed during consultative FRL workshops in 2017 and 2018. All forest types are aligned with the FAO Global Ecological Zones for forest reporting (FAO, 2012a).

Table 2: Description of the Solomon Islands main forest types used in the Solomon Islands historical annual land use and forest cover change assessment.

	Land Use Subtype	Global Ecological Zone	Forest Type	Disturbance	Short Description <sup>1</sup>
Forest Land	Natural Forest	Tropical Rain Forest (TAr)	Lowland Forest	Intact	Forest on level or nearly level land below 200 m.a.s.l. with no clearly visible indications of human activities and ecological disturbance.
				Degraded	Forest on level or nearly level land below 200 m.a.s.l. with visible indications of human disturbance.
			Hill Forest	Intact	Forest between 200-600 m.a.s.l. on well-drained soils with no clearly visible indications of human activities and ecological disturbance.
				Degraded	Forest between 200-600 m.a.s.l. on well-drained soils with visible indications of human disturbance.
		Freshwater Swamp and Riverine Forest	Intact	Forest on land with little relief and impeded drainage with no clearly visible indications of human activities and ecological disturbance.	
			Degraded	Forest on land with little relief and impeded drainage with visible indications of human disturbance.	
		Tropical Rain Forest (TAr),	Montane Forest	Intact	Forest on at higher altitude ridge tops, generally above 600 m.a.s.l. with no clearly visible indications of

<sup>1</sup> For a detailed definition of forest types according to the FAO Forest Resources assessment, refer to Annex 1

	Land Use Subtype	Global Ecological Zone	Forest Type	Disturbance	Short Description <sup>1</sup>
		Tropical Mountain System (TM)	(Upland Rainforest)		human activities and ecological disturbance.
				Degraded	Forest on at higher altitude ridge tops, generally above 600 m.a.s.l. with visible indications of human disturbance.
		Tropical Rain Forest (TAr),	Mangrove forest (Saline Swamp Forest)	Intact	Forest on land subjected to tidal influences such as estuaries and foreshores with no clearly visible indications of human activities and ecological disturbance.
				Degraded	Forest on land subjected to tidal influences such as estuaries and foreshores with visible indications of human disturbance.
	Plantation Forests	Tropical Rain Forest (TAr)	Industrial Plantation	n.a.	Large-scale commercial plantations > 3000 trees, mainly Eucalyptus, Teak and Gmelina.
			Community Woodlots	n.a.	Small-scale plantations with 250-3000 trees, mainly Teak, Eucalyptus and Mahogany. Agroforestry land-use systems that combine crops and trees.

### 2.3 Definition of REDD+ Activities

**Reducing emissions from Deforestation:** The conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10% threshold (FAO, 2007)

**Reducing emissions from Forest Degradation:** The long-term reduction of the overall potential supply of benefits from the forest, which includes carbon, wood, biodiversity and other goods and services (FAO, 2007), whilst maintaining a tree canopy cover above 10%. For the historical annual land use and forest cover change assessment, forest degradation is the result of different types/drivers of forest disturbance, as follows:

Table 3: Human forest disturbance categories used in the Solomon Islands historical annual land use and forest cover change assessment.

Disturbance Category	Disturbance Type/Driver
Human Impact	Commercial Logging
	Portable Saw Milling
	Temporary Gardening
	Grazing

	Mining
	Other Impact

**Enhancement of Forest Carbon Stocks:** The creation or improvement of carbon pools and reservoirs and their ability to sequester and capacity to store carbon. A key component of the REDD+ strategy, it includes forest management activities such as restoring existing but degraded forests and increasing forest cover through environmentally appropriate afforestation and reforestation.

**Sustainable Management of Forests:** The management of forest areas to maintain and enhance the economic social and environmental value of all types of forests, for the benefit of present and future generations.

**Conservation of Forest Carbon Stocks:** human actions directed towards maintaining the integrity and balance of forest ecosystems and biodiversity.

Table 4: Interrelations matrix for REDD+ Activities.

		To		Non Forest Land
		Forest Land		
From		Intact forest	Degraded forest /Tree Plantation	
Forest Land	Intact Forest	Forest Conservation	Forest Degradation	Deforestation
	Degraded Forest	Sustainable Management of Forests Enhancement of C stocks (F>F)	Sustainable Management of Forests	Deforestation
Non Forest Land		---	Enhancement of C stocks (NF>F)	---

## 2.4 Land Use Categories

The following six categories are used to classify non-forest land, in compliance with the 2006 IPCC guidelines:

Table 5: Description of non-forest Land-use classes used in the Solomon Islands historical annual land use and forest cover change assessment.

Land Use	Land Use Subtype	Land Use Subdivision (IPCC 2006) <sup>2</sup>
<b>Cropland</b>	<b>Subsistence Agriculture</b>	Subsistence Agriculture
		Temporary Gardening
	<b>Commercial Agriculture</b>	Pineapple
		Palm Oil
		Coffee
		Cocoa
		Coconut
		Mixed (Coconut & Others)
Other Agriculture		
Unknown Agriculture		
<b>Grassland</b>	<b>Grassland</b>	Herbland
		Rangeland
	<b>Other wooded land</b>	Shrubland
		Other Woodland
<b>Settlements</b>	<b>Settlements</b>	Urban
		Village
		Hamlet
		Infrastructure
<b>Other Land</b>	<b>Other land</b>	Bare soil
		Rock
		Others
<b>Wetlands</b>	<b>Wetlands</b>	River
		Lake
		Dam
		Swamp
<b>No Data</b>	<b>No Data</b>	Sea
		Clouds
		Other

### 3 Scope

The scope defines the set of REDD+ activities, carbon pools and GHG included in the construction of the FRL. All parameters were reviewed and validated by a broad group of stakeholders and technical experts during four consultative workshops held in 2017 and 2018.

#### 3.1 REDD+ Activities

The scope of REDD+ activities for the FRL covers:

1. **Deforestation**
2. **Forest degradation**

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<sup>2</sup> For a detailed description of other land use classes, refer to Annex 2

### **3. Enhancement of Forest Carbon Stock**

REDD+ activities that currently are **not separately treated** (but nevertheless included in the scope under forest degradation and carbon stock enhancement, see also ):

#### **4. Forest Conservation**

In the Solomon Islands, terrestrial protected areas exist at a very limited scale, which is why there is currently no data available to allow for a reliable estimation of emission removals from forest conservation. Furthermore, the inclusion of forest conservation would add a layer of complexity and increase costs of the MRV while likely not generating additional removals, as the reference and results period would cancel each other out (Assuming that the forests under conservation are in a climax state, were losses are balanced by gains). Considering SIGs limited data, resources, capacity and very initial REDD+ Readiness progress, the inclusion of forest conservation as a separate REDD+ activity is currently not recommendable. It may however be politically beneficial to include this activity in the future in order to demonstrate to the international community the important sink function and GHG mitigation potential of Solomon Islands' natural forests.

#### **5. Sustainable Management of Forests**

Unplanned logging is the most significant driver of forest degradation in the Solomon Islands, and while carbon emissions could be significantly reduced through SFM, there is currently very limited practice and no available data to allow for a reliable estimation of potential associated emission removals. Therefore, it is currently considered sufficient to address logging/SFM under the umbrella of forest degradation drivers, while it may be included as a separate REDD+ activity in the future if relevant, e.g. when the forest sector shifts from unplanned logging to SFM.

## **3.2 Carbon Pools**

The scope of carbon pools for the FRL covers:

- 1. Above-ground Biomass (ABG)**
- 2. Below-ground Biomass (BGB)**

Carbon pools currently not covered in the FRL are:

#### **3. Deadwood**

Deadwood can be a potentially significant carbon pool, especially in disturbed forest. The 2006 IPCC Guidelines do not provide default carbon stock values for deadwood, which is why this carbon pool can currently not be included in the FRL. With the implementation of the SI National Forest Inventory (NFI), country specific data on deadwood carbon stocks will become available and can be used to improve the accuracy of the FRL in the future.

#### **4. Litter**

Litter is generally not a significant carbon pool in tropical forests. The 2006 IPCC Guidelines provide default carbon stock values for litter in some forest types, but not for the forest types which occur in the Solomon Islands. Due to these circumstances, the litter carbon pool can currently not be covered in the FRL. The



implementation of the SI NFI will provide country specific data on litter carbon stocks, which can be used to improve the accuracy of the FRL in the future.

## 5. Soil Organic Carbon

Emissions from this carbon pool are expected to be significant under deforestation, which is one of the REDD+ activities selected for the FRL. According to the 2006 IPCC guidelines soil organic carbon should be estimated at a Tier 1 level for all considered REDD+ activities. However, Solomon Islands forest soils have not been classified into the soil types provided in 2006 IPCC Guidelines<sup>3</sup>, therefore it is currently not possible to estimate the emissions from soil organic carbon pools. The implementation of the SI NFI will provide data on soil types, which can be used to improve the accuracy of the FRL in the future.

### 3.3 Green House Gases (GHG)

CO<sub>2</sub> is the only GHG included in the FRL. Other gases related to fire and the drainage of organic soils (CH<sub>4</sub> and N<sub>2</sub>O) are currently not included because reliable data is not available. Moreover, their influence can likely be neglected against the CO<sub>2</sub> component of forest biomass.

## 4 Scale

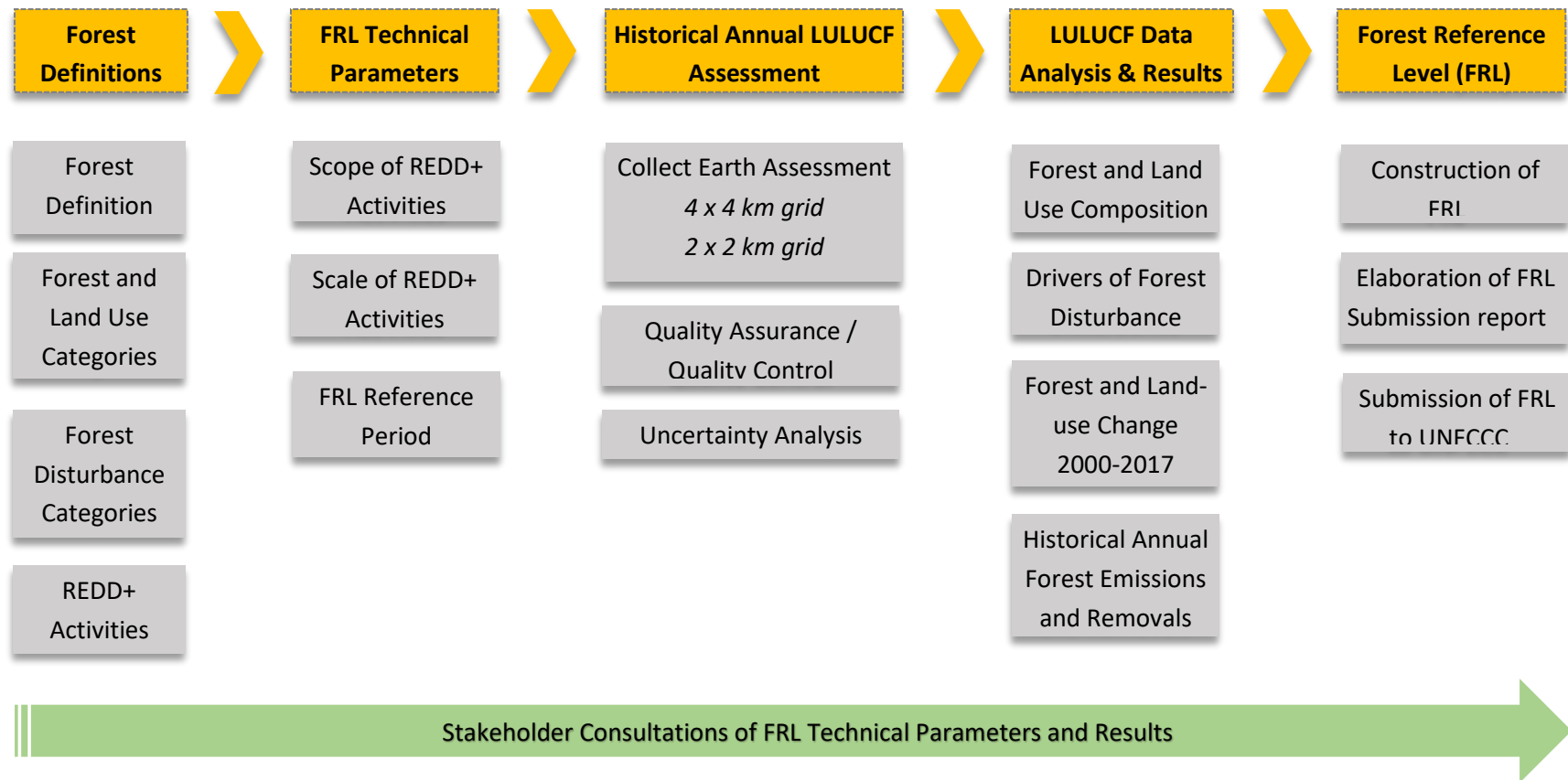
The scale of the Solomon Islands Forest Reference Level is the national level, in line with the UNFCCC decision 12/CP.17, which states that countries should aim to implement REDD+ at the national level. As a commitment to reduce forest emissions and improve forest governance, SIG has developed a National REDD+ Programme and set up the necessary institutional framework for REDD+ Readiness.

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<sup>3</sup> IPCC 2006 Chapter 2: Generic Methodologies Applicable to Multiple Land Use categories. Table 2.3: Default reference (under native Vegetation) soil organic C stocks for mineral soils.

## 5 Construction Methodology

### 5.1 Workflow Diagram for FRL Construction



## 5.2 Historical Annual Land Use Change Assessment

### 5.2.1 Overview

Activity data used for the construction of Solomon Islands national FRL were obtained from an annual historical time series analysis of land use, land-use change and forestry (LULUCF) carried out by the REDD+ Implementation Unit under Ministry of Forest and Research (MoFR) for the period of 2000 – 2017, using the Collect Earth.

Collect Earth (CE) is a forest monitoring tool that was developed by FAO under the Open Foris Initiative where software tools are open source and freely available online. Open source software allows any party to verify the assessment conducted therefore improves the transparency of REDD+ process. One of the advantages of using CE software is that it can be customized according to the country's specific requirements or circumstances and when the software is modified there are regular updates of this online. The tool is linked to various application programs to enable the CE tool to operate functionally, i.e., Google Earth, Google Earth Engine and Bing Maps. The approach used for the CE is based on point sampling and the assessment used is detailed to capture the data for the six IPCC land use categories.

Activity data have been generated following IPCC Approach 3 for representing the activity data as described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 3, Section 3.13), i.e., using spatially-explicit observations of land-use categories and land-use conversions over time, derived from sampling of geographically located points. Following this approach, a systematic 0.02-degree (about 2 x 2 km) grid sampling at national level was used to generate the national annual historical activity data for the entire area of the country. The result was forest and land use change for every year from 2001 to 2017.

### 5.2.2 Sampling Design

A systematic 0.02-degree (about 2 x 2 km) grid consisting of a total of 5,858 points was established at the national level to generate the historical activity data. Each point was visually interpreted, and its information was entered into a database on Forest and Land use changes at the national level. A preliminary assessment was conducted with a systematic 0.04-degree (about 4 x 4km) grid to define the method and common understanding, followed by the main (2 x 2 km) assessment. Further detailed assessment will be considered with a systematic 0.01-degree (about 1 x 1km) grid in future, for instance at provincial level.

The national level systematic sampling design allows to estimate the variables of interest using accepted unbiased estimators, although it must be noted that the main drawback of systematic sampling is the absence of an unbiased estimator for the variance.

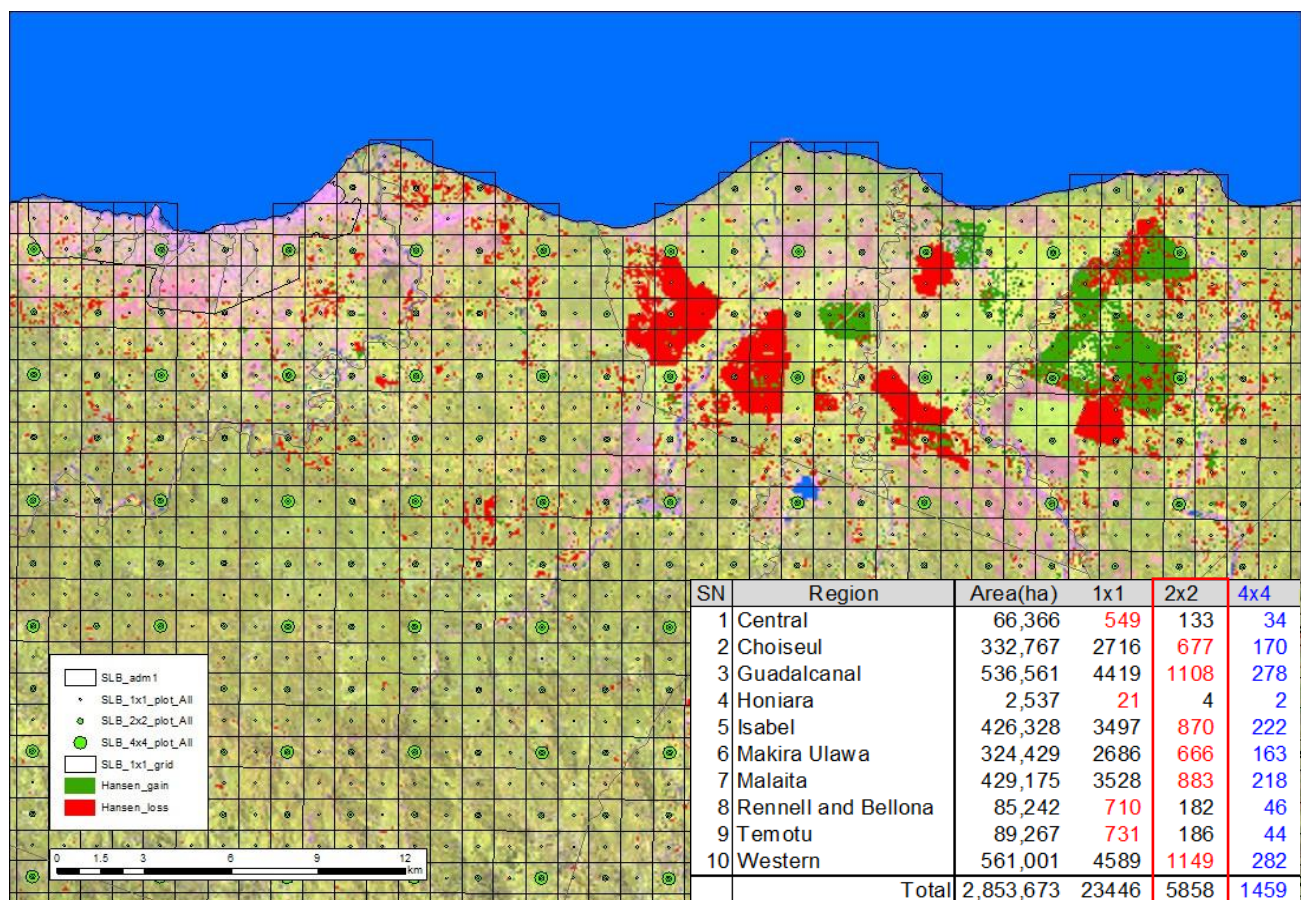


Figure 3: Sample Plots Distribution for Solomon Islands land use change assessment.

