Solomon Islands National Forest Reference Level

Modified Submission for the UNFCCC Technical Assessment 2019

Solomon Islands Government

July 2019

Prepared by: *REDD+ Implementation Unit*

Ministry of Forestry and Research

Contents

List of Tables

List of Figures

List of Equations

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 estimated sustainable rate of

248,000 cubic meters per annum (SI Forest Resource Assessment Update, 2006). Under a market-driven business as usual scenario, timber resources are expected to last only 2 more decades before exhaustion (SI Forest Resource Assessment Update , 2011). 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).

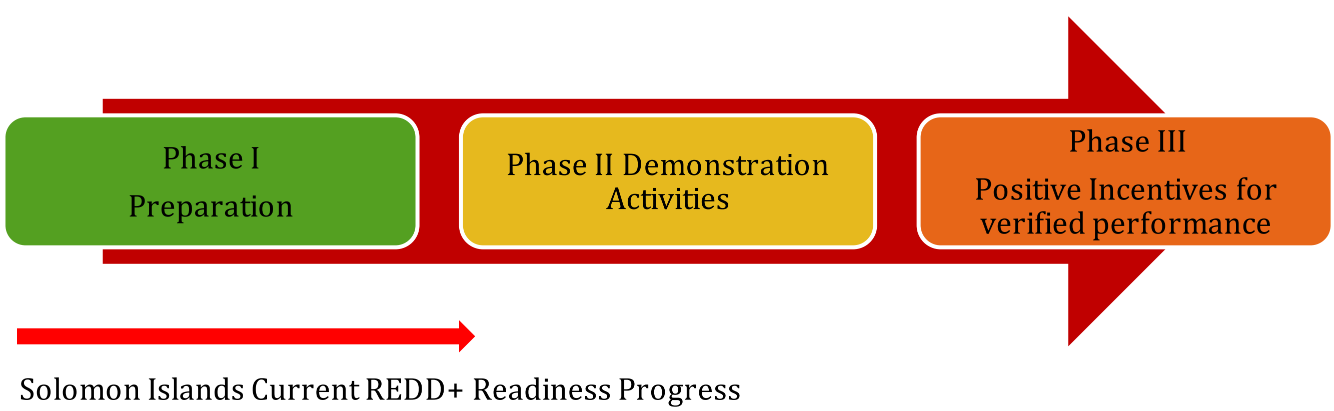


Figure 2: Illustration of the phased REDD+ Readiness approach and current progress in the Solomon Islands

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 21st 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. Forest data included in the Solomon Islands Second National Communications (SNC) to the UNFCCC (SIG, 2017) is based on the Solomon Islands Forest Resources Assessment 2006 (SOLFRIS), which does not address forest emissions. Therefore, the SNC does not include targets for emission reductions from the forest sector. These may be defined based on the results from national forest monitoring and can be included in future reporting. Currently, both the Intended Nationally Determined Contribution (SIG, 2015) and the SNC 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 a national forest definition of:

> ***"Land spanning more than 1 hectare 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).***

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	≥ 1 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. A forest minimum area threshold of 1 ha is expected to adequately represent small-scale forest cover changes.
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: 1. Mangroves (forest subjected to tidal influences); 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. 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.

		4. Agroforestry systems:Areas with a mix of agriculture and trees, with tree cover over 70% (areas with 30% crop cover are classified as cropland according to the hierarchy rules, compare 4.2.9). Agroforestry systems are currently not treated as a separate land-use category in the historical annual land-use and forest cover change assessment, but are classified as forest due to higher permanence, biodiversity and carbon stock as compared to cropland.

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[1]
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.

[1] 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[1]
				Degraded	Forest on land with little relief and impeded drainage with visible indications of human disturbance.
		Tropical Rain Forest (TAr), Tropical Mountain System (TM)	Montane Forest (Upland Rainforest)	Intact	Forest on at higher altitude ridge tops, generally above 600 m.a.s.l. with no clearly visible indications of 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 and natural forest disturbance categories used in the Solomon Islands historical annual land use and forest cover change assessment.

Disturbance Category	Disturbance Type/Driver
Anthropogenic Impact	Commercial Logging
	Portable Saw Milling
	Temporary Gardening
	Grazing
	Mining
	Fire
	Other Impact
Natural Impact	Cyclone
	Flooding
	Landslide

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.

From / To		Forest Land: Intact forest	Forest Land: Degraded forest /Tree Plantation	Non Forest Land
Forest Land	Intact Forest	Forest Conservation	Forest Degradation	Deforestation
Forest Land	Degraded Forest	Sustainable Forest Management Enhancement of C stocks (Forest remaining Forest)	Sustainable Forest Management	Deforestation
Non Forest Land		---	Enhancement of C stocks (Non-Forest to Forest)	---

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)[2]
Cropland	**Subsistence Agriculture**	Subsistence Agriculture
		Temporary Gardening
	Commercial Agriculture	Pineapple
		Palm Oil
		Coffee
		Cocoa
		Coconut
		Mixed (Coconut & Others)
		Other Agriculture
		Unknown Agriculture
Grassland	**Grassland**	Herbland
		Rangeland
	Other wooded land	Shrubland
		Other Woodland
Settlements	**Settlements**	Urban
		Village
		Hamlet
		Infrastructure
Other Land	**Other land**	Bare soil
		Rock
		Others
Wetlands	**Wetlands**	River
		Lake
		Dam
		Swamp
No Data	**No Data**	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**

[2] 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 **Error! Reference source not found.**):

4. Forest Conservation

In the Solomon Islands, terrestrial protected areas exist at a very limited scale: Within the scope of REDD+ activities, forest conservation refers to either community conservation areas or officially recognized conservation areas. Currently there aren't any CAs under the Protected Areas Act. Protected areas as per the Solomon Islands National Communication to the UNFCCC refers to all forest areas above 400 m.a.s.l. where logging is prohibited, but these are not conservation areas in a stricter sense as other human activities like agriculture, timber milling, mining are allowed there. There is currently no data available to allow for a reliable estimation of emission removals from community 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 vey 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)**

The following Carbon pools currently not covered in the FRL. These may be included as a future improvement to the FRL accuracy once reliable data becomes available through the National forest Inventory (chapter 10 a).

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. Organic Litter

There is no reliable carbon stock data for litter in SI The 2006 IPCC Guidelines provide default carbon stock values for litter in some forest types, but not for tropical evergreen broad leaf forests as they occur in the Solomon Islands. The IPCC 2006 Guidelines default value for litter in broadleaf deciduous forest in the tropical region is 2.1 tC/ha. This is 1.2 % of the average carbon stocks in total living biomass in primary forests in SI (about 181 tC/ha weighted average over all forest types, compare chapter 5.3.3 Biomass and Carbon Values and Emission Factors in Forest Land). It is therefore not a highly significant carbon pool and a conservative approach to carbon stock change estimations was taken by not including it in this FRL modified submission. However, the implementation of the SI NFI could provide country specific data on litter carbon stocksto 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[3], therefore it is currently not possible to estimate the emissions from soil organic carbon pools. Detailed soil classification, mapping and analysis was carried out in all provinces during the Solomon Islands Land Resources Study (Hansell, J.R.F. and Wall, J.R.D. 1976). Currently, some of the 8 Volumes and maps are available as hard copies at MoFR. It has yet to be evaluated whether existing soil data can be used to improve the accuracy of the FRL, or if new data needs to be collected during the National Forest Inventory.