### 5.2.3 Sampling Unit

The spatial sampling unit from each point was defined as a 1 ha (100 m x 100m) plot, where an internal grid of 5 x 5 points (20m x 20m grid) is overlapped. Each point from the internal grid has a weight coverage of 4%.



Figure 4: Image of the spatial sampling unit and the distribution of the assessment plots.

#### 5.2.4 Reference Data

The sampling approach for national historical activity data calculation based on systematic sampling has been designed and conducted using the high and medium resolution satellite image repository available through Google Earth, Bing Maps and Google Earth Engine as a visual assessment exercise. These imagery with the forms is designed to collect forest and land use change information on the points of the grid, which are automatically accessible through the Collect Earth tool. Google Earth Engine (Explorer and Code Editor) ensures the completeness of the series through Remote Sensing products from medium resolution imagery repositories between 2000 to 2017 (e.g. Annual TOA Reflectance Composite, Annual NDVI Composite, Annual Greenest-Pixel TOA Reflectance Composite, etc. from Landsat 5, 7 and 8).

Table 6: Satellite imagery used in the land use change assessment, source, type, year and purpose.

Source	Imagery type	Resolution	Acquisition Year	Purpose
Google Earth	World-View, QuickBird, Ikonos, SPOT, etc.	High (0.5-2.5m)	2000-2015 (to date)	Land use and disturbance
Bing Maps	World-View, QuickBird, Ikonos, SPOT, etc.	High (0.5-2.5m)	2000-2005, 2007-2015 (to date)	Land use and disturbance
Google Earth Engine	Landsat 7 (Annual Greenest Pixel)	Low (30m resolution)	1999-2013	Historical land use change
	Landsat 8 (Annual Greenest Pixel)		2014 -2018	Check Current Situation



## 5.2.5 Procedure of Assessment

The data collection process starts by launching the customized Collect Earth software on desktop computers with high-speed internet connections. Starting the Collect Earth automatically launches Google Earth, Google Earth Engine and Bing Map. This enables the systematic review of satellite images to assess land use and forest cover change. Data collection in this study is assessing the land use using the tools and materials described below:

- Collect Earth software is installed and opened, enabling the Google Earth to be automatically launched.
- Plot ID numbers located at the-side panel in Google Earth interface when double clicked automatically directs the screen to the sampling plot (Yellow Square) and the area of interest to be assessed. These sampling plots are used to quantify and characterize land cover within the plot area. For example, canopy cover percentage within the plot can be measured to apply the canopy cover threshold according to the Solomon Islands national forest definition.
- The cursor is placed inside the square plot and doubled-clicked, which opens the field form and activates Google Earth Engine and Bing Maps. Landsat 7 and 8 Annual Greenest Pixel are accessed through Google Earth Engine simultaneously.
- At the area of interest, the operator records information on the land characteristics and elements in a systematic and structured approach as they appear on the satellite image. Once the assessment of the area of interest is completed, the operator is automatically directed to the next plot.

### Data Collection Form:

The figure displays six screenshots of the Collect Earth software interface, each representing a different data collection form:

- 1. IPCC Landuse:** This form includes fields for Region (Guadalcanal, Ward: Malango, Elevation: 588, Slope: 6, Aspect: 66, Treecover2000: 97, Gain: 0, Loss: 0, Lossyear: 0, Datamask: 1, Gain (ha): 0, Loss (ha): 0), Current Land Use Category (Forest, Cropland, Grassland, Settlements, Other Land, Wetlands, No data), Current Land Use Category - Confidence (Yes, No), and Land Use Conversion (F to F, O to F, C to F, G to F, W to F, S to F).
- 2. Disturbance:** This form includes Disturbance Type (Commercial Logging, Portable Saw Milling, Temporary Gardening, Grading, Mining, Other Impact, Fire, Landslide, Flood, Cyclone, No Impact (Primary/Intact)), Disturbance Grade (Low, Medium, High), Disturbance Year (2016), and Disturbance Is continuous? (Yes, No).
- 3. Canopy cover:** This form includes Canopy Cover Rate (No cover (0%), 1 - 10%, 10 - 30%, 30 - 50%, 50 - 70%, 70 - 90%, 90 - 100%, Not Applicable), Canopy Cover Confidence (Yes, No), and Canopy Cover Type (Sparse, Linear, Grouped, Random, Unknown).
- 4. Elements:** This form includes a table for Topography with columns for Element and Coverage. The elements listed are Road, House, Garden, River, Lake, and Trees, each with a corresponding coverage range (e.g., Road: 30 - 50%, House: 0%).
- 5. Accessibility:** This form includes Site Accessibility (0-1 km, 1-2 km, 2-3 km, 3-5 km, 5-10 km, > 10 km, Inaccessible) and Site Directions.
- 6. Satellite Info:** This form includes Satellite Observation Date (08/16/2017), Satellite Type/Name (Digital Globe, Bing Maps, Landsat (GEE), Sentinel (GEE), CNES/Spot, Inge, CNES/Astrum, Other VHS, Recursive), and Satellite: Check latest Landsat? (Yes, No).

Figure 5: Solomon Islands context Collect Earth survey form (designed with Collect tool).

### 5.2.6 IPCC Land-use Assessment

The first step is to detect the ‘key land elements’ using medium to very high-resolution images. The key land elements are defined as a physical component of the land that characterize one or more land cover classes and/or land use categories.

Table 7: List of key land elements subdivided by land classes.

IPCC Land Use Category	Land Key Elements
1. Forest land	Tree crown cover
2. Settlement	Building, paved roads and bridges
3. Cropland	Food crops
4. Wetland	Water, rivers, swamp, dam, lake
5. Grassland	Grasses, scrubs
6. Other Land	Rocky outcrop, barren land, sand

The second step is to determine the land use function of the land based on the spatial distribution of the key land elements and classify the land use. If the land class is complex (more than one land class in the area of interest) the hierarchical threshold criteria as described under section 5.2.9 applies.

The final step is to determine if there is any land use change in the area of interest. The land use change is detected using Landsat 7 and 8 images using Google Earth Engine. Landsat 7 and 8 are enabled in Google Earth Engine once the sample plot is activated in Collect Earth.

### 5.2.7 Disturbance type Assessment

If the land use is classified as forest land, the next step is to assess if the forest is disturbed and identify the main drivers of change and key features as shown below:

Table 8: Forest Disturbance drivers and key features used in the CE assessment.

Driver of Disturbance	Key features	Remarks
Commercial Logging	Logging roads	Ununiformed road expansions
Portable Saw Milling	Near logging roads	
Temporary Gardening	Isolated or temporary clearings near settlements	Challenging to detect in Landsat
Grazing	Large scale pasture	Challenging to distinguish in Landsat
Mining	Mining clearings	Concession boundary is helpful
Other Impact	Disturbed by not above	
Fire	Burnt forest	Burned color or smoke (but challenging to detect by Landsat)
Landslide	Tree fallen with bare soil in mountain	
Flood	Inundation area near the river	
Cyclone	Inundation area near the coast	

### 5.2.8 Hierarchical Rules

A single land use class is easy to classify however, it becomes challenging when there is a combination of two or more land use classes within the area of interest. This is where the hierarchical rules are applied to determine the land use.

The rules or assigned percentages are based on the land use definition which refers to the “description of the socio-economic function of the land”, where a specific ‘land use’ is given preference over another when determining the ‘land use’ or ‘land cover’ type. This means that a plot with  $\geq 20\%$  coverage by ‘settlement’ is considered ‘settlement’ because the hierarchical rule determines that settlements takes precedence over forest, even if the plot has  $>10\%$  forest cover and so forth. The hierarchical rules that apply are shown in the table below:

Table 9: Hierarchical Rules for land use determination.

Priority	Land class	% Cover
1	Settlement	20
2	Cropland	30
3	Forestland	10
4	Grassland	20
5	Wetland	20

### 5.2.9 Quality Assurance / Quality Control

The data goes through the quality assurance and quality control (QA/QC). The data is checked by the Saiku application, which is an analytical tool of Open Foris / Collect Earth package to analyze the data but also to identify error plots. In Saiku, the data can be filtered according to the operator’s preference to display the information in tables or graphs, which can be also exported to Excel for further analysis. The error plots are re-assessed with guidance prepared by the Excel spreadsheet to check if the information or data provided is correct for these plots. The data goes through the cleaning process then a quality check is carried out on a certain percentage before the final analysis is conducted.

Another QA/QC was conducted by comparing Collect Earth data against Global Forest Change data (Hansen data) managed by University of Maryland (Hansen et al. 2013). All the plots were re-assessed where Hansen data shows a tree cover loss  $>10$  ha within a surrounding area of 100 ha (1x1 km) in 2000-2017, but neither deforestation nor forest degradation was recorded by Collect Earth assessment. In most cases the differences between Collect Earth data and Hansen data occurred due to the lack of detail in the land cover interpretation in the Hansen data. For instance, harvesting and replanting of oil palm plantations is reported as tree cover loss and gain in Hansen data but in Collect Earth assessment this is considered cropland remaining cropland, and therefore neither deforestation nor forest degradation. However, some of the missed deforestation and forest degradation could be identified and corrected through the QA/QC analysis. Also, all the plots were re-assessed where deforestation or forest degradation was recorded in Collect Earth assessment but where Hansen data shows a tree cover loss  $< 5$  ha within 100 ha around the plot. These QA/QC check ensures the reliability of the Collect Earth Assessment data.



### 5.2.10 Area Estimation by the Systematic Sampling Approach

The estimation of the areas corresponding to land-use and land-use changes categories in the framework of the systematic sampling approach are based on area proportions. According to 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 3, Section 3.33), the proportion of each land-use or land-use change category is calculated by dividing the number of points located in the specific category by the total number of points, and area estimates for each land-use or land-use change category are obtained by multiplying the proportion of each category by the total area of interest. The number of sampling plots, weight and expansion factors for area estimation are shown in the table below:

Table 10: Number of sampling plots, weight and expansion factors for area estimation.

Province	Area (ha)	Number of Plots	Plot Weight	Expansion Factor (ha)
Central	63,876	133	1	480.27
Choiseul	330,386	677	1	488.01
Guadalcanal	534,938	1108	1	482.80
Honiara	2,537	21	0.25	120.81
Isabel	421,451	870	1	484.43
Makira Ulawa	321,903	666	1	483.34
Malaita	421,306	883	1	477.13
Rennell and Bellona	67,143	182	1	368.92
Temotu	88,537	186	1	476.01
Western	549,485	1149	1	478.23

### 5.2.11 Stratification by Disturbance level / Forest condition

For the degradation analysis and associated emission calculations, forest land remaining forest land is stratified using the information assessed as disturbance level / forest condition. Although “disturbed by logging” and “Disturbed by others” are classified separately, the same carbon stock value is assigned because of lack of reliable data. Since REDD+ and the FRL focus on anthropogenic emissions and removals, natural disturbance is excluded from the calculation of emissions and removals for FRL construction.

Table 11: Stratification by disturbance level / forest condition.

LU category	Disturbance type	Disturbance category	LU stratification
Forest land	Commercial Logging	Human Impact	Disturbed by logging
	Portable Saw Milling		
	Temporary Gardening		Disturbed by others (Note: same carbon stock value with “disturbed by logging” is assigned since there is no reliable data)
	Grazing		
	Mining		
	Other Impact	Natural Disaster	Natural disaster (Note: excluded from calculation of emissions and removals for FRL construction, which focus on anthropogenic)
	Fire (other than the causes listed in Human Impact)		
	Landslide		
	Flood		
	Cyclone	Primary/Intact	Primary/Intact Forest
No Impact (Primary/Intact)			

### 5.2.12 Stratification by Global Ecological Zone for carbon stock

For assigning the carbon stock value from IPCC default values, forest and land use categories in the Solomon Islands are stratified using FAO Global Ecological Zones (GEZ) automatically in Collect Earth with considering the characteristics of the defined land use sub-type and land use subdivision as shown in .

Table 12: Stratification by Global Ecological Zone for carbon stock.

LU category	LU sub-type	LU subdivision	LU stratification
Forest land	Natural Forest	Lowland Forests	Tropical rain forest
		Hill Forests	
		Freshwater Swamp and Riverline Forest	
		Montane Forests (Upland Rainforest)	Tropical mountain system
		Mangroves	Tropical wet
	Commercial Plantation	Forest Plantation types	Plantation forest
Community Woodlot			
Cropland	Subsistence Agriculture	Subsistence agriculture	Cropland (Subsistence)
	Commercial Agriculture	Agriculture plantation types	Cropland (Commercial)
Grassland	Grassland	Herbland, Rangeland	Grassland (Grassland)
	Other Wooded Land	Shrub, Other Woodland	Grassland (Woodland)
Wetlands	Wetlands	River, Lake, Dam, Swamp	Wetlands
Settlements	Settlements	Urban, Village, Hamlet, Infrastructure	Settlements
Other Land	Other Land	Bare soil, Rock, Others	Other Land

### 5.2.13 Statistical Data Analysis by Saiku

The data collected in this assessment was analyzed in Saiku software, which Collect Earth utilize as statistical analytical tool. Saiku is an analysis software linked to Collect Earth that uses a drag-and-drop interface to perform queries. Saiku offers a user friendly, web-browser based analytics solution that lets users quickly and easily analyze data and create and share reports. A key function of Saiku is exporting the results in tables or in graphics to other file formats such as PDF, JPEG and Comma Separate Value (CSV). The commonly used Saiku export function in this assessment is exporting to CSV file format. This allows further analysis to be performed in Microsoft Excel using functions that are not available in Saiku.

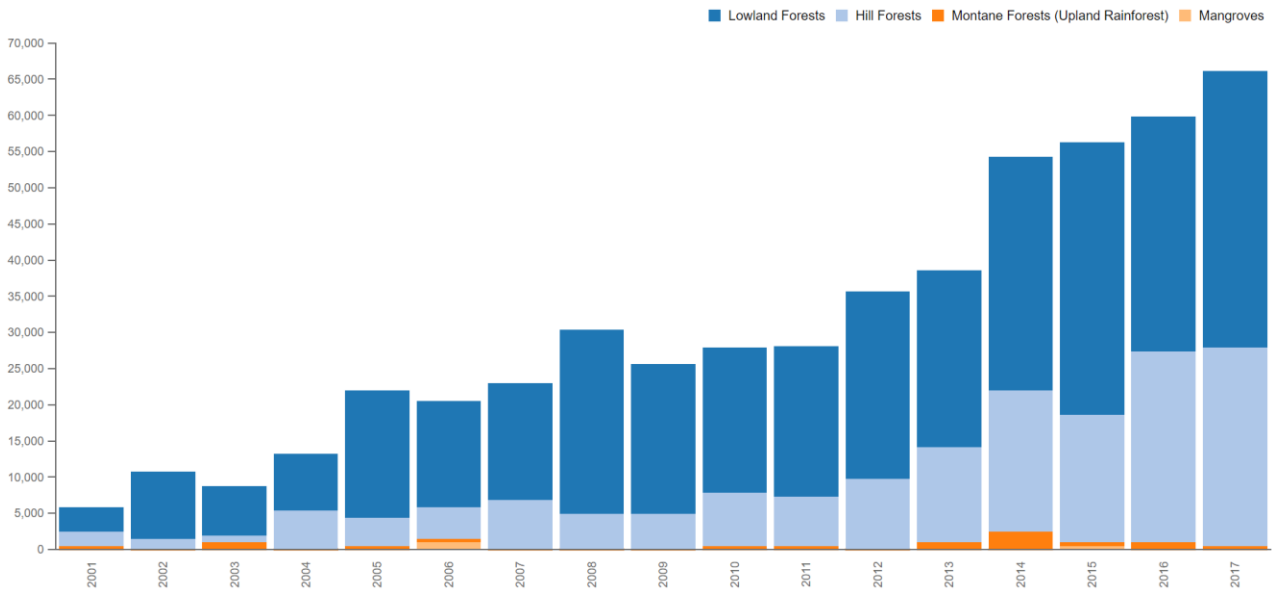
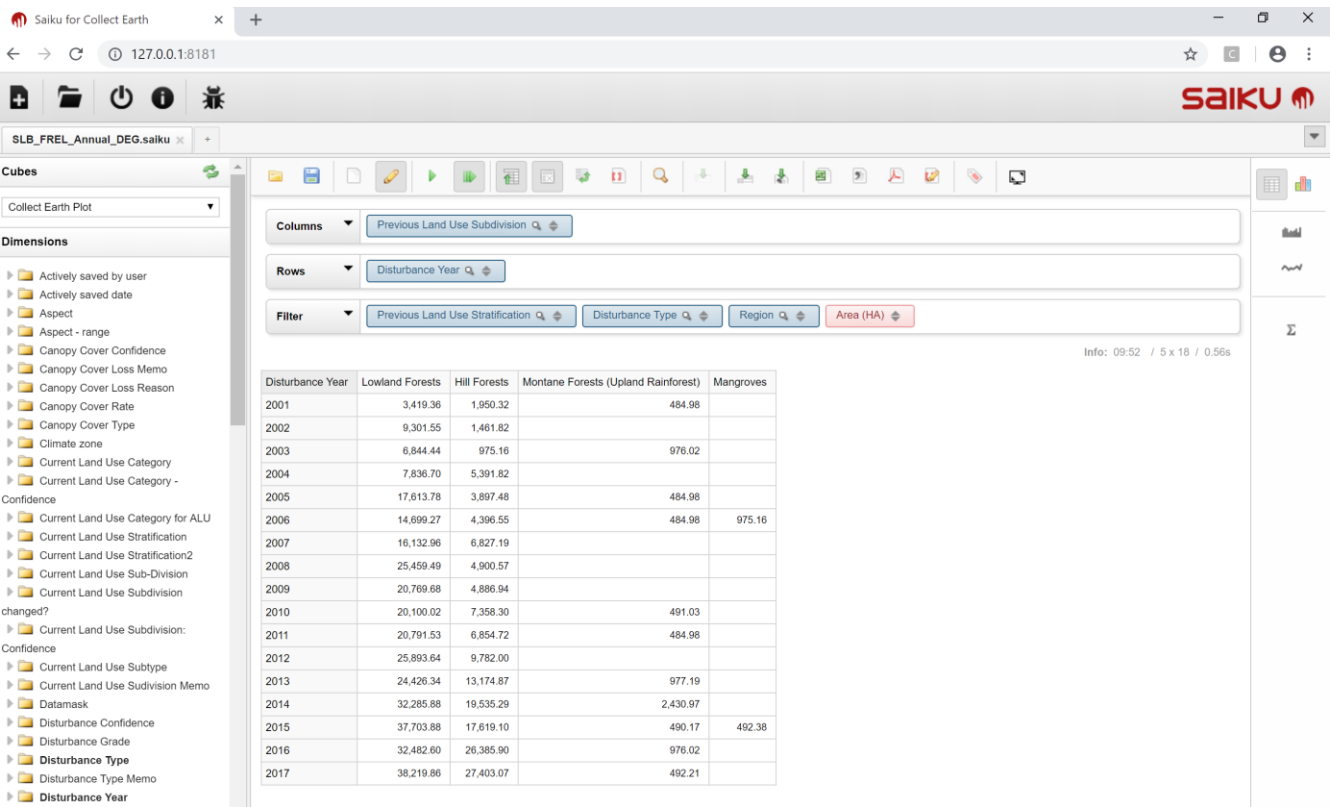


Figure 6: Saiku software interface showing the data fields grouped to produce result tables or charts.

## 5.3 Emission Factor Analysis

### 5.3.1 The IPCC Tier Concept

An emission factor (EF) is a coefficient that quantifies emissions per hectare of land use activity. To estimate emissions and removals from forest land, EFs are multiplied with data on the extent of human activity causing emissions and removals, commonly referred to as activity data. (AD). The IPCC classifies the methodological approaches for the estimation of GHG emissions and removals in three different Tiers, according to the quantity of information required, and the degree of analytical complexity. Moving from a lower to a higher Tier will positively affect the accuracy of the emission and removal estimates. Three Tier levels can be distinguished as follows:

**Tier 1:** Employs the gain-loss method and the default emission factors and other parameters provided by the IPCC. There may be simplifying assumptions about some carbon pools. Tier 1 methodologies may be combined with spatially explicit activity data derived from remote sensing. Tier 1 is feasible in situations where no or only limited country-specific data and/or technical capacity is available.

**Tier 2:** Generally, uses the same methodological approach as Tier 1 but applies country-specific emission factors and parameters, which are more appropriate to the forests, climatic regions and land use systems in that country. More highly stratified activity data may be needed in Tier 2 to correspond with country-specific emission factors and parameters for specific regions and specialized land-use categories. Tiers 2 and 3 can also apply stock change methodologies that use plot data provided by National Forest Inventories.

**Tier 3:** higher-order methods include models and can utilize plot data provided by NFIs tailored to address national circumstances. Properly implemented, these methods can provide estimates of greater certainty than lower tiers and can have a closer link between biomass and soil carbon dynamics.

### 5.3.2 Carbon and Emission Calculations

$$\mathbf{Carbon\ Stock\ (t\ ha^{-1}) = AGB + BGB * 0.47}$$

Where:

AGB= Above Ground Biomass (t d.m. ha<sup>-1</sup>)

BGB= Below-Ground Biomass (t d.m. ha<sup>-1</sup>)

0.47= Carbon Fraction default value (2006 IPPC Guidelines, Table 4.3)

Equation 1: Carbon Stock from Above and Below-ground Biomass.

$$\mathbf{Emission\ Factor = (Carbon\ Stock_{PRE} - Carbon\ Stock_{POS}) * \frac{44}{12}}$$

Where:

Carbon Stock<sub>PRE</sub> = Carbon Stock before Land Use Conversion (t C ha<sup>-1</sup>)

Carbon Stock<sub>POS</sub> = Carbon Stock after Land Use Conversion (t C ha<sup>-1</sup>)

$\frac{44}{12}$  = C to CO<sub>2</sub> Conversion factor

Equation 2: Emission Factor from Land use Conversion.

$$\text{Removal Factor} = (AGB_{INCR} + BGB_{INCR}) * 0.47 * \frac{44}{12}$$

Where:

$AGB_{INCR}$ = Increment of Above-Ground Biomass (t d.m. ha<sup>-1</sup> yr<sup>-1</sup>)

$BGB_{INCR}$ = Increment of Below-Ground Biomass (t d.m. ha<sup>-1</sup> yr<sup>-1</sup>)

0.47= Carbon Fraction default value (2006 IPPC Guidelines, Table 4.3)

$\frac{44}{12}$  = C to CO<sub>2</sub> Conversion factor

Equation 3: Removal Factor from Biomass Increment.

### 5.3.3 Biomass and Carbon Values and Emission Factors in Forest Land (Tier 1)

<i>Biomass/ Carbon Pool</i>	<i>Components</i>	<i>Units</i>	<i>Lowland Forests</i>	<i>Hill Forests</i>	<i>Freshwater Swamp/ Riverine Forest</i>	<i>Montane Forests</i>	<i>Mangrove Forest</i>	<i>Plantation Forests</i>
Biomass in primary forest	Above-ground biomass	t d.m. ha <sup>-1</sup>	300.0	300.0	300.0	140.0	192.0	150.0
	Root-shoot ratio	BGB /AGB	0.37	0.37	0.37	0.27	0.49	0.37
	Below-ground biomass	t d.m. ha <sup>-1</sup>	111.0	111.0	111.0	37.8	94.1	55.5
	Total living biomass	t d.m. ha <sup>-1</sup>	411.0	411.0	411.0	177.8	286.1	205.5
Biomass in degraded forest <sup>4</sup>	Above-ground biomass	t d.m. ha <sup>-1</sup>	196.0	196.0	196.0	92.0	126.0	98.0
	Root-shoot ratio	BGB /AGB	0.37	0.37	0.37	0.27	0.49	0.37
	Below-ground biomass	t d.m. ha <sup>-1</sup>	72.7	72.7	72.7	24.7	61.6	36.3
	Total living biomass	t d.m. ha <sup>-1</sup>	269.1	269.1	269.1	116.4	187.3	134.5
EF primary deforestation	Before	t d.m. ha <sup>-1</sup>	411.0	411.0	411.0	177.8	286.1	205.5
	After	t d.m. ha <sup>-1</sup>	0.0	0.0	0.0	0.0	0.0	0.0
	Difference	t d.m. ha <sup>-1</sup>	411.0	411.0	411.0	177.8	286.1	205.5
	Conversion	t d.m. / t CO <sub>2e</sub>	1.72	1.72	1.72	1.72	1.65	1.72
	Emission factor	t CO <sub>2e</sub> ha <sup>-1</sup>	708.3	708.3	708.3	306.4	473.1	354.1
EF forest degradation	Before	t d.m. ha <sup>-1</sup>	411.0	411.0	411.0	177.8	286.1	205.5
	After	t d.m. ha <sup>-1</sup>	269.1	269.1	269.1	116.4	187.3	134.5
	Difference	t d.m. ha <sup>-1</sup>	141.9	141.9	141.9	61.4	98.8	71.0
	Conversion	t d.m./t CO <sub>2e</sub>	1.72	1.72	1.72	1.72	1.65	1.72
	Emission factor	t CO <sub>2e</sub> ha <sup>-1</sup>	244.6	244.6	244.6	105.8	163.4	122.3
EF secondary deforestation (deforestation of degraded forest)	Before	t d.m. ha <sup>-1</sup>	269.1	269.1	269.1	116.4	187.3	134.5
	After	t d.m. ha <sup>-1</sup>	0.0	0.0	0.0	0.0	0.0	0.0
	Difference	t d.m. ha <sup>-1</sup>	269.1	269.1	269.1	116.4	187.3	134.5
	Conversion	t d.m./t CO <sub>2e</sub>	1.72	1.72	1.72	1.72	1.65	1.72
	Emission factor	t CO <sub>2e</sub> ha <sup>-1</sup>	463.7	463.7	463.7	200.6	309.7	231.9

Sources: 2006 IPCC Guidelines, Table 4.12, 4.4; 2013 Supplement to 2006 IPCC Guidelines, Wetlands Table 4.2 & 4.5

<sup>4</sup> Ratio biomass intact/disturbed forest (223/146), PNG 2017

### 5.3.4 Biomass and Carbon Values for Emission Factors in Non-forest Land (Tier1)

Land Use	Land Use Subdivision	AGB t ha <sup>-1</sup>	Root-Shoot Ratio (BGB/ABG)	ABG+BGB t ha <sup>-1</sup>	C t ha <sup>-1</sup>	EF t CO <sub>2</sub> ha <sup>-1</sup>	Source
Subsistence Agriculture		45		45	21	77	2006 IPCC Guidelines, Table 5.1
Commercial Agriculture	Coconut	196	0.37	269	126	463	2006 IPCC Guidelines, Table 5.3
	Palm Oil	136	0.37	186	88	321	2006 IPCC Guidelines, Table 5.3
	Coffee	120	0.32	158	74	273	2006 IPCC Guidelines, Table 5.2
	Cocoa	120	0.32	158	74	273	2006 IPCC Guidelines, Table 5.2
	Pineapple	60	0.32	79	37	136	IPCC EF DB 511318 Other Species
	Mixed	60	0.32	79	37	136	IPCC EF DB 511318 Other Species
	Other	60	0.32	79	37	136	IPCC EF DB 511318 Other Species
Grassland	Herbland	6.2	1.6	16	8	28	Good Practice Guidance for LULUCF, Table 3.4.2
	Rangeland	6.2	1.6	16	8	28	Good Practice Guidance for LULUCF, Table 3.4.2
	Shrub land	70	0.4	98	46	169	2006 IPCC Guidelines, Table 4.12 & 4.4
	Other Wooded Land	70	0.4	98	46	169	2006 IPCC Guidelines, Table 4.12 & 4.4
Wetlands (		0	0	0	0	0	No IPPCC guidance provided on CO <sub>2</sub> EF
Settlements		0	0	0	0	0	No reliable data
Other Land		0	0	0	0	0	No reliable data

### 5.3.5 Biomass and Carbon Values for Removal Factors in Forest Land (Post-deforestation Regrowth)

Parameters	Unit	Post-Deforestation Land Use				
		Coconut	Oil palm	Shifting cultivation	Subsistence Agriculture	other
Relative area	%	1%	30%	62%	3%	2%
AGB	t d.m. ha <sup>-1</sup>	196	136	44.68	44.68	44.68
Source		Table 5.3, IPCC 2006	Table 5.3, IPCC 2006	Table 5.1, IPCC 2006	Table 5.1, IPCC 2006	same as shifting cultivation
Growth duration	years	20	20	8	8	8
Mean annual increment in AGB	t d.m. ha <sup>-1</sup> yr <sup>-1</sup>	9.80	6.80	5.59	5.59	5.59

## 5.4 Reference Period

Solomon Islands needs to choose a suitable reference period for the FRL, based on historical annual emissions from deforestation and forest degradation, as a basis for measuring future emission reductions. The choice of the reference period underwent broad consultation and validation by experts and relevant stakeholder groups during 2017 and 2018.

Solomon Islands is HFLD country with very low historical and recently increasing emissions from deforestation and forest degradation, particularly after 2012. For the first Solomon Islands FRL submission, a 17-year reference period from 2001 -2017 is considered most suitable option because it covers both the historically low, as well as the recently steeply increasing forest emissions and therefore permits the construction of an FRL which is representative with regards to expected forest sector emissions during the results period.

The reference period was also selected to coincide with data availability for the annual land-use and forest cover change assessment:

1. The availability of reliable land use change data from satellite imagery after the launching of Landsat 7
2. The availability of forest cover loss/gain data from the global forest change time series analysis 2000-2017 (Hansen Global Forest Change Dataset) of the University of Maryland (Hansen et al., 2013)

## 5.5 Results Period

A results period from 2018-2021 (4 years) will be used to align the intervals of FRL reporting and Biannual Update Reports (BUR) to the UNFCCC, the latter of which is every 2 years.

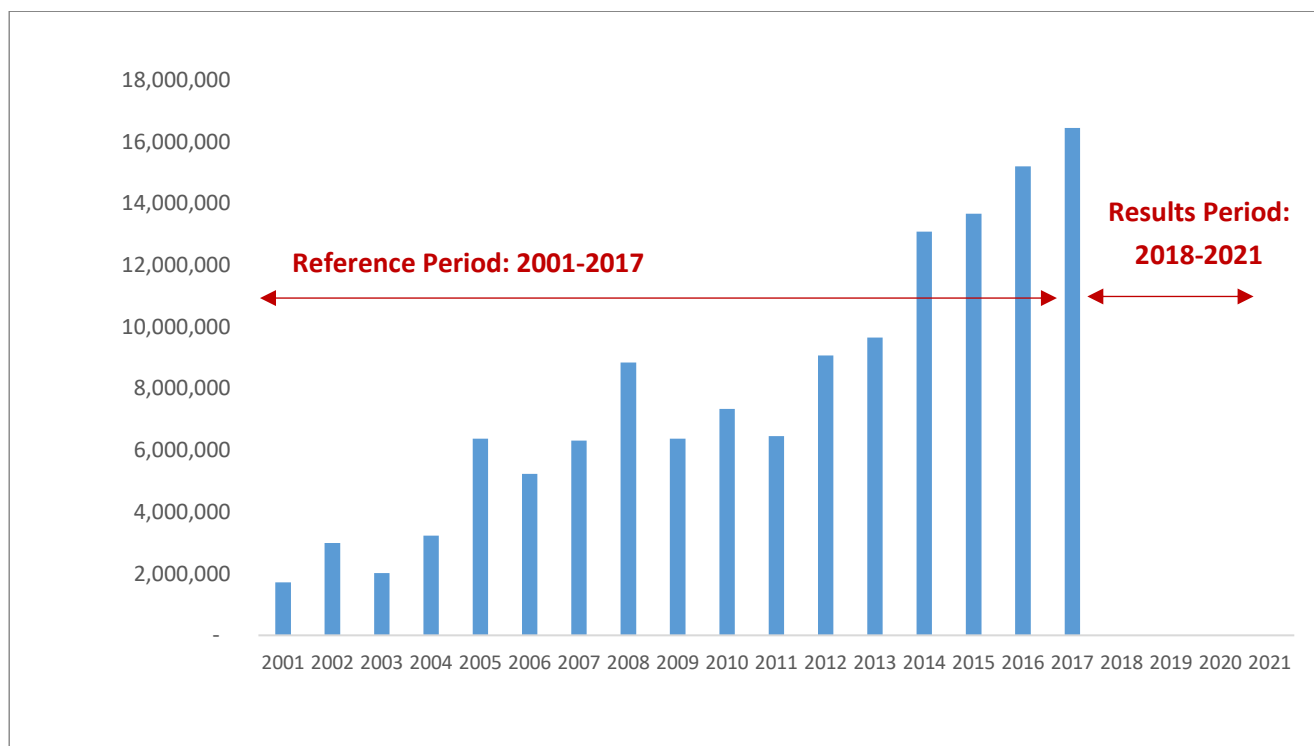


Figure 7: Reference and Results Period for the Solomon Islands FRL.



## 6 Results of the Land Use Change Assessment

The following chapter presents the current (2017) land use types in the Solomon Islands, as a result of the land use and forest cover change assessment using Collect Earth. The results were presented to and reviewed by a broad group of stakeholders and technical experts during 2018.

### 6.1 Composition and Distribution of Land Use Types

Solomon Islands has a land area of 2.8 Million hectares, of which 89.94% is covered by natural forests and forest plantations. The second major land use is cropland, which covers 7.94% of the land area. Wetlands cover 0.96% and Grassland cover 0.25%, while other land covers 0.21% of the land area which includes bare soil and rock. Settlements, which includes urban, villages, hamlets and infrastructure cover 0.70% of the total land area.