3.3 Green House Gases (GHG)

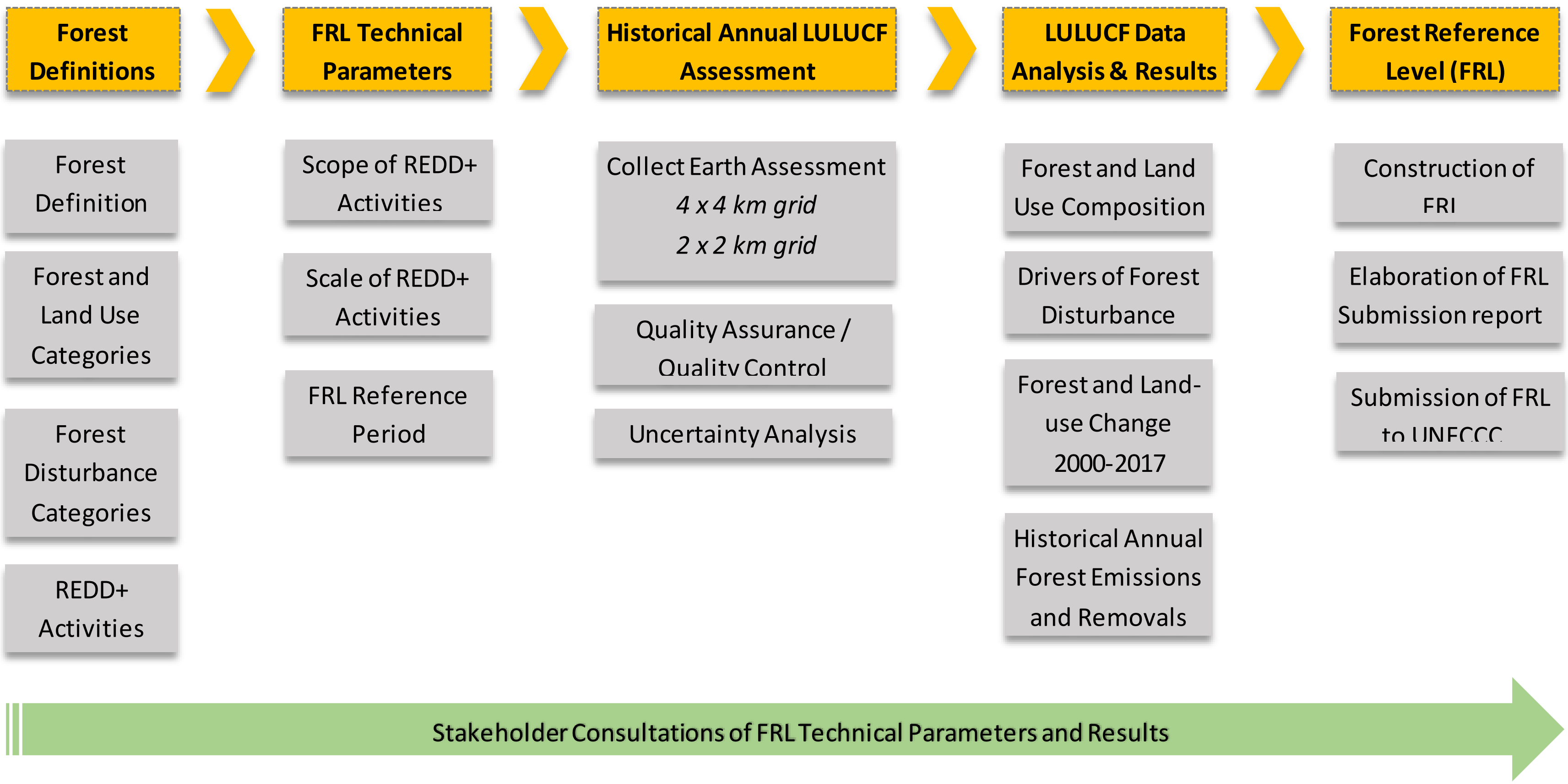
CO2 is the only GHG included in the FRL. Other gases related to fire and the drainage of organic soils (CH4 and N2O) are likely significant but can currently not be included because reliable data is not available. The inclusion of NO2 and CH4 into the FRL calculation is considered as a future improvement (compare chapter 10, item g). At the moment, the exclusion of other GHG from the FRL can be considered a conservative approach. 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.

[3] 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.

4 Construction Methodology

4.1 Workflow Diagram for FRL Construction



4.2 Historical Annual Land Use Change Assessment

4.2.1 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.

4.2.2 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.