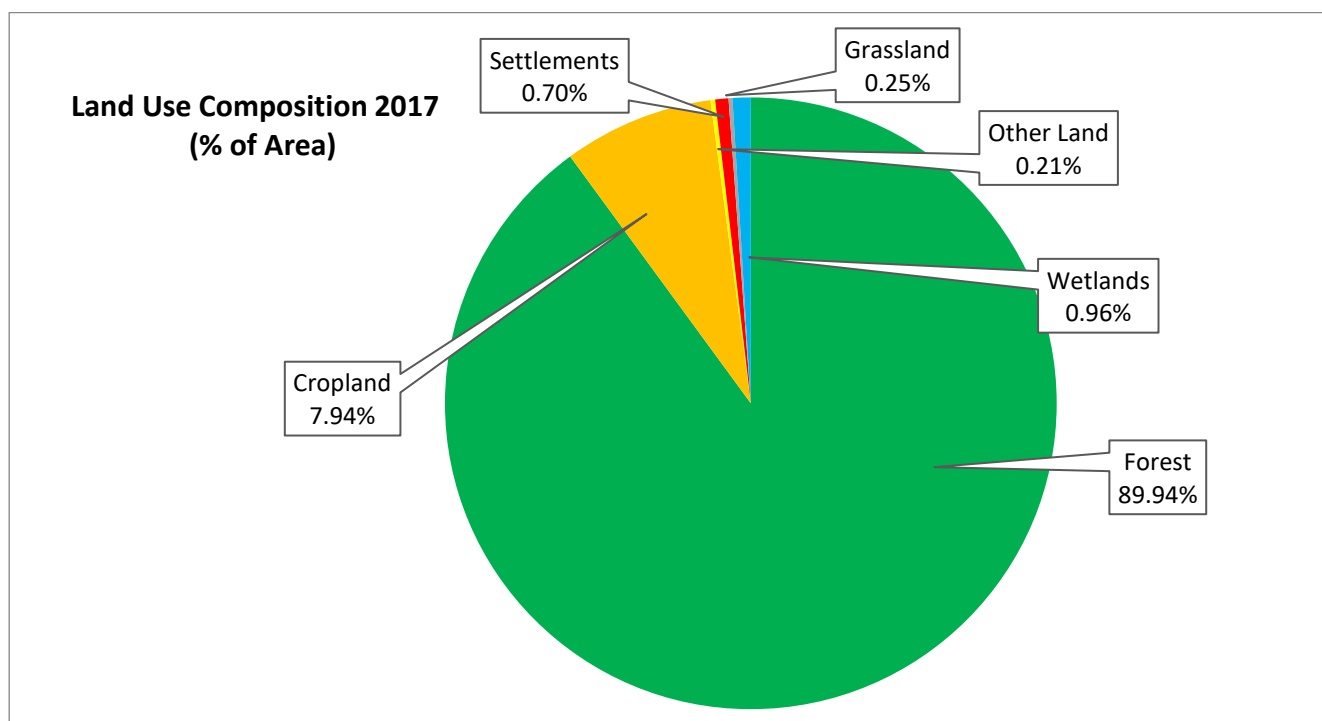


Figure 8: Current composition of land use types in the Solomon Islands.

Table 13: Areas of current land uses in the Solomon Islands (2017).

Current Land Use (2017)	Area (ha)
Forest	2,519,801.75
Cropland	222,575.23
Grassland	6,945.93
Settlements	19,615.94
Other Land	5,822.65
Wetlands	26,800.49
Total Land Use	2,801,561.99

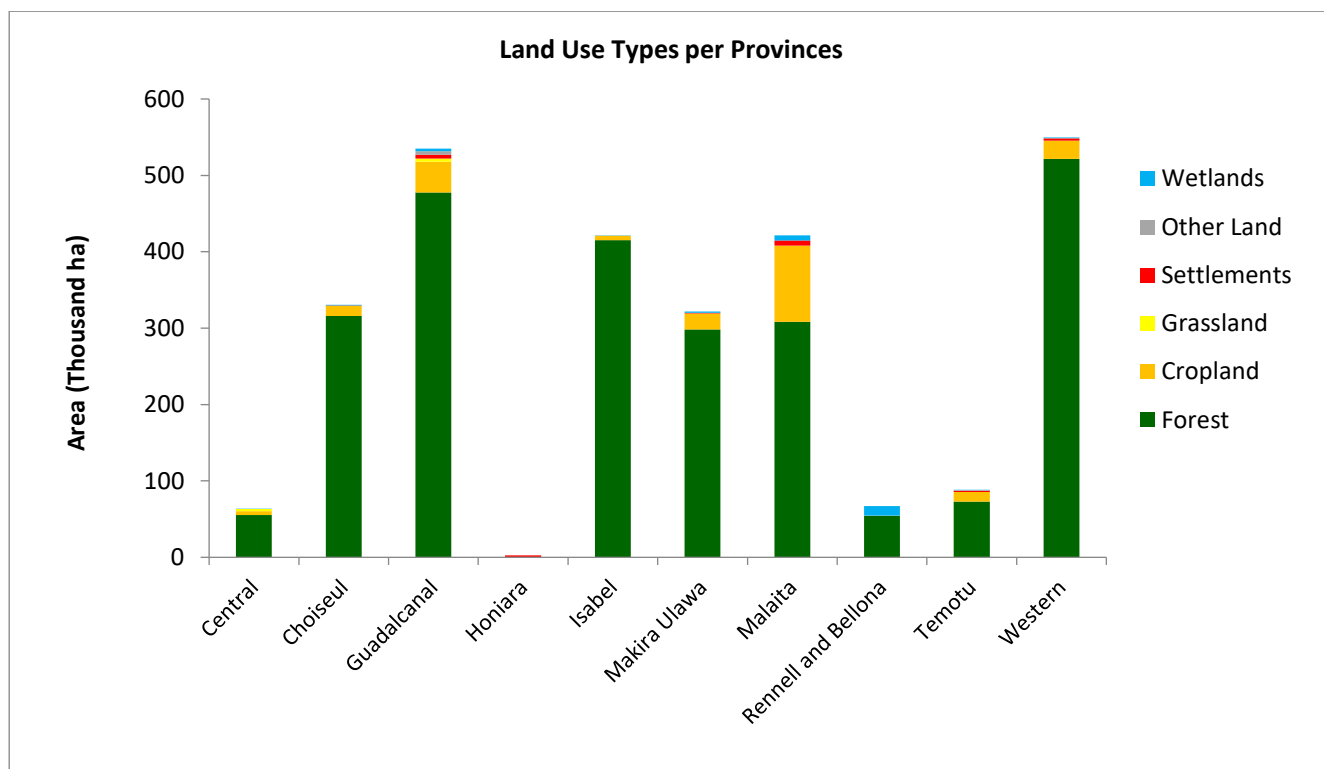


Figure 9: Current composition of land use types in different provinces (2017).

Figure 9 presents the composition of different land use types in different provinces of the Solomon Islands. Forest is the land use type which occupies the largest land area in all provinces (total: 2.5 Million hectares), followed by crop land (total: 222,575 hectares). In Malaita, the percentage of cropland is the highest of all provinces (24%). Significant areas of grassland only occur in Guadalcanal and Central province.

## 6.2 Forest Composition and Distribution

The vast majority of the forest area in the Solomon Islands is natural forest, followed by small areas of commercial plantations and community woodlots. Natural forest comprises 99% of the total forest area, while commercial forest contributes 0.95% and community woodlots is 0.04% of the total forest area. Figure 10 shows the composition and distribution of natural and plantation forests.

Table 14: Current area distribution of main forest types (2017).

Current Forest Types (2017)	Area (ha)
Natural Forest	2,494,815.09
Industrial Plantation	24,011.50
Community Woodlot	975.16

The three main forest types in the Solomon Islands are Natural forest, Industrial Plantations and Community woodlots. The vast majority of the forests in the Solomon Islands are natural forests while industrial plantations and Community Woodlots (mainly Eucalyptus, Teak, and Gmelina) currently only cover relatively limited areas.

The five main natural forest types are, in order of area extension, lowland forest, hill forest, montane forest, mangrove forest and fresh water swamp/riverine forest.

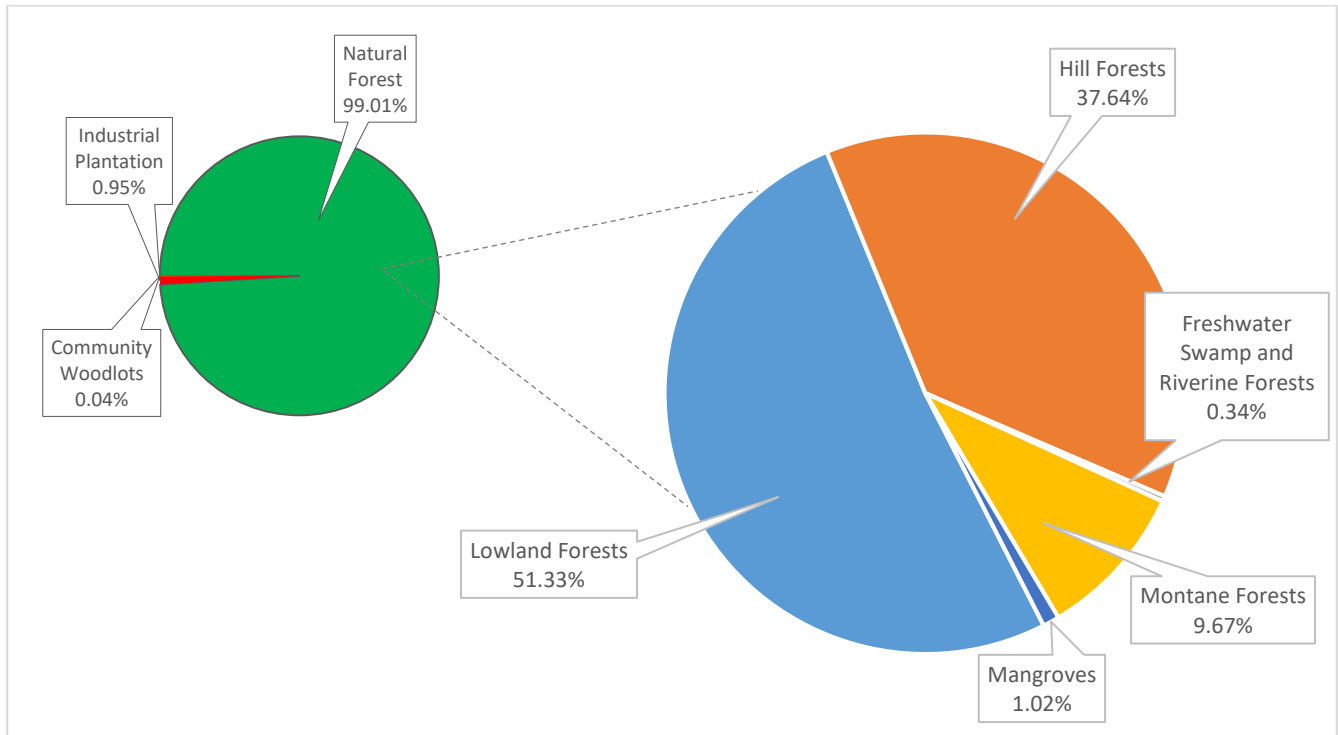


Figure 10: Current composition of forest and types in the Solomon Islands (2017).

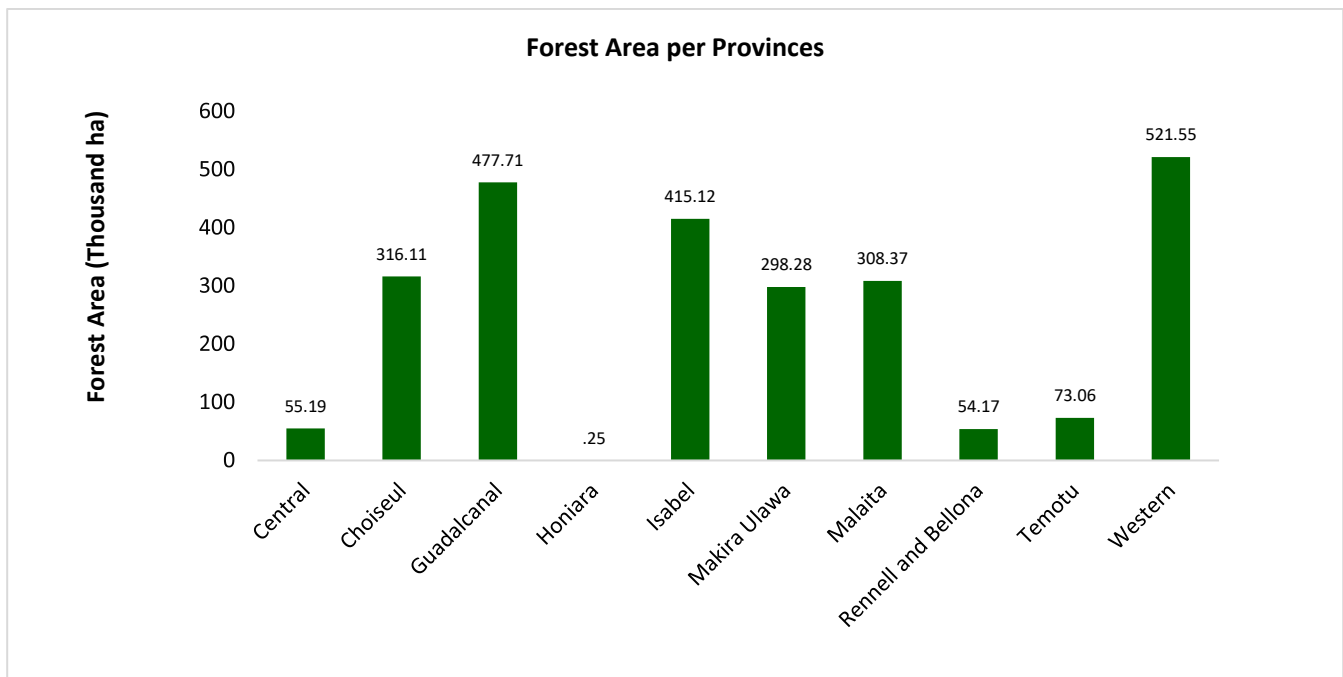


Figure 11: Current distribution of the forest area in different provinces (2017).

The largest part of Solomon Islands forests are located in Western Province, Guadalcanal and Isabel.

### 6.3 Composition and Distribution of Non-Forest Land

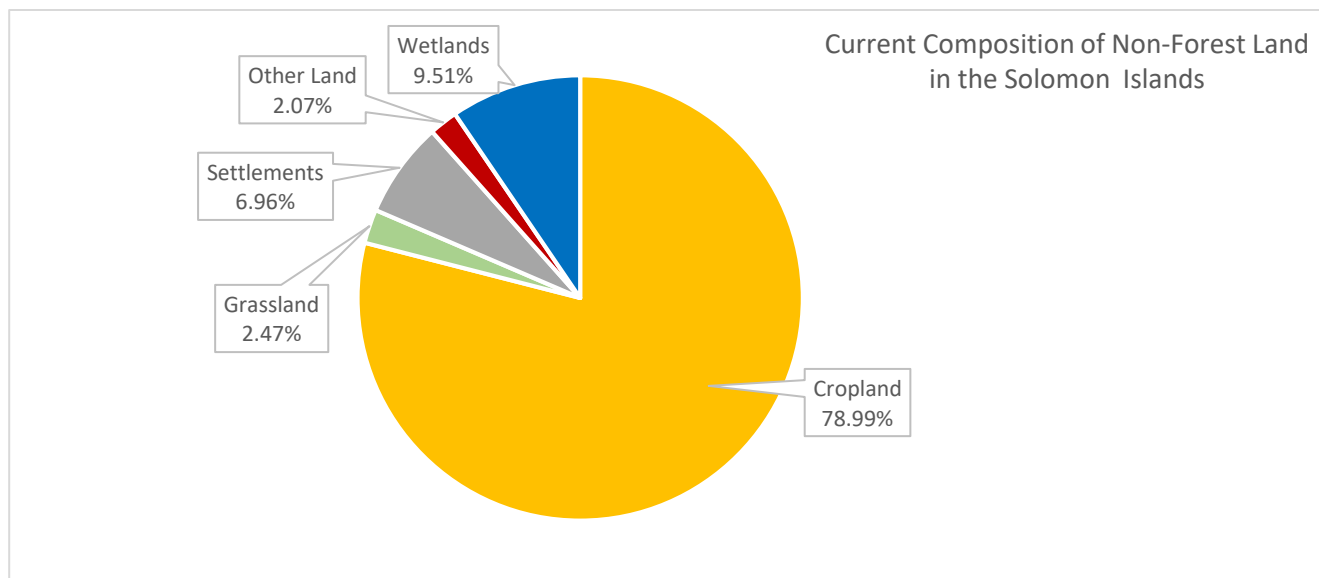


Figure 12: Current composition of non-forest land in the Solomon Islands (2017).

Outside forest land, there five main land uses which cover 281,760 ha or about 10% of Solomon Islands land area. Out of these, cropland is the most extensive and composes 79% of non-forest land area. Wetlands (inland water bodies) occupy 10%, settlements occupy 7% and grasslands occupy 2% of the total non-forest area. Bare soil and rock compose 2% of non-forest land.

Table 15: Current area distribution of non-forest land in the Solomon Islands (2017).

Current Non-Forest Land (2017)	Area (ha)
Cropland	222,575.23
Grassland	6,945.92
Settlements	19,615.94
Other Land (Bare Soil and Rock)	5,822.65
Wetlands	26,800.49
<b>Total non-forest land</b>	<b>281,760.24</b>

### 6.4 Forest Cover and Land Use Change 2001-2017

#### 6.4.1 Deforestation

Between 2001 and 2017, the total forest area of the Solomon Islands was reduced by 9,840 hectares, which represents a **total deforestation rate of 0.39%** over the assessment period, or a **mean annual deforestation rate of 0.02%**.

Table 16: Land use change in the Solomon Islands between 2000 (base year) and 2017.

Land Use	Area 2000 (ha)	Area 2017 (ha)	Change Area(ha)	Rate of Change
Forest	2,529,641.34	2,519,801.75	-9,839.59	-0.39%
Cropland	214,201.83	222,575.23	8,373.40	+3.91%

Land Use	Area 2000 (ha)	Area 2017 (ha)	Change Area(ha)	Rate of Change
Grassland	7,430.91	6,945.92	-484.98	-6.53%
Settlements	18,149.75	19,615.94	1,466.19	+8.10%
Other Land	5,822.65	5,822.65	0.00	0.00%
Wetlands	26,315.50	26,800.49	484.98	+1.84%

The main driver of deforestation in the Solomon Islands is the conversion of forest to subsistence agriculture. This occurs predominantly in lowland forest and, to a lesser extent, in hill forest. 65% of all converted forest is lowland forest.

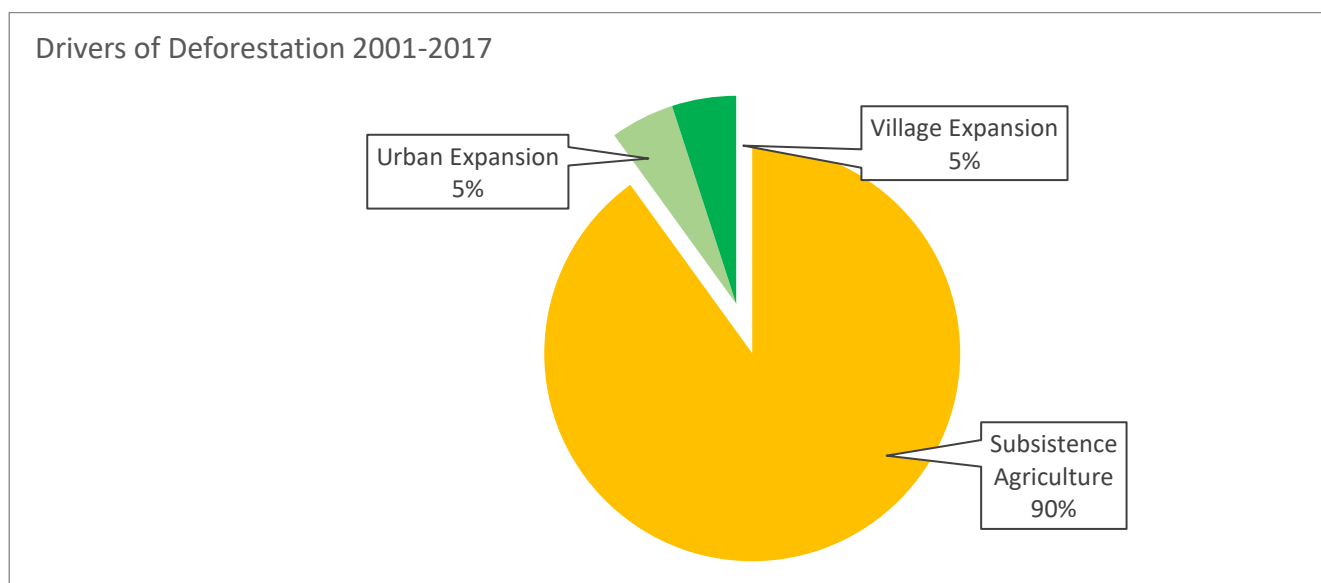


Figure 13: The main drivers of deforestation in the Solomon Islands.

Table 17: Types and areas of forest conversion in the Solomon Islands.

Land Use Conversion	Previous Land Use	Current Land Use (ha)		
		Subsistence Agriculture	Urban Area	Village
Forest >> Cropland	Lowland Forest	6,403.22		
Forest >> Settlement	Lowland Forest		490.17	491.03
Forest >> Cropland	Hill Forest	1,964.13		
Forest >> Cropland	Montane Forests	491.03		

### 6.4.2 Deforestation per Forest Types

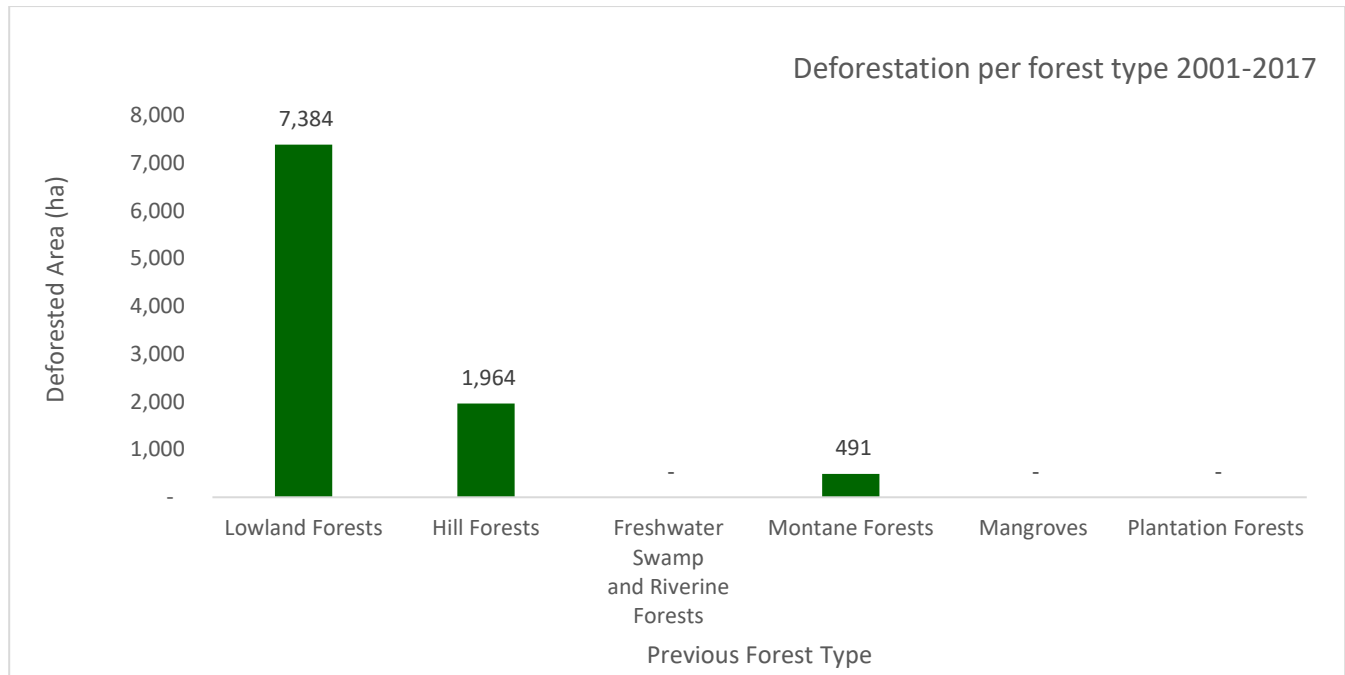


Figure 14: Deforested Area per forest type in the Solomon Islands.

### 6.4.3 Forest Disturbance

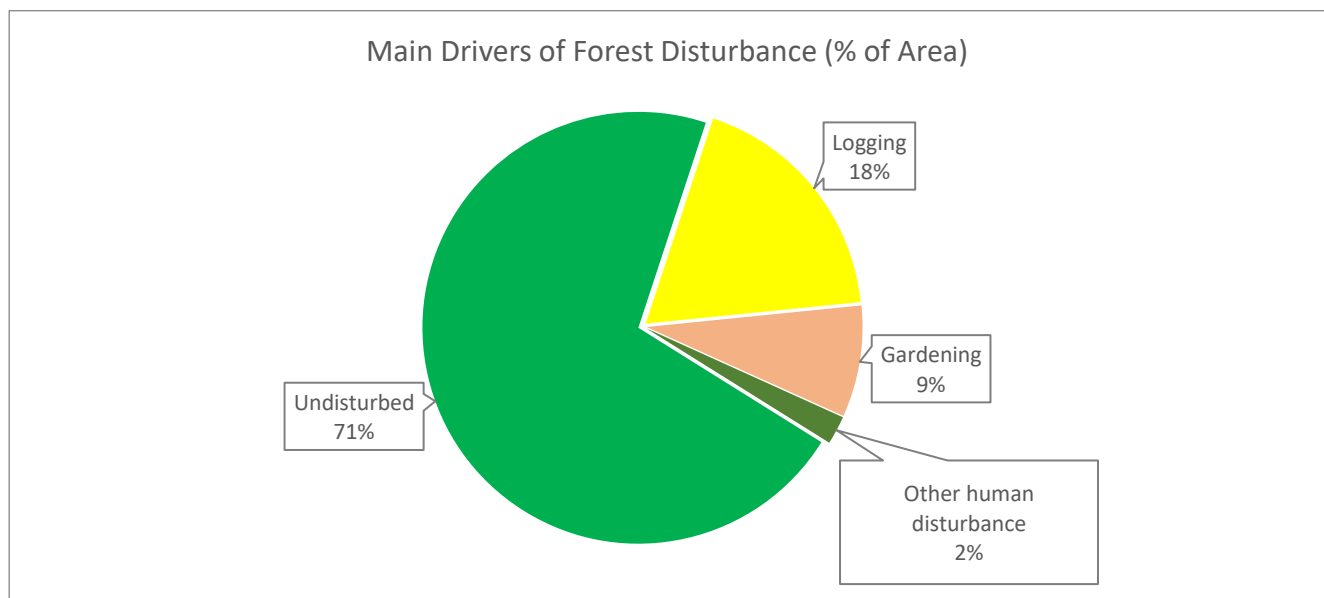


Figure 15: Main drivers of forest disturbance in the Solomon Islands.

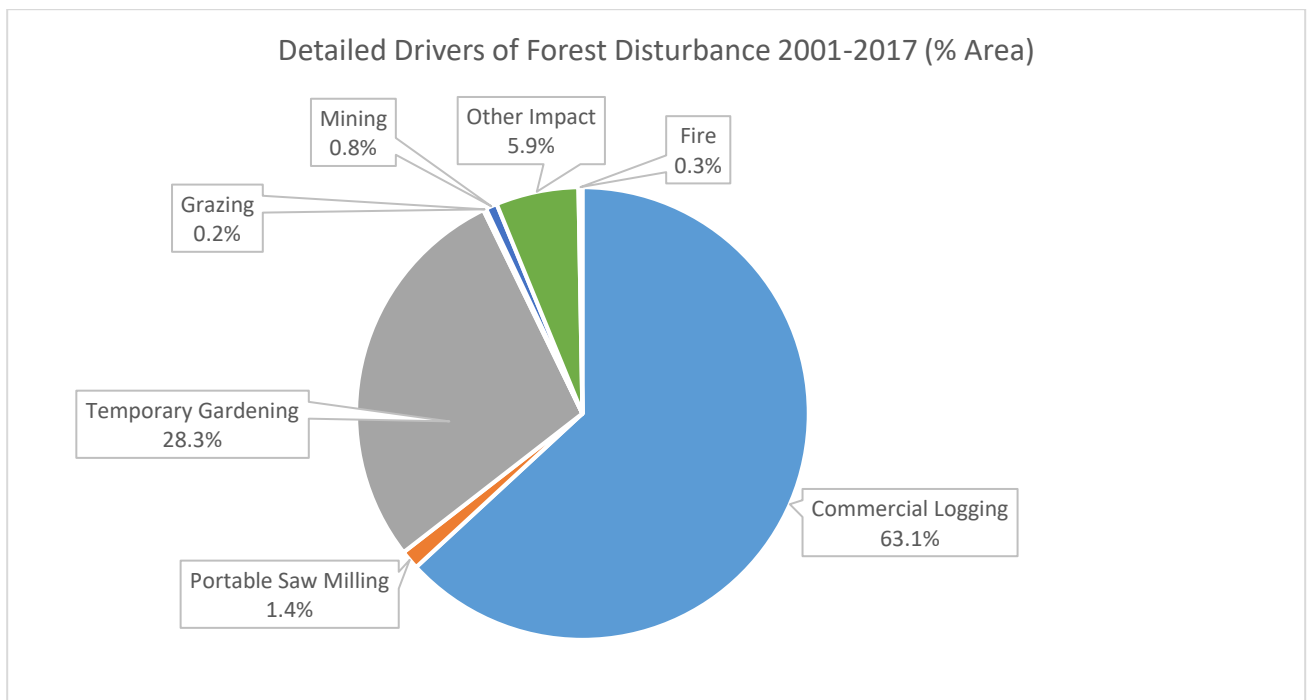


Figure 16: Detailed drivers of forest disturbance in the Solomon Islands.

Figure 15 shows that the largest portion of Solomon Islands forests remains undisturbed. Between 2001 and 2017, 416,000 ha of forest were degraded by logging and 201,000 ha by temporary gardening. Lowland and hill forest are the forest types most affected by disturbance, predominantly by commercial logging followed by gardening. In montane and mangrove forests, degradation is comparatively low and caused mainly by temporary gardening and other human disturbance.

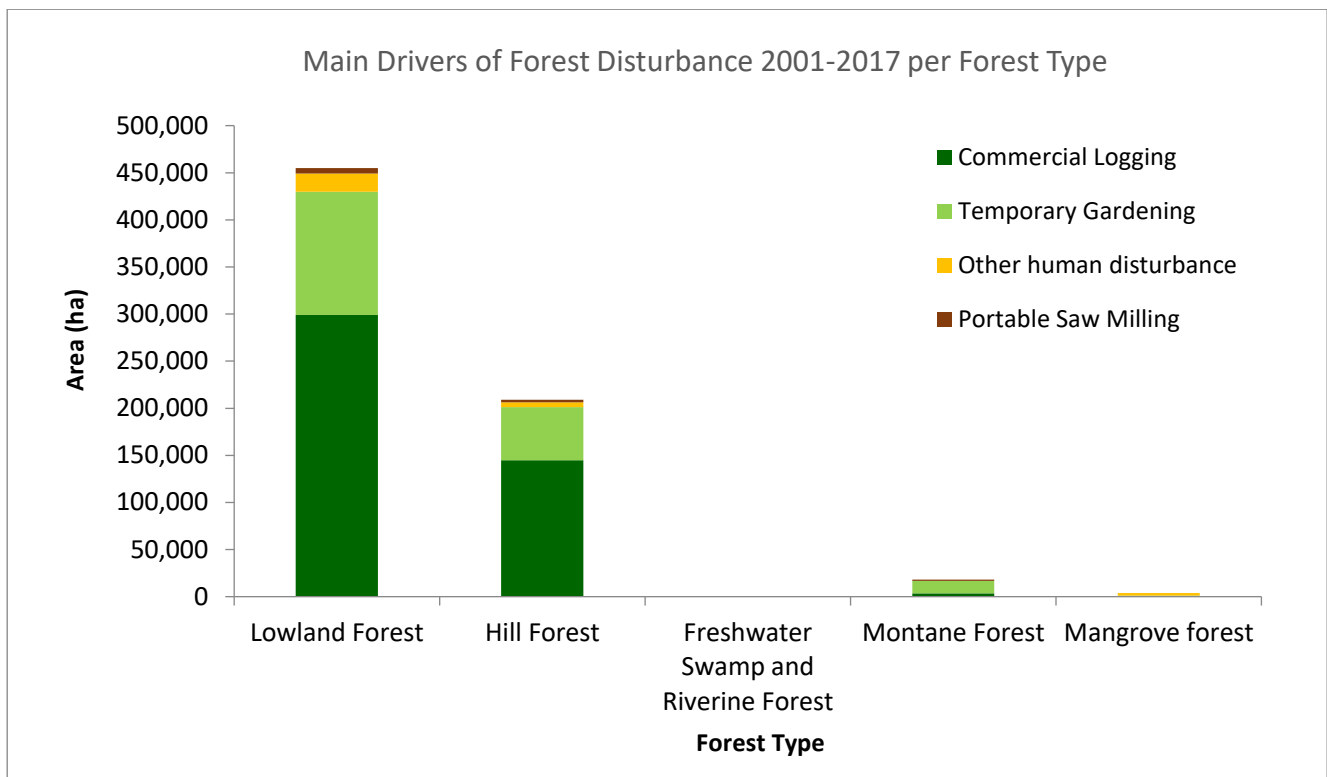


Figure 17: Main drivers of forest disturbance in the Solomon Islands.