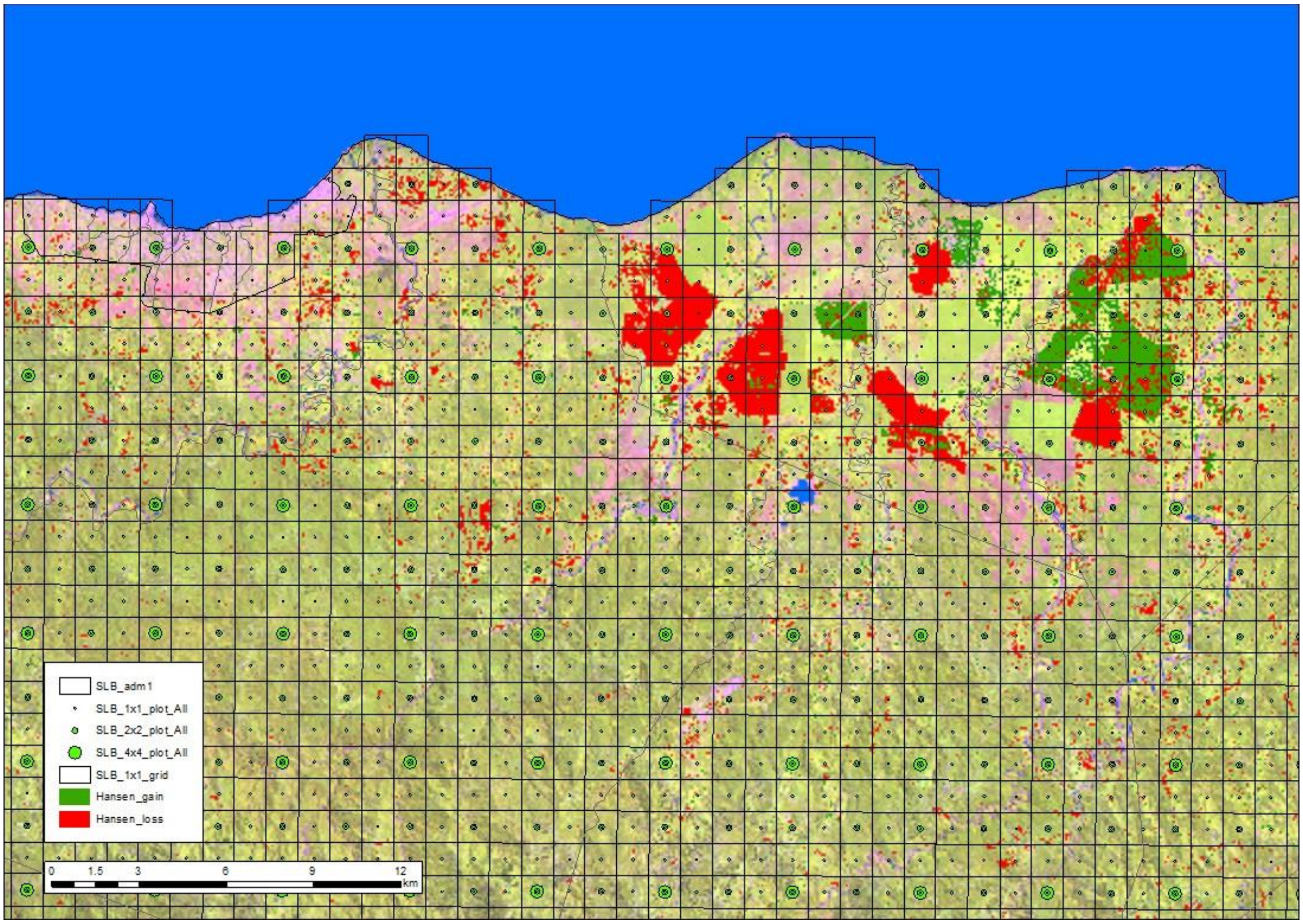


Figure 3: Sample Plots Distribution for Solomon Islands land use change assessment.

4.2.3 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%.

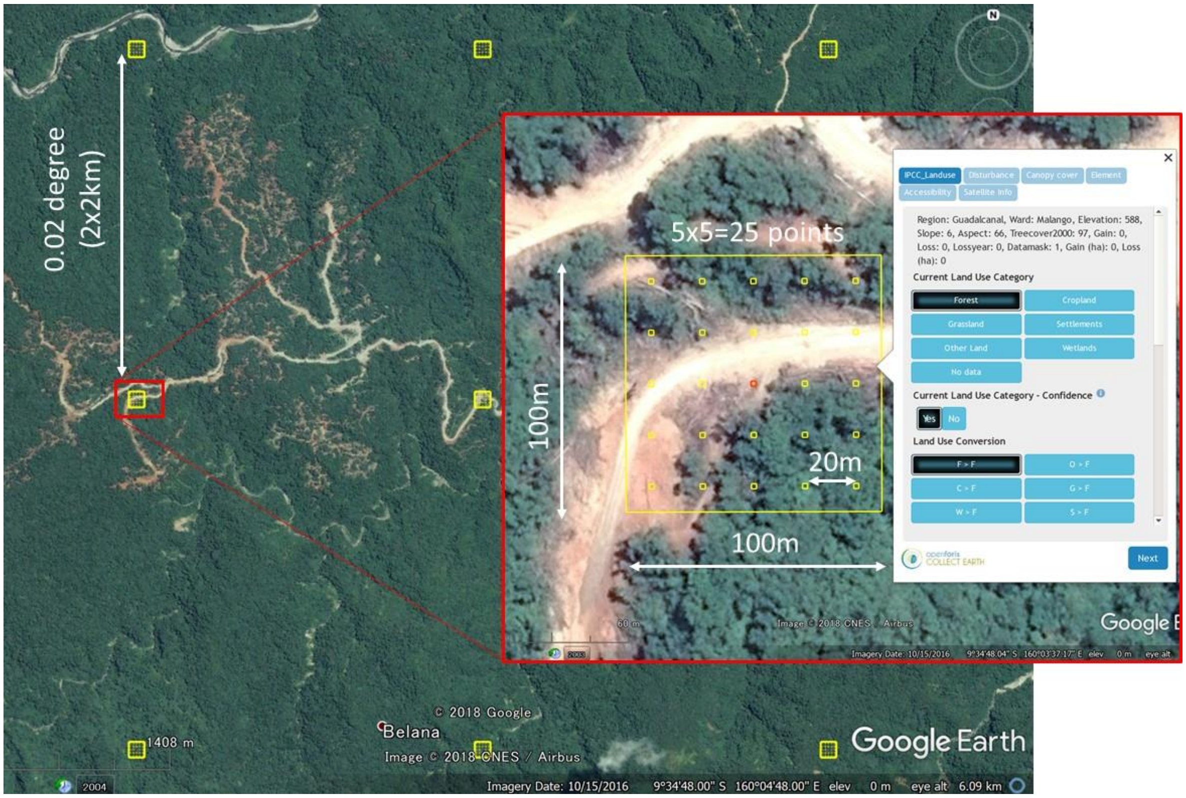


Figure 4: Image of the spatial sampling unit and the distribution of the assessment plots.

4.2.4 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. The 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). SI-FRL assessment team carried out the current land use assessment and further classifications based on 2017 Landsat 8 imagery with referencing high resolution images (if available but the year may vary) and historic time series Landsat 7 imagery. Referencing in this context means comparing land-use between the Landsat and high resolution image to understand if land-use change occurred. Hansen data was used as ancillary data to assess tree cover loss. Identifying the forest degradation in the absence of high-resolution images is challenging so if there are no visible clues of disturbance such as logging roads, the plot is not recorded as not disturbed for a conservative approach

The year, month and date were recorded for all the plots which are covered by high resolution satellite imagery. The SI FRL assessment team analyzed the information of the satellite observation date (years and months, see annex 4).

All of SI is located inside the tropical rain forest zone, with no seasonal changes in the forest vegetation.

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)	2000-2017 (to date)	Land use and disturbance

Bing Maps	World-View, QuickBird, Ikonos, SPOT, etc.	High (0.5-2.5m)	2000-2005, 2007-2017 (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

About 84% (4935 plots) of the total plots (5875 plots) are covered by high resolution images (Digital Globe or Bing Maps) but the year of image observation varies (this is the best achievable result using free of charge imagery). There is not a single plot for which more than one high resolution image is available for a single year. The detailed discrimination of all the sample plots per land use category and image type is presented in Annex 4 of this document and in the worksheet "Satellite_Plots" of the supplemental material "Supplemental_tables_2019_0308".

4.2.5 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:

(a) Collect Earth software is installed and opened, enabling the Google Earth to be automatically launched.

(b) 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.

(c) 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.

(d) 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:

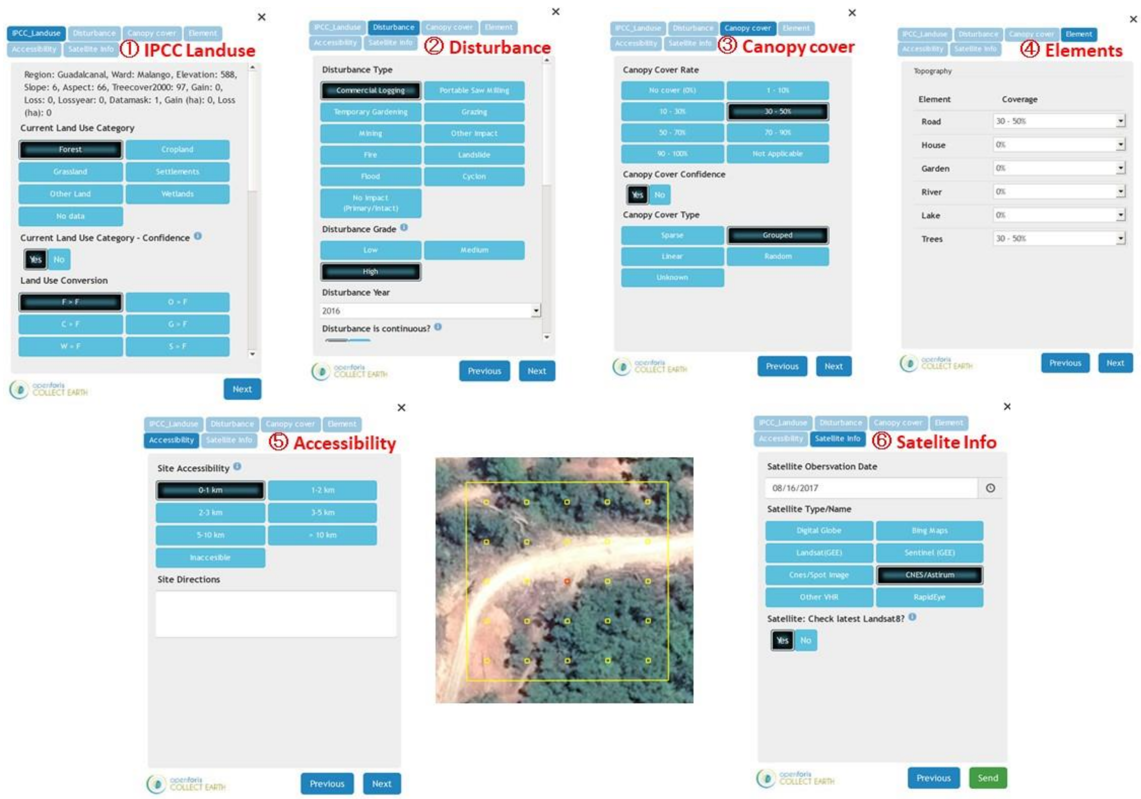


Figure 5: Solomon Islands context Collect Earth survey form (designed with Collect tool).

4.2.6 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.

4.2.7 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
Anthropogenic		
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	Burnt color or smoke (but challenging to detect by Landsat)
Fuelwood extraction	No features yet	Evidence of fuelwood extraction cannot be confirmed in historical manner due to the limited resolution image used in the Collect Earth assessment. Therefore emissions/carbon losses from such activities are not accounted for in the SI FRL construction
Natural		
Landslide	Forest canopy disturbance (gaps) on steep slopes and inaccessible areas	Hansen data show loss and/or bare soil visible but no logging or gardening activity visible
Flood	Forest canopy disturbance located near large rivers.	Hansen data show loss, but no logging activity or gardening visible in the area
Cyclone	Plots with forest canopy disturbance (gaps), near the coast and no logging activity in the area.	Hansen data show loss, but no logging activity or gardening visible in the area. Occurrence of cyclone confirmed for date of the image[4]

[4] Reference: Southern hemisphere Cyclone Data Portal: http://www.bom.gov.au/cyclone/history/tracks/

4.2.8 Assessment of Carbon Stock Enhancement

- Carbon stocks enhancement comprises the emission removals that occur in areas where non-forest grows into forest and in areas where forest remains forest. The current SI Collect Earth assessment methodology is suitable to detect such changes, however no pixel or plot was identified in these categories
- Although enhancement of carbon stocks can be expected to occur, it is challenging to identify compared to deforestation and forest degradation where changes usually happens on a short term, whereas the changes of carbon stock enhancement are gradual and therefore not easily detectable by remote sensing only
- SI currently does not have country-specific tree increment data (removal factors) from natural forests and plantations. Therefore, even if the areas of potential carbon stock enhancement are identified, the calculation of emission removals is currently not possible
- There may be potential to use the disturbed/deforested area history records and monitor the area if it is recovering but the current assessment did not work until that level.

4.2.9 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 ≥ 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.
In the current assessment method, if the land-use is determined as settlement by hierarchy rule no biomass will be assigned to that plot The composition of the pixels is not exactly recorded but the percentage of the elements (Road, House, Garden, River, Lake, Trees are classified with %) has been assessed per plot. There is potential analyses to increase the accuracy of biomass estimations in settlements which could be incorporated as a future improvement.

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

4.2.10 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 (for the process of QA/QC, refer to Quality Assurance / Quality Control Process in chapter 4.6).

4.2.11 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 plots located in the specific category by the total number of plots, and area estimates for each land-use category are obtained by multiplying the proportion of each category by the total area of interest. In order to extrapolate the sampled area of the different land-use categories to the total area of each province,-specific expansion factors are applied. The number of sampling plots, weight and expansion factors for area estimation are shown in the table below. Due to the smaller area, for Honiara, a reduced sample plot grid of 1x1km was used in order to reliably identify different land uses. The posterior application of a weight of 0.25 for the Honiara plots guarantees comparability with the remaining plots which are arranged in a 2x2km grid.

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

Province	Area (ha)	Number of Plots	No Data Plots[5]	Plot Weight	Expansion Factor (ha)
Central	63,876	133	8	1	511.01
Choiseul	330,386	677	6	1	492.38
Guadalcanal	534,938	1108	5	1	484.98
Honiara	2,537	21	1	0.25	126.85
Isabel	421,451	870	4	1	486.66
Makira Ulawa	321,903	666	12	1	492.21
Malaita	421,306	883	25	1	491.03
Rennell and Bellona	67,143	182	6	1	381.49
Temotu	88,537	186	3	1	483.81
Western	549,485	1149	28	1	490.17

[5] Spreadsheet with "no data" plots in terms of land use category ("Landuse_Plots" worksheet) and the breakdown of "No data" in terms of land use subdivision ("NoData_Plots" worksheet) are provided in supplemental tables.

Total	2,801,562	5875	98		

- There are 98 plots recorded as "No data". 68 plots are located in the sea, 26 plots are covered by clouds and 4 plots are unable to assess by other reasons such as image noise. These plots are removed from the final sample, and from the calculation of the Plot Weight per Province
- Although sea mask was applied beforehand using the government administrative boundary, it does not perfectly match with the terrestrial land in the imagery and 68 plots are located in the sea
- The final sample size is a total of 5,777 plots (total if 5875 plots – 98 no data plots), which are correctly described in annex 3 and in Table 10 (see also "Province_Plots" worksheet in supplemental tables)

4.2.12 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		
	Fire ()		
		Natural Disaster	Natural disaster (Note: excluded from calculation of emissions and removals for FRL construction, which focus on anthropogenic)
	Landslide		
	Flood		
	Cyclone		