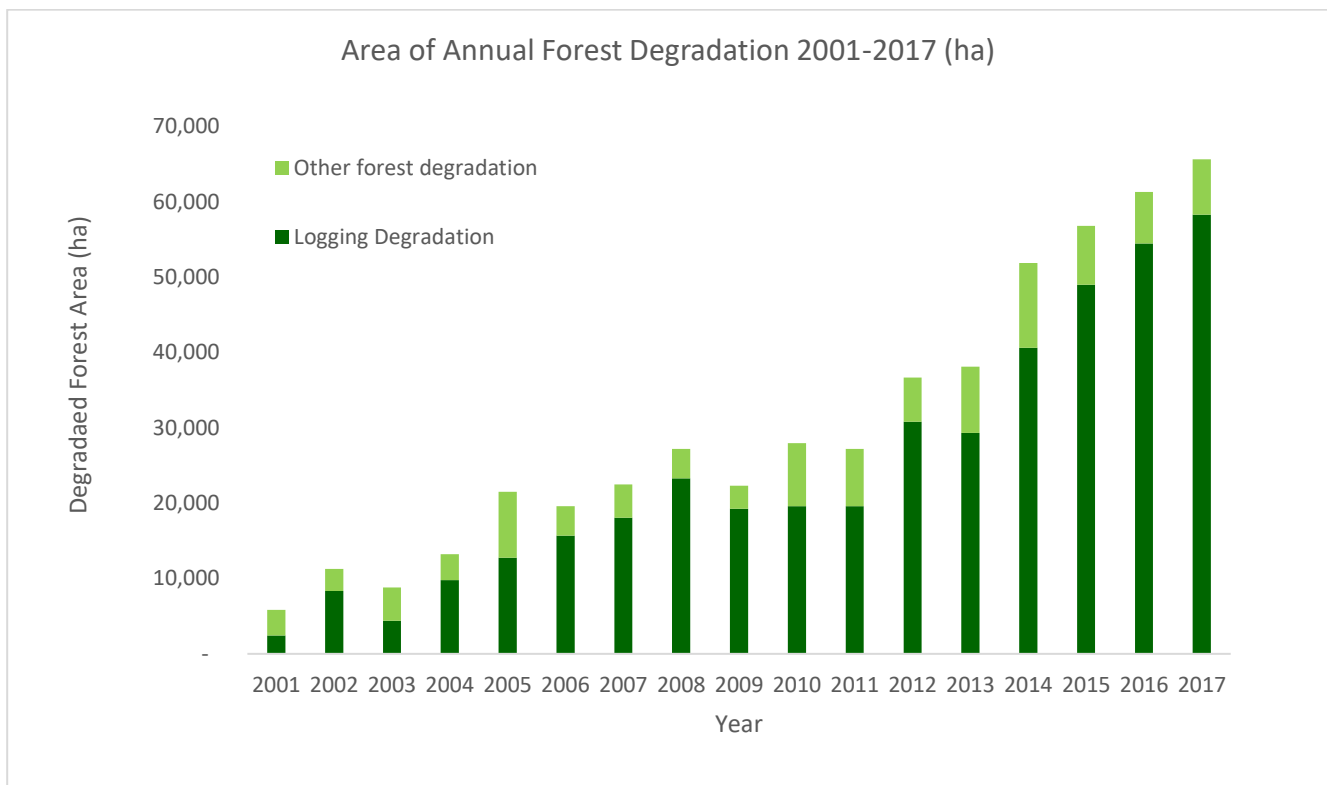


Figure 18: Annual area of forest degradation in the Solomon Islands 2001-2017.



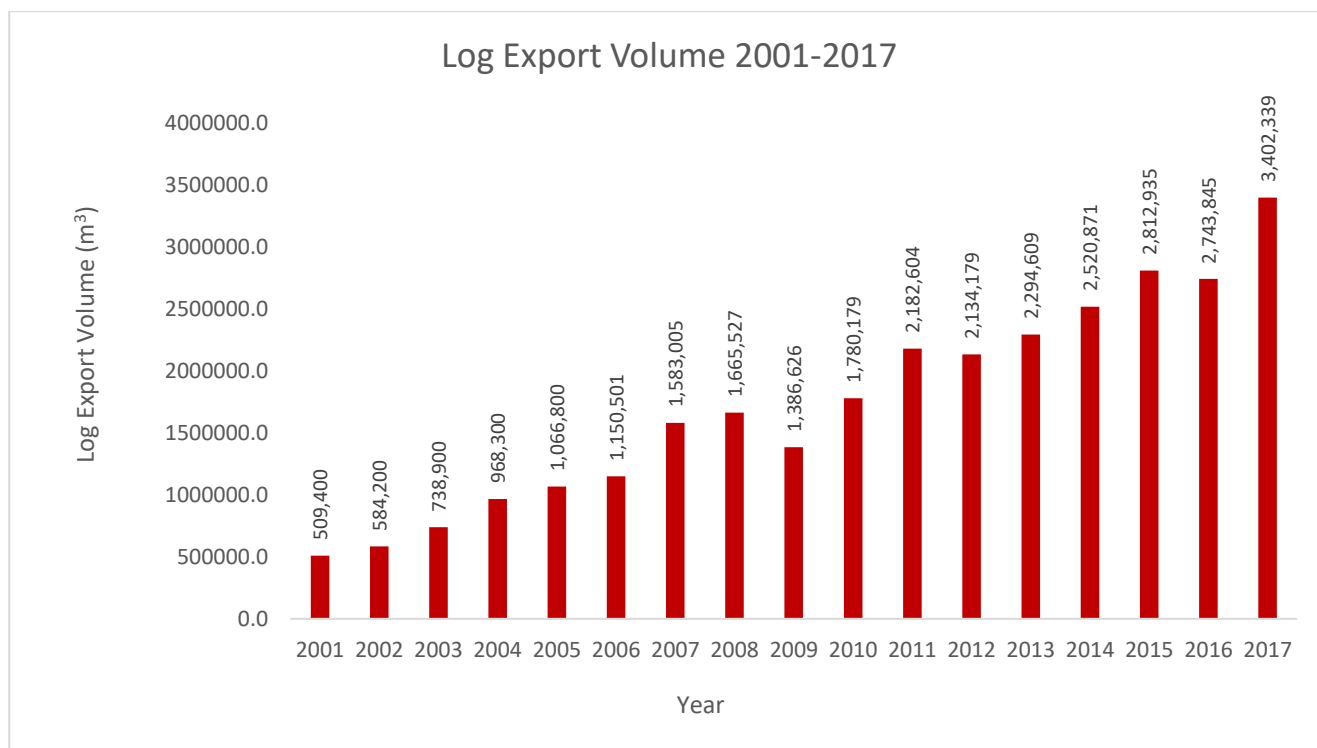


Figure 19: Annual round log export volumes in the Solomon Islands 2001-2017<sup>5</sup>.

Figure 18 and Figure 19 demonstrate that the logged area from the forest cover change assessment shows the similar trend to declared log export volumes with a few exceptions. Discrepancies in some years (e.g. 2011, 2016) can be attributed to sampling errors as well as incorrect/incomplete log volume records.

## 6.5 Uncertainty Analysis

The activity data and emissions factors used in the construction of Solomon Island FRL underwent both quantitative and qualitative uncertainty analysis described in this section. This has made it possible to identify opportunities for future improvements.

### 6.5.1 Qualitative uncertainty analysis

In terms of activity data, several major sources of error in estimating historical forest and land use change trends from the Collect Earth assessment are expected.

- Classification error (random and systematic error)
- Sampling error (random error)

To reduce the uncertainty of classification error, Solomon Islands defines the land use subdivision based on the country's existing classification system, which is described in chapter 2.2: Classification of Forest Types and chapter 5.2: Historical Annual Land Use Change Assessment. A forest stratification based on the country's specific forest carbon stocks will be considered in future if a national forest inventory is implemented.

<sup>5</sup> Data Source: Solomon Islands Ministry of Finance and Treasury

The major sources contributing to uncertainties of sampling assessments such as Collect Earth are the sampling error such as unrepresentative samples and variability resulting from the use of samples and the human error such as misinterpretation of historical annual land use and land use change and forest.

In terms of emission factors, there are also several important error sources to be considered in estimating carbon stocks for SI's land use types. The set of emission factors used are derived from IPCC default values and limited information is available on their error. Nonetheless, SI expects typical errors to occur for the emission factors, as follows:

- Sampling error (random and systematic error) since the plot-based measurements that underlie estimates reported in the IPCC guidelines only sample the forests.
- Representation error from using IPCC default values that might be imperfectly suitable for SI's forests (systematic error).
- Representation error from approximating forest carbon stocks in all of SI's forest types from IPCC default values that were developed only for the most abundant types of forests (systematic error).
- Model error from inferring on forest degradation carbon stocks from measurements in one type of forest only (systematic error).

#### 6.5.2 Quantitative uncertainty analysis

In case of activity data, since Solomon Islands does not have enough (ground-truthed) data for verifying the area of each land use category, the sampling error was calculated using spreadsheet developed by FAO, which is based on IPCC guideline complemented by GFOI Methodological Guidance for estimating uncertainties of land areas estimated by proportion, by multiplying the total area A, for which land categories are to be estimated, by proportion of sample plots in the specific land category. The percentage uncertainty associated with the area estimate is calculated as  $\pm 1.96$  times the standard error of  $A_i$  divided by  $A_i$ .

The standard error<sup>6</sup> of an area estimate is obtained as:

$$A * \sqrt{\frac{p_i(1 - p_i)}{n - 1}}$$

Where:

**p<sub>i</sub>** is the proportion of points in the particular land-use category (stratum) i;  $p_i = \frac{n_i}{n}$

**A** the total area of the territory,

**n** the total number of sample points,

**n<sub>i</sub>** is the number of points under a particular land-use category.

Equation 4: Standard Error of mean<sup>7</sup>.

<sup>6</sup> The standard error is the standard deviation of the sampling distribution

<sup>7</sup> Chapter 3, volume 4 (AFOLU), of 2006 IPCC Guidelines, pp 3.33-3.34

Sampling errors and the uncertainty of area estimates of each land use category and conversion during 2001-2017 using the spreadsheet developed by FAO without ground verification (ground-truthing) based on the equation shown above are shown in Annex 3: Uncertainty calculation. In summary, the uncertainty of intact stable forest, secondary stable forest, primary deforestation, forest degradation and stable non-forest, are respectively  $\pm 1.98\%$ ,  $\pm 8.83\%$ ,  $\pm 43.13\%$ ,  $\pm 5.33\%$ , and  $\pm 7.96\%$ .

In terms of emission factors, the information of forest carbon stocks calculated from IPCC default values do not come with reliable quantitative information on errors.

### 6.5.3 Approach towards reducing errors

The current estimation of the uncertainties of activity data is purely statistical with no ground truthing. SI is one of the difficult countries to implement statistically-valid ground truthing survey since the country is composed of many islands and large parts of the forest area is inaccessible for round truthing surveys. But if the national forest inventory is implemented in the future, the estimation of the uncertainties using ground-truthing data will be considered. Although it is difficult to collect ground truthing data in SI, one possibility to estimate the human error is to choose operators who have good experience at ground survey and remote sensing for the QA/QC, who will be evaluating plots that have been assessed by other operators. It is currently under consideration to use the data collected from this QA/QC operators as ground-truthing substitute and compare this to the data collected by “normal operators”. Although the current approach to establishing emission factors may include several error sources, SI strives to implement a national forest inventory to improve and develop country specific forest carbon stock data and emission factors in future.

## 7 Forest Emissions and Removals

### 7.1 Emissions per Forest Types

76% of all forest related emissions in the Solomon Islands are caused by commercial logging and small-scale portable sawmill operations (Milling) in lowland and hill forest.

Table 18: Emissions from different forest types in the Solomon Islands between 2001-2017.

Forest Type	Emissions 2001-2017 t CO <sub>2e</sub>		
	Deforestation	Logging Degradation (incl. Milling)	Other Degradation
Lowland Forests	5,230,316	67,552,496	18,272,158
Hill Forests	1,391,174	33,151,268	5,592,984
Freshwater Swamp and Riverine Forests	0	0	0
Montane Forests	50,457	361,898	413,052
Mangroves	0	80,430	79,223
Plantation Forests	0	0	0
<b>Total</b>	<b>6,771,946</b>	<b>101,146,092</b>	<b>24,357,417</b>

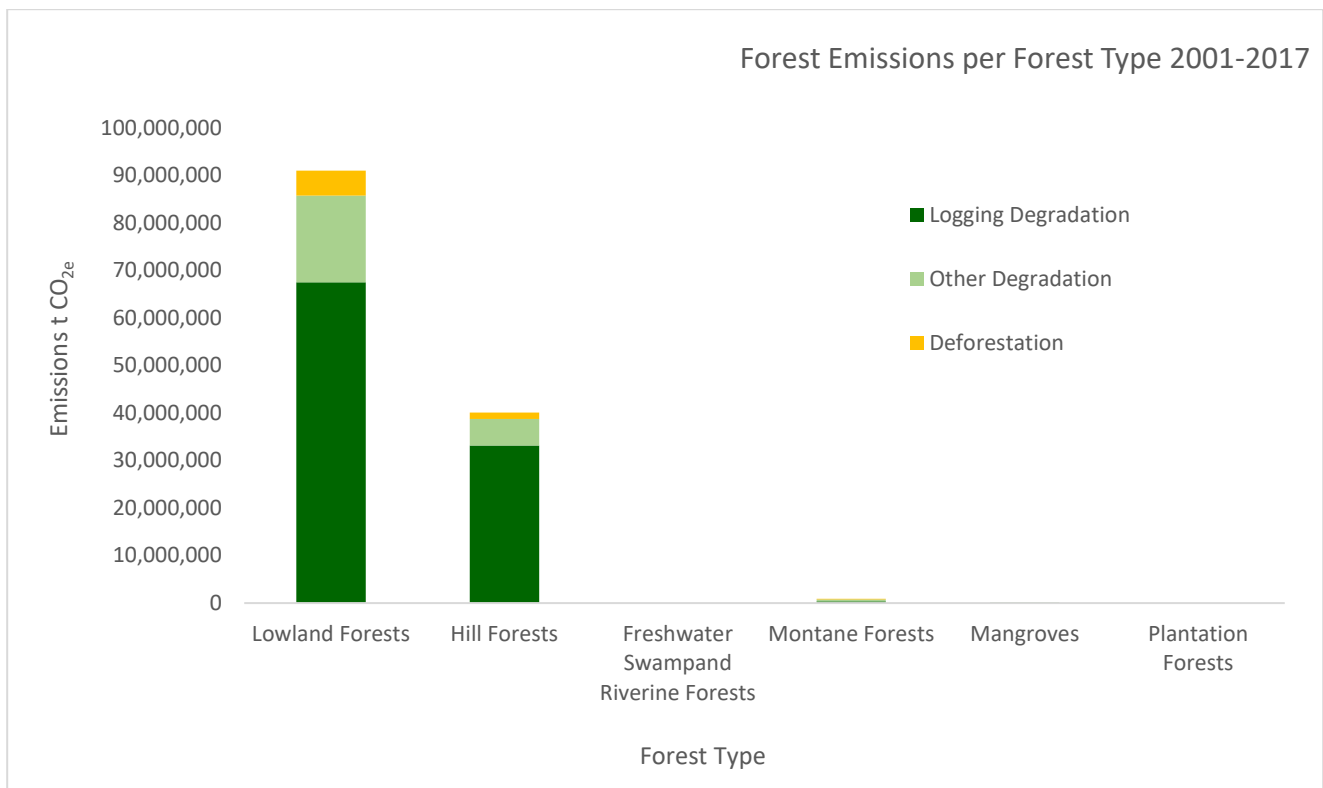


Figure 20: Emissions from different forest types in the Solomon Islands between 2001-2017.

## 7.2 Annual Forest Emissions 2000-2017

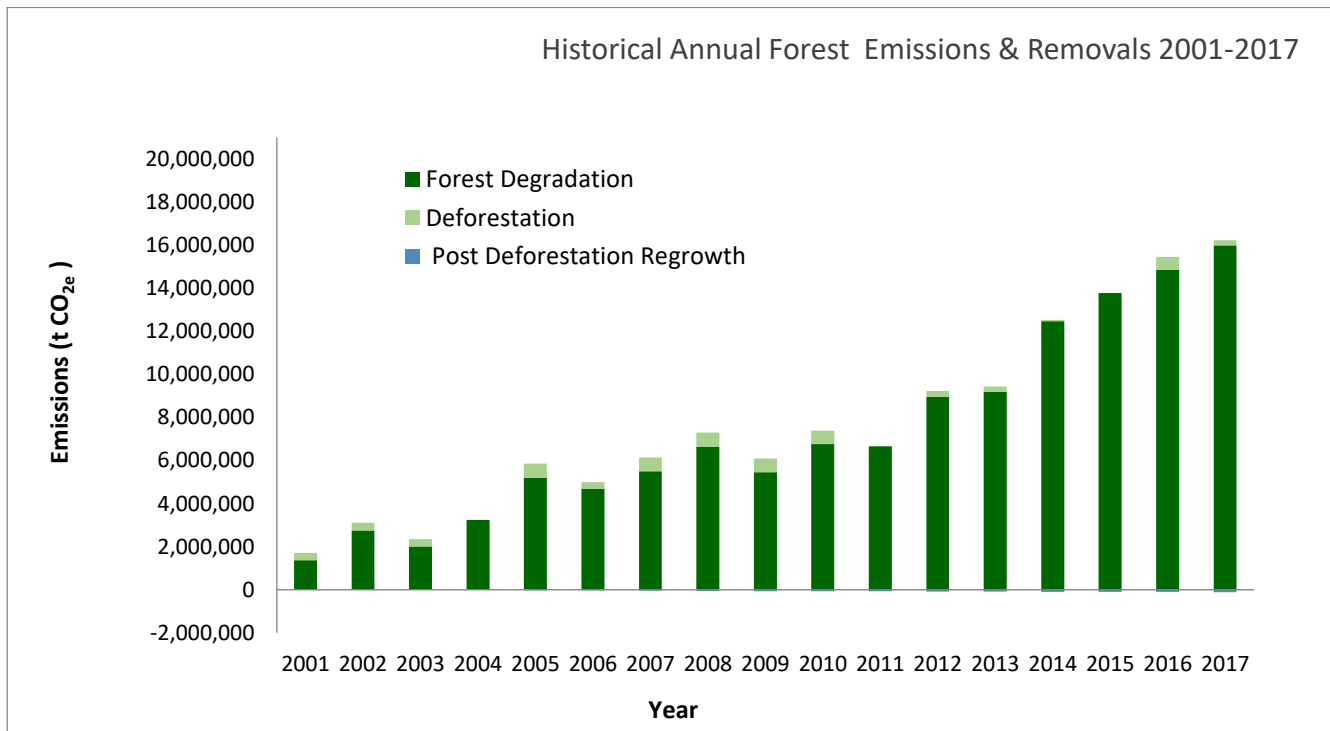


Figure 21: Historical annual forest emissions and removals in the Solomon Islands 2001-2017.

Table 19 Historical annual forest emissions and removals 2001-2017.

Year	Deforestation Emissions	Forest Degradation Emissions	Post-Deforestation Regrowth Removals	Total Emissions & Removals
	<i>t CO<sub>2e</sub></i>			
2001	347,793	1,364,555	-5,469	1,706,879
2002	361,942	2,750,971	-11,161	3,101,751
2003	347,793	2,015,674	-16,631	2,346,837
2004		3,235,295	-16,631	3,235,295
2005	696,418	5,191,826	-27,583	5,860,661
2006	347,793	4,680,854	-33,052	4,995,595
2007	694,979	5,495,402	-43,981	6,146,400
2008	696,418	6,651,573	-54,933	7,293,058
2009	695,587	5,460,763	-65,872	6,090,478
2010	691,303	6,765,858	-76,743	7,380,418
2011		6,652,156	-76,743	6,652,156
2012	348,625	8,967,249	-82,226	9,233,648
2013	348,625	9,179,502	-87,708	9,440,418
2014	150,457	12,474,871	-93,178	12,532,150
2015		13,778,464	-93,178	13,778,464
2016	695,587	14,855,862	-104,117	15,447,333
2017	348,625	15,982,635	-109,599	16,221,660
<b>Total</b>	<b>6,771,946</b>	<b>125,503,509</b>	<b>-998,806</b>	<b>131,276,649</b>

displays the historical annual forest emissions and removals during the assessment period from 2001-2017. Removals from forest plantations have not been included due lack of reliable data. Recent emissions from forest degradation are around 14-16 Million tons of CO<sub>2e</sub> annually and as such have tripled compared to values 10 years ago.

Solomon Islands forest emissions are very high as compared to the GHG emissions from all other sectors combined, which in 2010 amounted to only 618.000 t CO<sub>2e</sub> or about 8% of the forest emissions in the same year (SIG, 2017). Although these numbers have to be treated carefully, they nevertheless demonstrate the importance of including AFOLU emissions into the NDC.

## 8 Forest Reference Level

The Solomon Islands Forest Reference Level consists of the linear projection of historical emissions during the Reference Period 2001-2017. A linear regression best fits the historical emission trend, as is demonstrated by a high correlation coefficient  $R^2=0.91$ . Therefore, the projection is expected to be representative of future

emissions during the results period, as is described in the following chapters on expected future emissions trends and national circumstances.

Linear Regression of the Solomon Islands Forest Reference Level 2018-2021:

$$\text{Annual Emissions (t CO}_{2e} \text{ yr}^{-1}) = 845,868 * \text{Year} - 1,691,626,006$$

Equation 5: Linear Regression of Solomon Islands FRL.

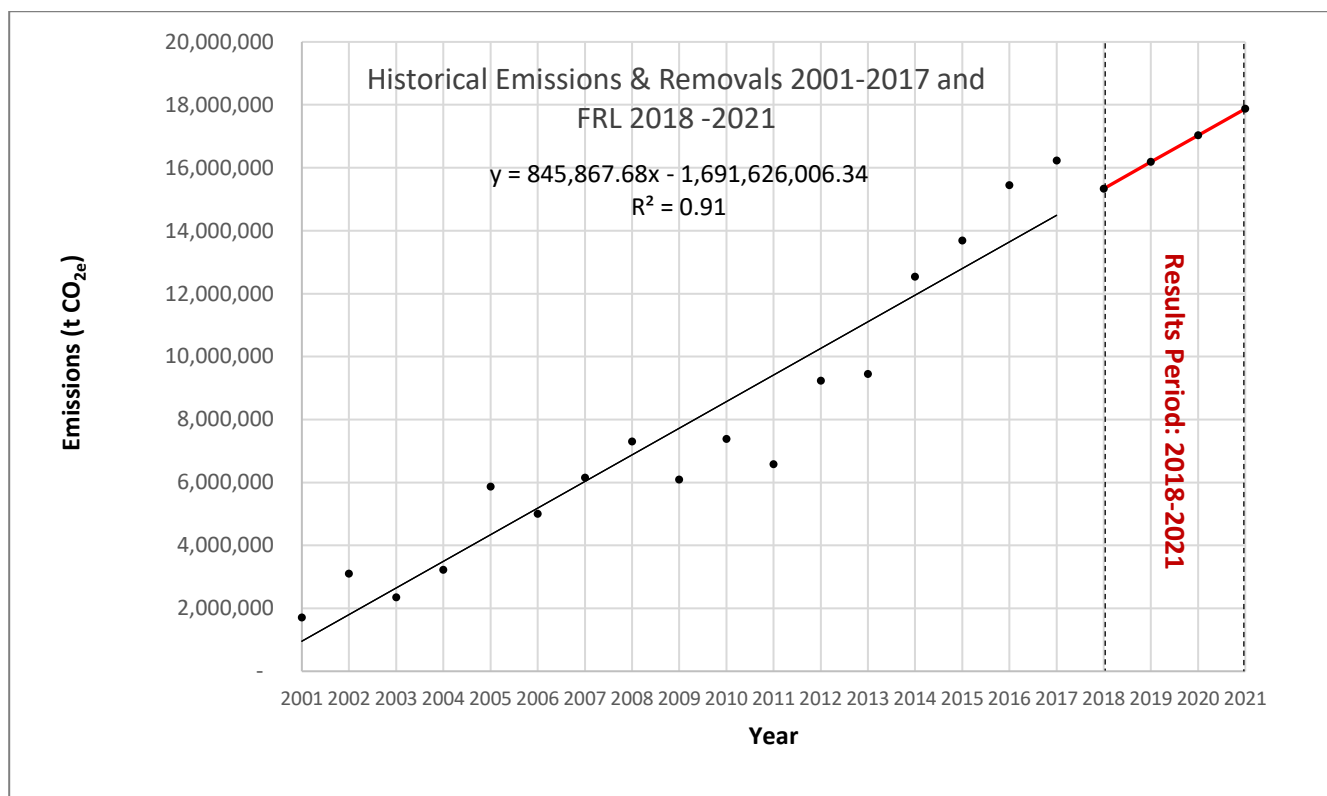


Figure 22: Solomon Islands National Forest Reference Level.

The estimated forest emissions during the results period are presented in the table below:

Table 20: Estimated annual forest emissions in the Solomon Islands during the results period 2018-2021.

Results Period (Year)	Estimated Emissions (t CO <sub>2e</sub> )
2018	15,359,822
2019	16,207,233
2020	17,054,643
2021	17,902,053

## 9 Expected Future Trends of Deforestation and Forest Degradation

### 9.1 Drivers of Deforestation

Table 21: Expected future trends for the main drivers of deforestation.

Main Driver	Underlying Cause(s)	Future Trend (Until end of Results Period in 2021)
Subsistence Agriculture	Population Growth Food Security	Expected to increase due to high population growth and growing demand for food.
Village/Urban Expansion	Population Growth Economic Development	Expected to increase as Solomon Island's population is growing at nearly 4% p.a. and young people are migrating away from small villages/hamlets to village or urban centers in search of employment and income opportunities.

### 9.2 Drivers of Forest Degradation

Table 22: Expected future trends for drivers of forest degradation.

Main Driver	Underlying Cause(s)	Future Trend (Until end of Results Period in 2021)
Commercial Logging	Economic Development	Currently commercial logging is the most important driver of forest emissions in the Solomon Islands. It is also one of the pillars of the Solomon Islands economy, accounting for 20% of the GDP and 70% of export revenue. Due to prolonged overharvesting of the commercially viable forests, logging developments are expected to decrease in numbers in the mid-term, due to the loss of forest productivity. It is not easy to predict the time when this will start to occur on a larger scale, due to a lack of updated national forest resources data (the commonly used dataset for timber resources estimations was collected in the early 90's during the Solomon Islands Forest Resources Inventory -SOLFRIS). One of the key findings of the Solomon Islands National Forest Resources Assessment 2011 update is that under the continuation of a market-driven, business-as-usual scenario, the logging industry is unlikely to crash in the next few years, despite the acceleration in logging activity, as re-entry into secondary forests is projected to sustain significant levels of logging for another 2 decades. This assumption is however based on a projection of future harvesting volumes of 1.45 Million m <sup>3</sup> /a, whereas from 2012 onwards the volumes have consistently surpassed the 2 million, and more recently, the 3 million m <sup>3</sup> /a mark. Therefore, the loss of forest productivity is likely to occur earlier than expected.

Main Driver	Underlying Cause(s)	Future Trend (Until end of Results Period in 2021)
		<p>The Solomon Islands government recognizes the forest sector’s predicament and urgent need for change and, through the Ministry of Forestry and Research has developed the following reforms:</p> <ol style="list-style-type: none"> <li>1. Participative/inclusive review of the Forest Act to include forest sector sustainability and forest ecosystem conservation measures. To date, the review is still underway and it unclear when the new Forest Act will be completed/gazetted.</li> <li>2. 2018 Launching of the Logging Sustainability Policy, which includes immediate measures to prevent the depletion of forest resources and an associated collapse of the logging industry. These measures include the reduction of harvesting volumes, felling licenses, as well as log production and environmental impact monitoring and legal enforcement.</li> <li>3. 2018 Launching of the National Forest Policy, which includes strategies and objectives for the transformation of logging sector towards economic sustainability, social equity and environmental balance.</li> </ol> <p>Considering the information above, <b>the following logging trend can be expected for the results period:</b></p> <p>Logging and log exports will continue to increase at the current highly unsustainable business as usual rate. Timber resources, even at the currently exceedingly high harvesting rates, will likely still sustain logging beyond the results period. There are no government interventions in place yet to curb the current trend, and it is unclear if and when the abovementioned reforms will come into effect and drive changes. In the upcoming national elections in March 2019, a new government could come into power which may not prioritize sustainability reforms in the forest sector. Furthermore, the current constraints in the forest sector are to a high degree driven by lack of investment into monitoring and legal enforcement. The Solomon Islands would need to allocate significant funds to build up and operationalize an effective legal control mechanism, given the high logistics costs associated to mostly remote locations. Moreover, since the Solomon Islands is a least-developed, small Islands country with limited funds and capacity, it’s likely that forest sector reforms will be implemented in a slow, step-wise manner that will take considerable time beyond the results period to produce significant results.</p>
Temporary Gardening	Population Growth Food Security	Expected to increase due to population growth and growing demand for food. Expected to expand due to soil degradation in overused areas.



Main Driver	Underlying Cause(s)	Future Trend (Until end of Results Period in 2021)
Portable Saw Milling	Economic Development Population Growth	Expected to increase during results period due to population growth and growing demand for construction timber. Portable Saw milling depends on forest access (logging infrastructure), as well as log transport (forest machines). Therefore, the milling trend is positively correlated to the logging trend. When logging developments start decreasing due to loss of forest productivity, so will portable saw milling.
Mining	Economic Development	Expected to increase in the mid and long term as a source of government revenue due to the loss of logging revenue. No significant changes expected during the results period.
Fire	Population Growth	Expected to decrease as areas susceptible to wild fires, such as grasslands, are decreasing (compare ). Fires from slash and burn agriculture are expected to increase.

## 10 National Circumstances

Solomon Islands is a High forest Cover Low Deforestation Country (HFLD) with low historical but very high and steeply increasing recent forest emissions (compare Figure 21), due to growing logging pressure. The FRL should be representative of the forest sector business-as-usual, i.e. how the pressure on forests will likely evolve without REDD+ actions from the government. In this regard, it can be expected that emissions will continue to increase during the results period (see )

A linear projection of historical emissions from 2001-2017 is considered the most representative model for the national Forest Reference Level, as it best reflects expected future forest emissions during the results period. As such, it will be suitable benchmark to assess the impacts national policies and measures on forest emissions. The FRL is based on annual assessments and datasets from a 17 years reference period that covers low historical as well as recently high forest emissions and therefore can be considered sufficiently robust.

## 11 Future Improvements

According to the stepwise approach to setting out the FRL, Solomon Islands proceeds to submit the current report with the anticipation that several aspects of the FRL will require further improvement in the near future. In the future it is anticipated that SI's FRL report will include some of the following key improvements as indicated below:

- The inclusion of other carbon pools apart from living biomass such as, deadwood, litter and soil organic carbon. The current FRL only includes above-ground biomass and below-ground biomass due to limitation of available data (if national forest inventory (NFI) is supported and implemented in future)

- A distinction between degradation drivers. There is currently no information available for emission factors which would allow for a distinction between forest degradation due to logging and other kinds of forest degradation. It is anticipated this data will become available if NFI is implemented.
- Systematically tracking managed and unmanaged lands over time. Currently, anthropogenic and non-anthropogenic emission are separated through interpreters' knowledge, going forward a more systematic way to separating managed and unmanaged lands may be introduced.
- The generation of emission estimates for provincial level. The estimates presented in this FRL are not disaggregated for use of local governments. In future, more detail may become available on activity data or emission factors that might make it possible to generate estimates at the level of provinces.
- Improving the accounting for post-deforestation regrowth. After deforestation some of the land is covered by perennial crops. The FRL deducts removals from post-deforestation regrowth in such perennial but there is currently no reliable information available on the rates of increment in those crops, nor are these being tracked over time, which made it necessary to resort to the use of default increment factors and averaging techniques. As better data become available, this approach may be improved.
- Broadening the scope of the FRL to include further REDD+ activities such as sustainable management of forests or conservation of forest carbon stocks. With regard to the sustainable management of forests, there is no current data available that would allow for quantifying emissions from conventional forest management as opposed to sustainable forest management. Such data would typically be collected at the level of forest concessions, however, stakeholders recognize the high importance of this improvement because of ongoing efforts to improve forest management practices in SI. There is also some potential improvements regarding some aspects of carbon stock enhancement. Notably tree planting, is still limited. It is hoped that in the near future better data will become available which will generate better information on the results of tree planting campaigns throughout the country.

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## Annex 1: Detailed Description of Forest Types

Land Use	Land Use Subtype	Land Use Subdivision	Land Use Disturbance	Definition (from FRA 2015)
Forest Land	Natural Forest	Lowland Forests	Primary	On level or nearly level land, has a complex structure and composition and is a variation of the better drained lowland that occurs on hills. Localized elements of freshwater swamp forests may be present. This is the most widespread vegetation type, in Solomon Islands and it contains about 60 common tree species, of which these are very common: <i>Calophyllum kajewskii</i> , <i>C. vitiense</i> , <i>Camptosperma brevipetiolata</i> , <i>Dillenia salomonensis</i> , <i>Elaeocarpus sphaericus</i> . The understory of the lowland rain forest contains a variety of short, thick-stemmed, low-statures trees such as <i>Barringtonia papeh</i> , <i>Leea indica</i> and <i>Tapeinosperma spp.</i> , as well as palms ( <i>Areca catechu</i> , <i>Licuala lauterbachii</i> and <i>Strongylocaryum latius</i> ), <i>Pandanus spp.</i> and bamboos.
			Logged or Degraded	This category includes: degraded forests, cleared to sparse remnant forests, very open canopy, with isolated trees. Forests classified as "logged forest type" are not included in the merchantable area if the logging has been done recently. This is because there are grave doubts that the forest will recover within the foreseeable future from the severe logging. Degraded forests also includes those area cleared less recently where regrowth is not high enough to permit to define these area as forest land.
		Hill Forests	Primary	Occurs on well-drained sites. It is complex in composition and structure. Hill forest forms the great bulk of forests with commercial potential in the Solomon Islands. A variant of this class of forest is dominated by <i>Casuarina papuana</i> which typically occurs on very alkaline ultra-mafic soils.
			Logged or Degraded	This category includes: degraded forests, cleared to sparse remnant forests, very open canopy, with isolated trees. Forests classified as "logged forest type" are not included in the merchantable area if the logging has been done recently. This is because there are grave doubts that the forest will recover within the foreseeable future from the severe logging. Degraded forests also includes those area cleared

Land Use	Land Use Subtype	Land Use Subdivision	Land Use Disturbance	Definition (from FRA 2015)
				less recently where regrowth is not high enough to permit to define these area as forest land.
		Montane Forests (Upland Rainforest)	Primary	Montane forest occurs on higher altitude ridge tops and mountain summit, generally above 600 meters. Occasionally it is present at lower elevations in relatively harsher conditions. Often tall-statured 25 to 35 m lowland rain forest changes abruptly to a lower-saturated 15 to 20 m tall montane rain forest on wet, cloudy, windy sites and on ridges of <i>Ardisia</i> and <i>Rhododendron</i> , <i>Metrosideros collina</i> , <i>M. salomonensis</i> , several species of <i>Ficus</i> , <i>Psychotria</i> , and <i>Schefflera</i> , and the gymnosperms <i>Dacrydium cf. xanthandrum</i> and <i>Podocarpus pilgeri</i> . Scrub stands of bamboo are common.
		Freshwater Swamp and Riverine Forest	Primary	This forest type is common where there is little micro relief and drainage is impeded. There are extensive areas of freshwater swamp in the Solomons, especially in the New Georgia group of islands, and several distinctive types can be delineated. In different areas, the swamp is dominated by a closed canopy of <i>Camnosperma brevipetiolata</i> or <i>Terminalia brassii</i> , or by a mix of species; <i>Inocarpus fagifer</i> and <i>Syzygium tierneyana</i> are generally restricted to these poorly drained sites, but other species, such as <i>Barringtonia racemosa</i> , <i>Calophyllum vexans</i> , <i>Camnosperma brevipetiolata</i> , <i>Intsia bijuga</i> , <i>Pterocarpus indicus</i> and <i>Terminalia brassii</i> can also be found on well-drained soils.
			Logged or Degraded	This category includes: degraded forests, cleared to sparse remnant forests, very open canopy, with isolated trees. Forests classified as "logged forest type" are not included in the merchantable area if the logging has been done recently. This is because there are grave doubts that the forest will recover within the foreseeable future from the severe logging. Degraded forests also includes those area cleared less recently where regrowth is not high enough to permit to define these area as forest land.