4.2.13 Stratification by Global Ecological Zone for carbon stock

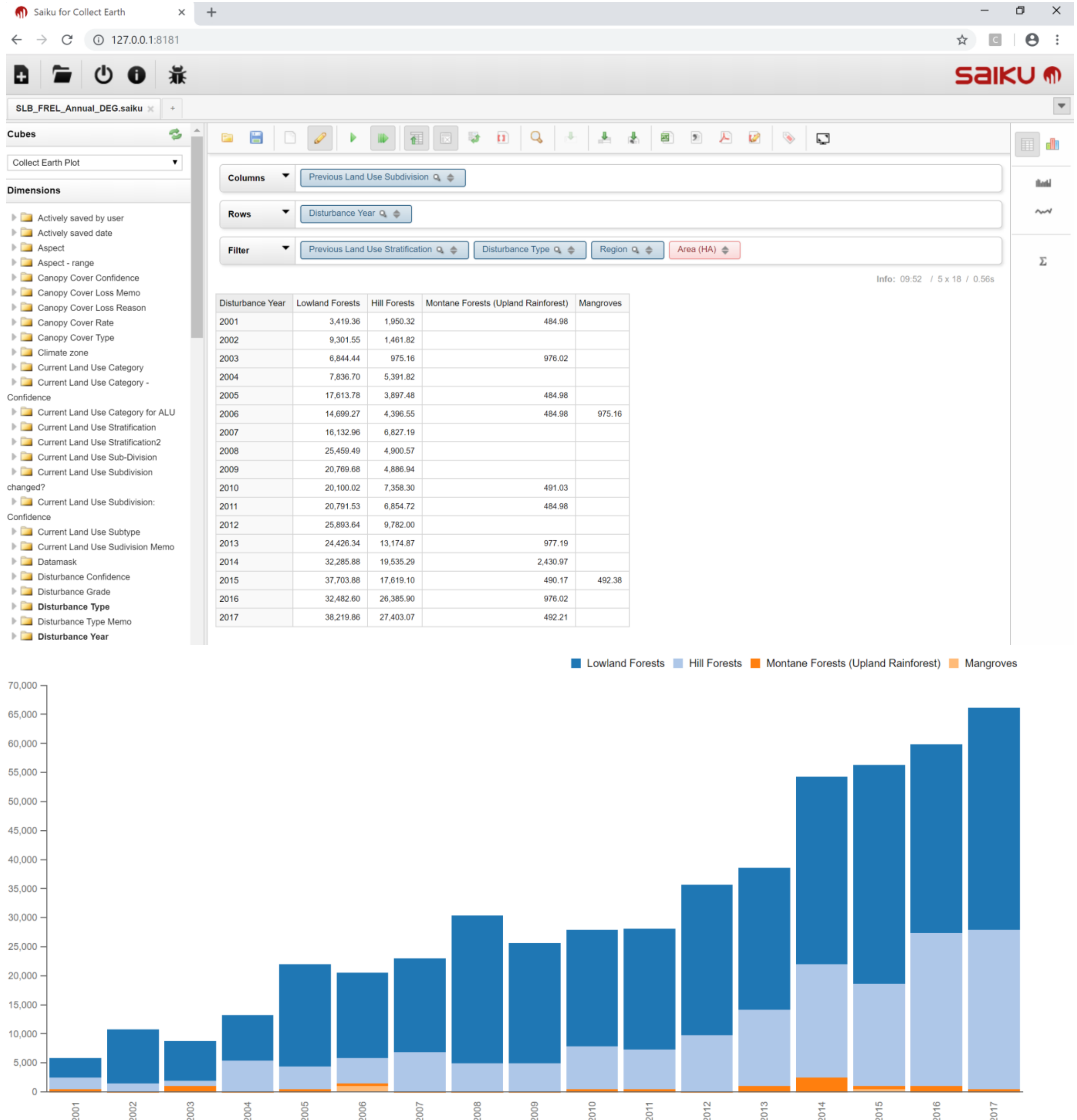
For assigning the carbon stock value from IPCC default values, forest and land use categories in the Solomon Islands are stratified using FAO Global Ecological Zones (GEZ) automatically in Collect Earth with considering the characteristics of the defined land use sub-type and land use subdivision as shown in **Error! Reference source not found.**.

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

4.2.14 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.



Disturbance Year	Lowland Forests	Hill Forests	Montane Forests (Upland Rainforest)	Mangroves
2001	3,419.36	1,950.32	484.98	
2002	9,301.55	1,461.82		
2003	6,844.44	975.16	976.02	
2004	7,836.70	5,391.82		
2005	17,613.78	3,897.48	484.98	
2006	14,699.27	4,396.55	484.98	975.16
2007	16,132.96	6,827.19		
2008	25,459.49	4,900.57		
2009	20,769.68	4,886.94		
2010	20,100.02	7,358.30	491.03	
2011	20,791.53	6,854.72	484.98	
2012	25,893.64	9,782.00		
2013	24,426.34	13,174.87	977.19	
2014	32,285.88	19,535.29	2,430.97	
2015	37,703.88	17,619.10	490.17	492.38
2016	32,482.60	26,385.90	976.02	
2017	38,219.86	27,403.07	492.21	

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

4.3 Emission Factor Analysis

4.3.1 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.

4.3.2 Carbon and Emission Calculations

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

Where:

ABG= Above Ground Biomass (t d.m. ha^{-1})

BGB= Below-Ground Biomass (t d.m. ha^{-1})

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

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

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

Where:

Carbon Stock $_{PRE}$ = Carbon Stock before Land Use Conversion (t C ha^{-1})

Carbon Stock $_{POS}$ = Carbon Stock after Land Use Conversion (t C ha^{-1})

$\frac{44}{12}$ = C to CO_2 Conversion factor

Equation 2: Emission Factor from Land use Conversion.

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

Where:

AGB_{INCR}=	Increment of Above-Ground Biomass (t d.m. ha^{-1} yr^{-1})
BGB_{INCR}=	Increment of Below-Ground Biomass (t d.m. ha^{-1} yr^{-1})
0.47=	Carbon Fraction default value (2006 IPPC Guidelines, Table 4.3)
$\frac{44}{12}$=	C to CO_2 Conversion factor

Equation 3: Removal Factor from Biomass Increment.

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

In chapter 4.3.3, the following assumptions were made on the EF forest degradation:

Currently, Solomon Islands has no reliable data regarding the differences in carbon stocks between intact and degraded forest. Therefore, a proxy had to be used to estimate emissions from forest degradation. PNG calculated a corresponding ratio based on field assessments, which is expected to be sufficiently applicable for forests in the Solomon Islands due to (a) floristic and structural similarity of commercial forests (mainly lowland and hill forests) and (b) similar, largely unplanned logging practices with high harvesting intensity. It can furthermore be expected that due to a higher level of supervision by the Forest Authority in PNG, the frequency of re-entry logging is lower than in the Solomon Islands. This means that Solomon Islands commercial forests are likely more degraded and have lower carbon stocks than PNG's commercial forests. In this sense, the application of the PNG EF for forest degradation ratio can be considered conservative. Solomon Islands considers the establishment of a national Emission Factor for forest degradation a future improvement of the FRL (cp.chapter 10), once reliable data becomes available.

Biomass/ Carbon Pool	*Components*	*Units*	*Lowland Forests*	*Hill Forests*	*Freshwater Swamp/ Riverine Forest*	*Montane Forests*	*Mangrove Forest*	*Plantation Forests*
Biomass in primary forest	Above-ground biomass	t d.m. ha^{-1}	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^{-1}	111.0	111.0	111.0	37.8	94.1	55.5
	Total living biomass	t d.m. ha^{-1}	411.0	411.0	411.0	177.8	286.1	205.5
Biomass in degraded forest[6]	Above-ground biomass	t d.m. ha^{-1}	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^{-1}	72.7	72.7	72.7	24.7	61.6	36.3
	Total living biomass	t d.m. ha^{-1}	269.1	269.1	269.1	116.4	187.3	134.5
EF primary deforestation	Before	t d.m. ha^{-1}	411.0	411.0	411.0	177.8	286.1	205.5
	After	t d.m. ha^{-1}	0.0	0.0	0.0	0.0	0.0	0.0
	Difference	t d.m. ha^{-1}	411.0	411.0	411.0	177.8	286.1	205.5
	Conversion	t d.m. / t CO_{2e}	1.72	1.72	1.72	1.72	1.65	1.72
	Emission factor	t CO_{2e} ha^{-1}	708.3	708.3	708.3	306.4	473.1	354.1
EF forest degradation	Before	t d.m. ha^{-1}	411.0	411.0	411.0	177.8	286.1	205.5
	After	t d.m. ha^{-1}	269.1	269.1	269.1	116.4	187.3	134.5

[6] Ratio biomass intact/disturbed forest (223/146), PNG 2017

Biomass/ Carbon Pool	*Components*	*Units*	*Lowland Forests*	*Hill Forests*	*Freshwater Swamp/ Riverine Forest*	*Montane Forests*	*Mangrove Forest*	*Plantation Forests*
	Difference	t d.m. ha^{-1}	141.9	141.9	141.9	61.4	98.8	71.0
	Conversion	t d.m./t CO_{2e}	1.72	1.72	1.72	1.72	1.65	1.72
	Emission factor	t CO_{2e} ha^{-1}	244.6	244.6	244.6	105.8	163.4	122.3
EF secondary deforestation (deforestation of degraded forest)	Before	t d.m. ha^{-1}	269.1	269.1	269.1	116.4	187.3	134.5
	After	t d.m. ha^{-1}	0.0	0.0	0.0	0.0	0.0	0.0
	Difference	t d.m. ha^{-1}	269.1	269.1	269.1	116.4	187.3	134.5
	Conversion	t d.m./t CO_{2e}	1.72	1.72	1.72	1.72	1.65	1.72
	Emission factor	t CO_{2e} ha^{-1}	463.7	463.7	463.7	200.6	309.7	231.9

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

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

Land Use	Land Use Subdivision	AGB t ha^{-1}	Root-Shoot Ratio (BGB/ABG)	ABG+BGB t ha^{-1}	C t ha^{-1}	EF t CO_2 ha^{-1}	Source
Subsistence Agriculture		45		45	21	77	2006 IPPC Guidelines, Table 5.1
Commercial Agriculture	Coconut	196	0.37	269	126	463	2006 IPPC Guidelines, Table 5.3
	Palm Oil	136	0.37	186	88	321	2006 IPPC Guidelines, Table 5.3
	Coffee	120	0.32	158	74	273	2006 IPPC Guidelines, Table 5.2
	Cocoa	120	0.32	158	74	273	2006 IPPC Guidelines, Table 5.2
	Pineapple	60	0.32	79	37	136	IPCC EF DB 511318 Other Species
	Mixed/Other	60	0.32	79	37	136	IPCC EF DB 511318 Other Species[7]
Grassland	Herbland	6.2	1.6	16	8	28	2006 IPPC Guidelines Chapter 6, Table 6.4, 2003 IPCC Good Practice Guidance for LULUCF, Table 3.4.2

[7] For mixed/other crops, an EF from IPCC EF Database was used, instead of the EF of 120 t.d.m. from the 2006 IPCC guidelines in that category. Mixed/others crops in SI are usually composed of non-perennial type crops so using 2006 IPCC default value would overestimate the biomass in the national context.

Land Use	Land Use Subdivision	AGB t ha^{-1}	Root-Shoot Ratio (BGB/ABG)	ABG+BGB t ha^{-1}	C t ha^{-1}	EF t CO_2 ha^{-1}	Source
	Rangeland	6.2	1.6	16	8	28	2006 IPPC Guidelines Chapter 6, Table 6.4, 2003 IPCC Good Practice Guidance for LULUCF, Table 3.4.2
	Shrub land	70	0.4	98	46	169	2006 IPPC Guidelines, Table 4.12 & 4.4
	Other Wooded Land	70	0.4	98	46	169	2006 IPPC Guidelines, Table 4.12 & 4.4
Wetlands (		0	0	0	0	0	No IPPCC guidance provided on CO_2 EF
Settlements		0	0	0	0	0	No reliable data
Other Land		0	0	0	0	0	No reliable data

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

The Historical annual land use and forest cover change assessment considers post deforestation regrowth during the reference period 2000-2017. Currently, no assumptions are made on the impact of pre-2000 rate of deforestation regrowth on the reference period.

		coconut	oil palm	cocoa	Mixed (coconut & others)	unknown agriculture	subsistence agriculture
relative area	%	8.6%	4.1%	0.2%	5.7%	0.4%	80.8%
AGB	t d.m.	196	136	120	128	10.64	44.68
Root-shoot ratio	BGB / AGB	0.37	0.37	0.37	0.37	0.32	0.00
Source		Table 5.3, IPCC 2006	Table 5.3, IPCC 2006	Table 5.2, IPCC 2006	Table 5.2, IPCC 2006	Table 5.9, IPCC 2006	Table 5.1, IPCC 2006
Growth duration	years	20	20	20	20	1	8
Mean annual increment in AGB	t d.m. /ha/yr	9.80	6.80	6.00	6.40	10.64	5.59

4.4 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)

4.5 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.

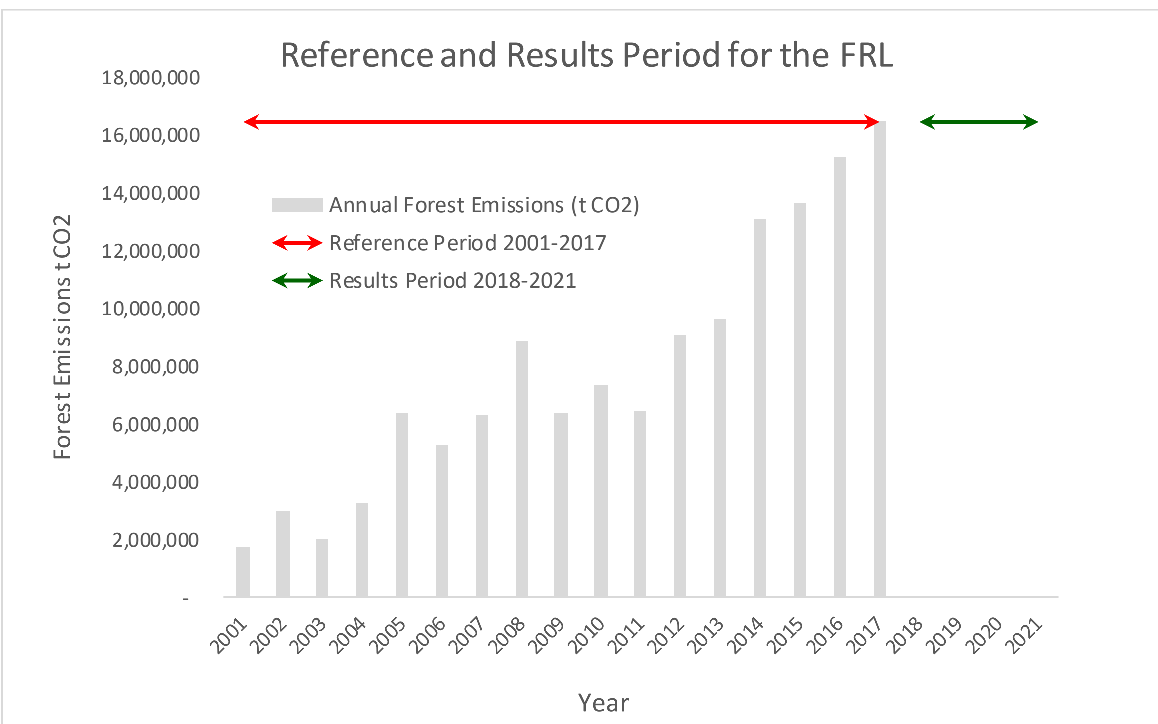


Figure 7: Reference and Results Period for the Solomon Islands FRL.