Land Use	Land Use Subtype	Land Use Subdivision	Land Use Disturbance	Definition (from FRA 2015)
		Mangroves (Saline Swamp)		Saline swamp occurs on land subject to tidal and supra tidal influences such as estuaries and foreshores. Two structural types of mangrove forest can be distinguished: one is a low, stunted, 2-5 m tall forest dominated by <i>Rhizophora apiculata</i> ; the other is up to 25 m tall and composed of <i>Bruguiera parviflora</i> , <i>B. sexangula</i> , <i>Rhizophora apiculata</i> and <i>R. stylosa</i> , with local populations of <i>Dolichandrone spathacea</i> . Other mangrove species include <i>Cerriops tagal</i> and <i>Lumnitzera littorea</i> , the latter sometimes forming pure stands. The palm <i>Nypa fruticans</i> is also present. Differing structure and composition are related both to habitat differences and to past habitat disturbance.
	Commercial Plantation	Eucalyptus		Forest land dominantly composed of exotic Eucalyptus tree species established through planting and/or deliberate seeding. Usually occurs on low-land and hill forest.
		Mahogany		Planted forest predominantly composed of exotic Mahogany tree species established through planting and/or deliberate seeding. Usually occurs on low-land and hill forest.
		Teak		Planted forest predominantly composed of exotic Teak tree species established through planting and/or deliberate seeding.
	Community Woodlots: Planted forest by community for small scale rehabilitation/ reforestation programs.	Terminalia		Planted forest predominantly composed of native Terminalia tree species established through planting and/or deliberate seeding.
		Acacia		Planted forest predominantly composed of exotic Acacia tree species established through planting and/or deliberate seeding.
		Gmelina		Planted forest predominantly composed of exotic Gmelina tree species established through planting and/or deliberate seeding.
		Others		Any other forest plantation composed of trees established through planting and/or deliberate seeding. For example, Balsa, Araucaria, Rubber, Pine, Canarium and others that are not listed.
		Agroforestry		Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in

Land Use	Land Use Subtype	Land Use Subdivision	Land Use Disturbance	Definition (from FRA 2015)
				some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economical interactions between the different components. Agroforestry can also be defined as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. In particular, agroforestry is crucial to smallholder farmers and other rural people because it can enhance their food supply, income and health. Agroforestry systems are multifunctional systems that can provide a wide range of economic, sociocultural, and environmental benefits.

## Annex 2: Detailed Description of other Land Use Categories

Land Use	Land Use Subtype	Land Use Subdivision	Land Use Disturbance
<b>Cropland</b>	Subsistence Agriculture	Subsistence Agriculture	Agriculture farming whereby crops are planted mainly to sustain the families. In Solomon Islands, this form of agriculture includes crops such as sweet potato, cassava, taro and bananas etc. The surplus is sold in the local markets for cash.
	Commercial Agriculture	Pineapple	The pineapple ( <i>Ananas comosus</i> ) is a tropical plant with an edible multiple fruit consisting of coalesced berries, and the most economically significant plant in the <i>Bromeliaceae</i> family. Medium scale pineapple fruit farms are planted purposely for the domestic market (mostly in Malaita).
		Palm Oil	So far, the only major Palm oil Plantation can be found at the lowlands at the Guadalcanal Plains. The Plantation covers more than 75,000 ha, including out growers around the Tetera and Balasuna area. Matured palm oil plantations are visible through satellite images with regular patterns.
		Coffee	Coffee is a genus of flowering plants whose seeds, are used to make various coffee beverages and products. Coffee planting in the Solomon Islands is still gaining momentum. There is only one major coffee plantation in the Hograno highlands of Isabel Province.

Land Use	Land Use Subtype	Land Use Subdivision	Land Use Disturbance
		Cocoa	Cocoa is a tree crop that grows to max. height of 6m. Cocoa plantations are usually found on lowland and flat plain areas. In some cases, cocoa trees are planted mixed with other agriculture crops such as coconut.
		Coconut	Coconut is a palm tree and Coconut plantations can be visible through satellite images. However, some coconut trees can be seen mixed within forest stands, which in that case is not for commercial use. However, some coconut plantations are only as subsistence (irregular pattern) and not commercial agriculture (regular pattern).
		Mixed (Coconut & Others)	Land use that is composed of two or more different agricultural crops planted together. Coconut and cocoa are two common crops.
		Other Agriculture	Crop that is planted for commercial purposes, that is not a coconut, cocoa, coffee or pineapple.
		Unknown Agriculture	Commercial agriculture crop that cannot be identified.
<b>Grassland</b>	Grassland	Herbland	Land that is dominantly vegetated with non-woody plants and grass.
		Rangeland	Rangeland is land vegetated with non-woody plants or grass, that is used for grazing domestic livestock.
	Other Wooded land	Shrub	Woody perennial plant (e.g. short-lived plants, small flowering plants), generally more than 0.5 meters and less than 5 meters in height at maturity and without a definite crown.
		Other Woodland	Land not defined as forest, spanning more than 0.5 hectares; with trees higher than 5 meters and a canopy cover of >5 <10 percent, or trees able to reach these thresholds; or with a combined cover of shrubs, bushes and trees above 10 percent. It does not include land that is predominantly under agricultural or urban landuse.
<b>Settlements</b>	Settlements	Urban	Urban areas are built-up areas mainly used for commercial and residential purpose. They have less vegetation and are dominated by buildings. In the case of Solomon Islands, this include Honiara, the Provincial headquarters and Sub-centres.
		Village	A village is a clustered human settlement or community, larger than a hamlet but smaller than a town, with a population ranging from a few hundred to a few thousand. Residential areas outside of the Urban areas. A group of more than ten (10) houses, situated in a rural area, that is not a Provincial headquarter or Sub-center. Can be delineated from urban areas by the greater amount of gardens and other vegetation.



Land Use	Land Use Subtype	Land Use Subdivision	Land Use Disturbance
		Hamlet	A small settlement, smaller than a village, around 1- 10 houses. Generally smaller than a village, and strictly one without a church, schools or a clinic.
		Infrastructure	Infrastructure covers power generation facilities within urban areas, port facilities, airports and all types of roads and bridges. Within crop land a permanent track is considered as an infrastructure element.
<b>Other Land</b>	Other land	Bare soil	Land that can be categorized as not covered by vegetation or artificial cover. Includes sand beaches and mud flats.
		Rock	Land area which is not covered by vegetation and dominated by continuous rock surface or coarse rock fragments, with some areas covered by shallow layers of soil or isolated pockets of soil or a mixture of both.
		Others	Other land that is not dominated by rock surface, bare soil, and/or not covered by vegetation or artificial cover (Low tide seashore, sea grass beds, reefs)
<b>Wetlands</b>	Wetlands	River	A river is a natural flowing watercourse, usually freshwater, flowing towards an ocean, sea, lake or another river.
		Lake	A large area of inland water body surrounded by the land on all sides.
		Dam	A barrier constructed to hold water and/or raise the water level, form a reservoir, for use as a water supply or for electricity generation.
		Swamp	A low-lying area, mostly uncultivated ground, where water is collected (stored) all year round. This is different from saline swamp (Mangrove). The regional classification scheme does not count mangroves as wetland.
<b>No Data</b>	No Data	Sea	A sea is a large body of salt water that is surrounded in whole or in part by land. More broadly, "the sea" is the interconnected system of Earth's salty, oceanic waters.
		Clouds	A cloud is an aerosol comprising a visible mass of minute liquid droplets, frozen crystals, or particles suspended in the atmosphere above the surface of the Earth. All satellite images from the different time series of the same area are partially covered with clouds where one cannot see the land cover of interest.
		Other	Any empty or null values, noise or error on the imagery apart from sea and clouds.

## Annex 3: Uncertainty calculations

Sampling size (Plot Count) and Area per IPCC Land Use Category

IPCC Land Use Category	Initial Land Use		Current Land Use	
	Plot Count	Area (ha)	Plot Count	Area (ha)
Forest land	5,201	2,529,641	5,181	2,519,802
Cropland	439	214,202	456	222,575
Grassland	15	7,431	14	6,946
Other land	12	5,823	12	5,823
Wetland	61	26,316	62	26,800
Settlement	49	18,150	52	19,616
<b>Total</b>	<b>5,777</b>	<b>2,801,562</b>	<b>5,777</b>	<b>2,801,562</b>

Sampling error and uncertainty of area estimate of each land use category (Land Use Category)

Land Use Category	Sample Size	Area	pi	Area [Ai] ( mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (ha)	Uncertainty %
Forest	5,181	2,519,802	0.89683	2,512,531.2	0.004002	11,212.8	± 21,977.1	± 0.87%
Cropland	456	222,575	0.07893	221,137.7	0.003548	9,939.5	± 19,481.4	± 8.75%
Grassland	14	6,946	0.00242	6,789.3	0.000647	1,812.5	± 3,552.5	± 51.14%
Other land	12	5,823	0.00208	5,819.4	0.000599	1,678.3	± 3,289.5	± 56.49%
Wetland	62	26,800	0.01073	30,067.0	0.001356	3,798.3	± 7,444.7	± 27.78%
Settlement	52	19,616	0.00900	25,217.5	0.001243	3,481.6	± 6,823.9	± 34.79%
All Classes	5,777	2,801,562						

Sampling error and uncertainty of area estimate of each land use category (Land Use Conversion)

Land Use Conversion	Sample Size	Area	pi	Area [Ai] ( mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (ha)	Uncertainty %
F > F	5,181	2,519,802	0.89683	2,512,531.2	0.004002	11,212.8	± 21,977.1	± 0.87%

Land Use Conversion	Sample Size	Area	pi	Area [Ai] ( mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (ha)	Uncertainty %
C > C	438	213,717	0.07582	212,408.5	0.003483	9,757.8	± 19,125.3	± 8.95%
F > C	18	8,858	0.00312	8,729.1	0.000733	2,054.4	± 4,026.7	± 45.46%
O > O	12	5,823	0.00208	5,819.4	0.000599	1,678.3	± 3,289.5	± 56.49%
G > G	14	6,946	0.00242	6,789.3	0.000647	1,812.5	± 3,552.5	± 51.14%
W > W	61	26,316	0.01056	29,582.0	0.001345	3,767.9	± 7,385.0	± 28.06%
G > W	1	485	0.00017	485.0	0.000173	485.0	± 950.5	± 195.99%
S > S	49	18,150	0.00848	23,762.6	0.001207	3,380.5	± 6,625.8	± 36.51%
F > S	2	981	0.00035	969.9	0.000245	685.8	± 1,344.1	± 136.98%
C > S	1	485	0.00017	485.0	0.000173	485.0	± 950.5	± 195.99%
All Classes	5,777	2,801,562						

Sampling error and uncertainty of area estimate of each land use category (Land Use Subdivision)

Land Use Subdivision	Sample Size	Area	pi	Area [Ai] ( mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (ha)	Uncertainty %
Lowland Forests	2,647	1,280,615	0.458	1,283,665.3	0.006556	18,366.8	± 35,998.9	± 2.81%
Hill Forests	1,919	939,061	0.332	930,621.0	0.006197	17,362.1	± 34,029.8	± 3.62%
Freshwater Swamp and Riverine Forest	17	8,369	0.003	8,244.2	0.000713	1,996.7	± 3,913.6	± 46.76%
Montane Forests (Upland Rainforest)	495	241,263	0.086	240,050.8	0.003683	10,317.8	± 20,222.8	± 8.38%
Mangroves	52	25,508	0.009	25,217.5	0.001243	3,481.6	± 6,823.9	± 26.75%
Eucalyptus	36	17,646	0.006	17,458.2	0.001035	2,900.9	± 5,685.7	± 32.22%
Teak	4	1,961	0.001	1,939.8	0.000346	969.7	± 1,900.5	± 96.93%
Gmelina	1	490	0.000	485.0	0.000173	485.0	± 950.5	± 193.91%

Land Use Subdivision	Sample Size	Area	pi	Area [Ai] ( mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (ha)	Uncertainty %
Other Plantation	8	3,914	0.001	3,879.6	0.000489	1,370.8	± 2,686.8	± 68.64%
Other Woodlot	2	975	0.000	969.9	0.000245	685.8	± 1,344.1	± 137.83%
Subsistence Agriculture	369	179,874	0.064	178,946.9	0.003217	9,014.0	± 17,667.4	± 9.82%
Coconut	39	19,239	0.007	18,913.1	0.001077	3,018.5	± 5,916.3	± 30.75%
Palm Oil	19	9,221	0.003	9,214.1	0.000753	2,110.6	± 4,136.7	± 44.86%
Cocoa	1	485	0.000	485.0	0.000173	485.0	± 950.5	± 195.99%
Mixed (Coconut &Others)	26	12,787	0.005	12,608.7	0.000881	2,467.4	± 4,836.1	± 37.82%
Unknown Agriculture	2	969	0.000	969.9	0.000245	685.8	± 1,344.1	± 138.74%
Herbland	14	6,946	0.002	6,789.3	0.000647	1,812.5	± 3,552.5	± 51.14%
Urban	23	5,440	0.004	11,153.9	0.000829	2,321.3	± 4,549.8	± 83.64%
Village	19	9,286	0.003	9,214.1	0.000753	2,110.6	± 4,136.7	± 44.55%
Hamlet	9	4,400	0.002	4,364.6	0.000519	1,453.8	± 2,849.5	± 64.76%
Infrastructure	1	490	0.000	485.0	0.000173	485.0	± 950.5	± 193.91%
Bare soil	1	490	0.000	485.0	0.000173	485.0	± 950.5	± 193.91%
Others	11	5,332	0.002	5,334.5	0.000574	1,607.0	± 3,149.7	± 59.07%
River	11	5,366	0.002	5,334.5	0.000574	1,607.0	± 3,149.7	± 58.70%
Lake	37	14,540	0.006	17,943.2	0.001050	2,940.6	± 5,763.6	± 39.64%
Swamp	14	6,894	0.002	6,789.3	0.000647	1,812.5	± 3,552.5	± 51.53%
All Classes	5,777	2,801,562						

Sampling error and uncertainty of area estimate of each land use category (Land Use Stratification: Disturbed type)

Land Use Stratification	Sample Size	Area	pi	Area [Ai] ( mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (ha)	Uncertainty %
Forest (Primary)	3,630	1,767,630	0.628	1,760,372.2	0.006358	17,813.7	± 34,914.8	± 1.98%
Forest (Disturbed by Logging)	941	457,571	0.163	456,338.9	0.004859	13,612.0	± 26,679.5	± 5.83%
Forest (Disturbed by Others)	559	269,614	0.097	271,087.6	0.003890	10,897.9	± 21,359.9	± 7.92%
Forest (Plantation)	51	24,987	0.009	24,732.5	0.001231	3,448.2	± 6,758.5	± 27.05%
Cropland	456	222,575	0.079	221,137.7	0.003548	9,939.5	± 19,481.4	± 8.75%
Grassland	14	6,946	0.002	6,789.3	0.000647	1,812.5	± 3,552.5	± 51.14%
Settlements	52	19,616	0.009	25,217.5	0.001243	3,481.6	± 6,823.9	± 34.79%
Other Land	12	5,823	0.002	5,819.4	0.000599	1,678.3	± 3,289.5	± 56.49%
Wetlands	62	26,800	0.011	30,067.0	0.001356	3,798.3	± 7,444.7	± 27.78%
All Classes	5,777	2,801,562						

Sampling error and uncertainty of area estimate of each land use category (Land Use Stratification: IPCC default)

Land Use Stratification	Sample Size	Area	pi	Area [Ai] ( mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (ha)	Uncertainty %
Tropical rain forest	4,583	2,228,045	0.793	2,222,530.5	0.005328	14,926.6	± 29,256.2	± 1.31%
Tropical mountain system	495	241,263	0.086	240,050.8	0.003683	10,317.8	± 20,222.8	± 8.38%
Tropical wet	52	25,508	0.009	25,217.5	0.001243	3,481.6	± 6,823.9	± 26.75%
Plantation forest	51	24,987	0.009	24,732.5	0.001231	3,448.2	± 6,758.5	± 27.05%
Cropland (Subsistence)	369	179,874	0.064	178,946.9	0.003217	9,014.0	± 17,667.4	± 9.82%

Land Use Stratification	Sample Size	Area	pi	Area [Ai] ( mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (ha)	Uncertainty %
<b>Cropland (Commercial)</b>	87	42,701	0.015	42,190.7	0.001603	4,489.5	± 8,799.5	± 20.61%
<b>Grassland (Grassland)</b>	14	6,946	0.002	6,789.3	0.000647	1,812.5	± 3,552.5	± 51.14%
<b>Wetlands</b>	62	26,800	0.011	30,067.0	0.001356	3,798.3	± 7,444.7	± 27.78%
<b>Settlements</b>	52	19,616	0.009	25,217.5	0.001243	3,481.6	± 6,823.9	± 34.79%
<b>Other Land</b>	12	5,823	0.002	5,819.4	0.000599	1,678.3	± 3,289.5	± 56.49%
<b>All Classes</b>	5,777	2,801,562						

Sampling error and uncertainty of area estimate of each land use category (Land Use Strata Change)

Land Use Strata Change	Sample Size	Area	pi	Area [Ai] ( mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (ha)	Uncertainty %
<b>Stable Forest (Primary)</b>	3,630	1,767,630	0.628	1,760,372.2	0.006358	17,813.7	± 34,914.8	± 1.98%
<b>Stable Forest (Secondary)</b>	452	219,788	0.078	219,197.9	0.003534	9,899.5	± 19,403.0	± 8.83%
<b>Deforestation (Primary)</b>	20	9,840	0.003	9,699.0	0.000773	2,165.2	± 4,243.8	± 43.13%
<b>Forest Degradation</b>	1,099	532,384	0.190	532,961.2	0.005164	14,468.2	± 28,357.6	± 5.33%
<b>Stable Non-Forest</b>	576	271,921	0.100	279,331.8	0.003942	11,044.3	± 21,646.9	± 7.96%
<b>All Classes</b>	5,777	2,801,562						