4.6 Quality Assurance / Quality Control Process

In the initial assessment, SI-FRL assessment team found several data errors to be corrected caused by customization of the tool. In addition, since the Collect Earth is a user friendly tool that require minimum GIS and Remote Sensing skills but requires good understanding of the land, it is important to have quality-assurance and quality control process and system in place to ensure the results are standardized and consistent between with the various assessment by the officers. The same quality-assurance and quality-control process were applied for all the data during assessment period. There were three (3) sessions of data checking and cleaning were conducted during the assessment. Following figure shows the general process applied to conduct the whole QAQC process.

For the first session some of these issues were resolved included correction of integrity errors such as missing or blank records, odd values, typing errors or incorrect input values. After cleansing of these errors a group of operators were invited to perform sessions 2 and 3 of data cleansing.

On the second session, data was compared with Global Forest Change (GFC or Hansen data). Using sampling plot of 1 km by 1 km grid, GFC tree cover loss information was integrated. Sampling plots containing more than 10 ha of GFC tree cover loss within a surrounding area of 100 ha (1x1 km) were aggregated. It was found that deforestation and forest disturbance can be overestimated. To overcome this, sampling plots with less than 5 ha of GFC tree cover loss within 100 ha around the plot were selected. In total 937 sampling plots were identified. These sampling plots were re-assessed and modified to contain a land use conversion or allocated a human impact. Sampling plot was unchanged if GFC tree cover was incorrect due to some image processing error.

On the third session, because the version of the Hansen data which the SI team used was until 2016 but Hansen data was updated until 2017 by the time of third session of data cleaning, same QA/QC process were applied to the all the plots. In total 718 sampling plots were identified, reviewed and verified.

5 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.

5.1 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.

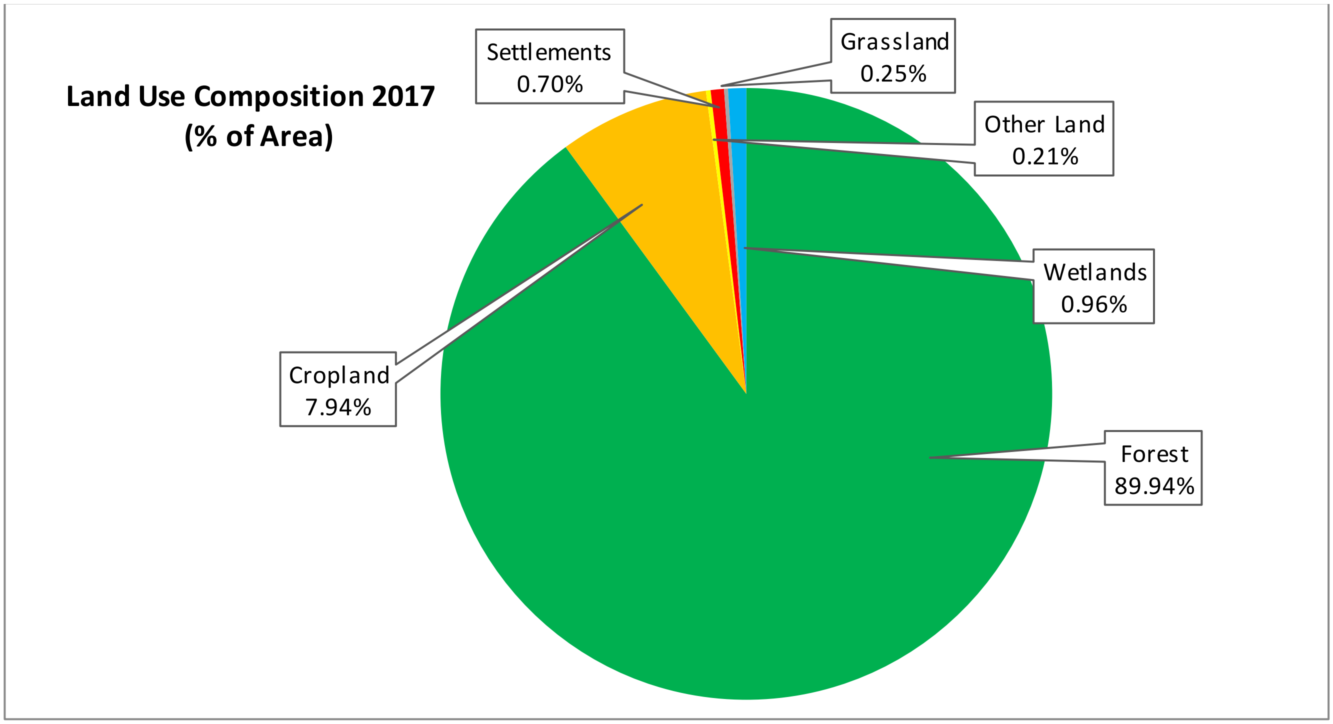


Figure 8: Current composition of land use types in the Solomon Islands.

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

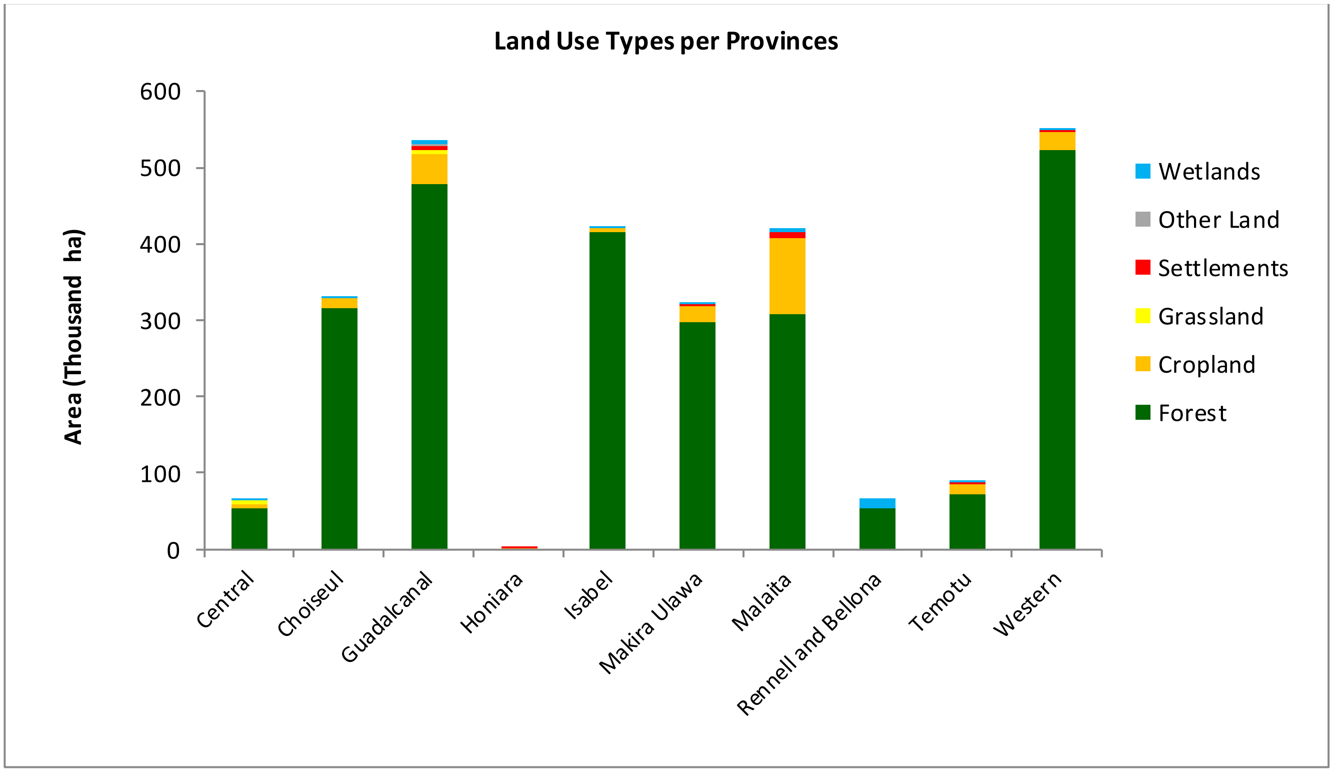


Figure 9: Current composition of land use types in different provinces (2017).

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.

5.2 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**Error! Reference source not found.** 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.

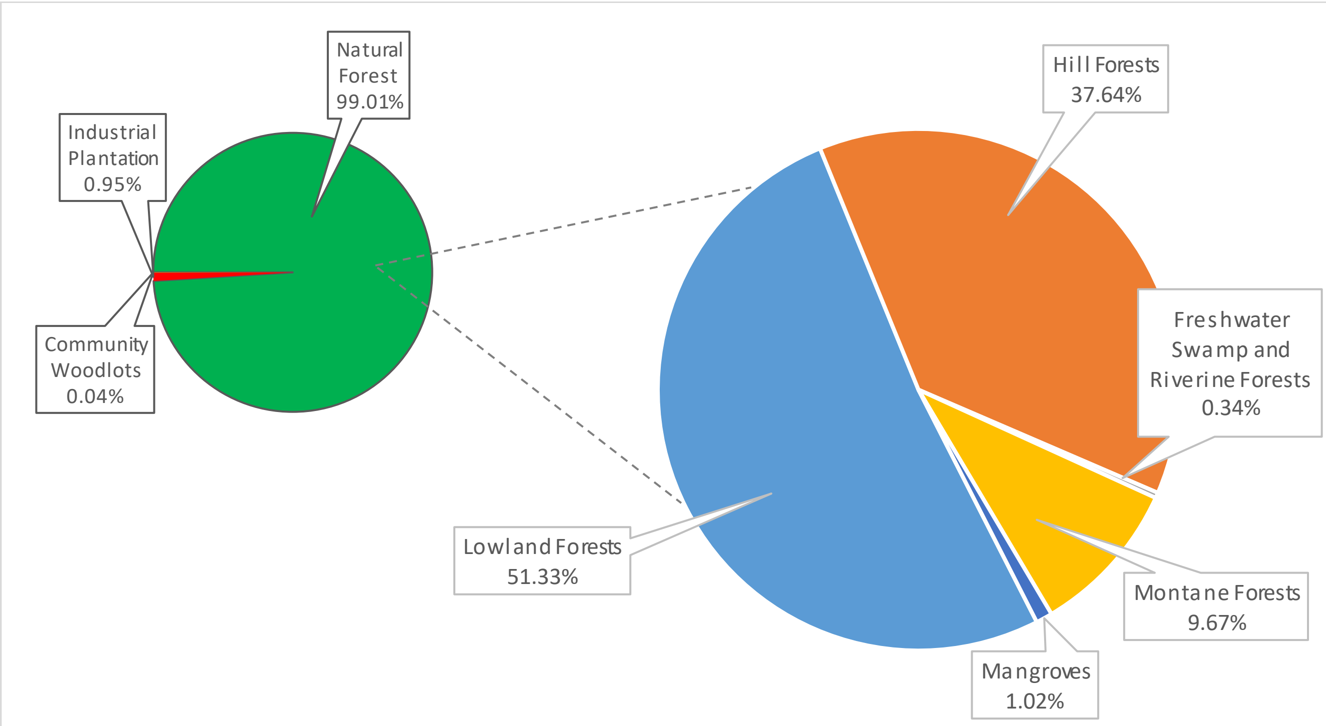


Figure 10: Current composition of forest and types in the Solomon Islands (2017).

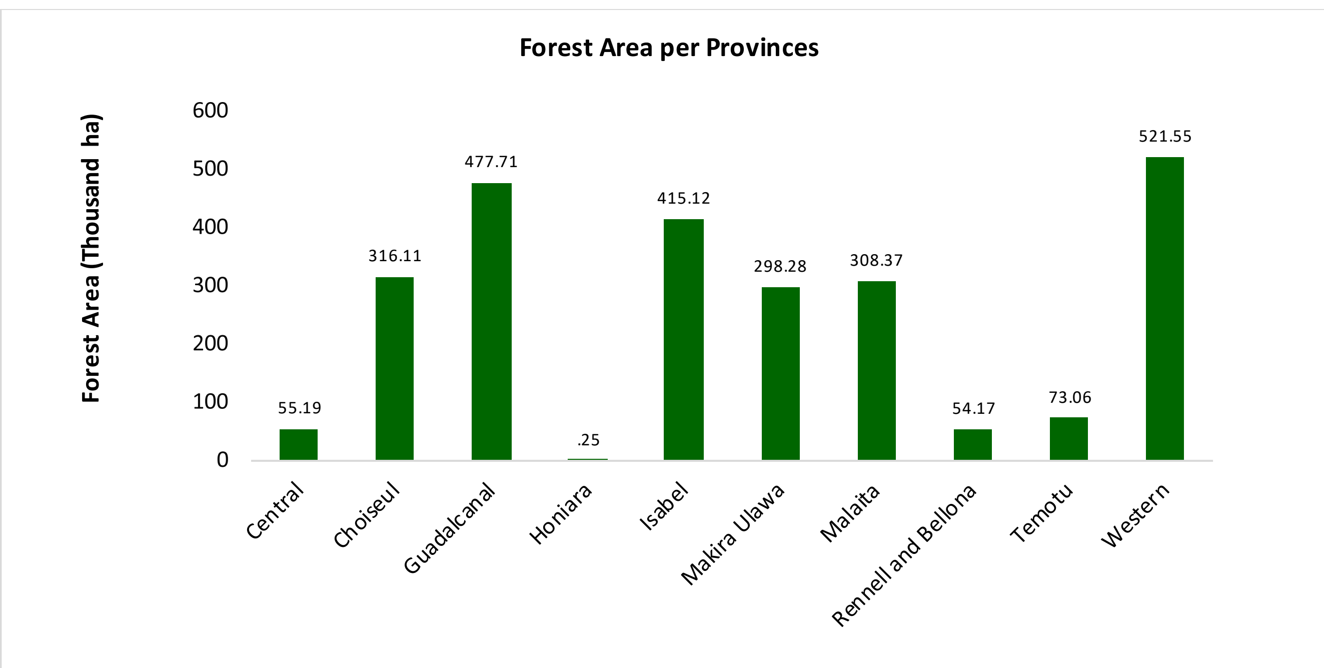


Figure 11: Current distribution of the forest area in different provinces (2017).

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

5.3 Composition and Distribution of Non-Forest Land

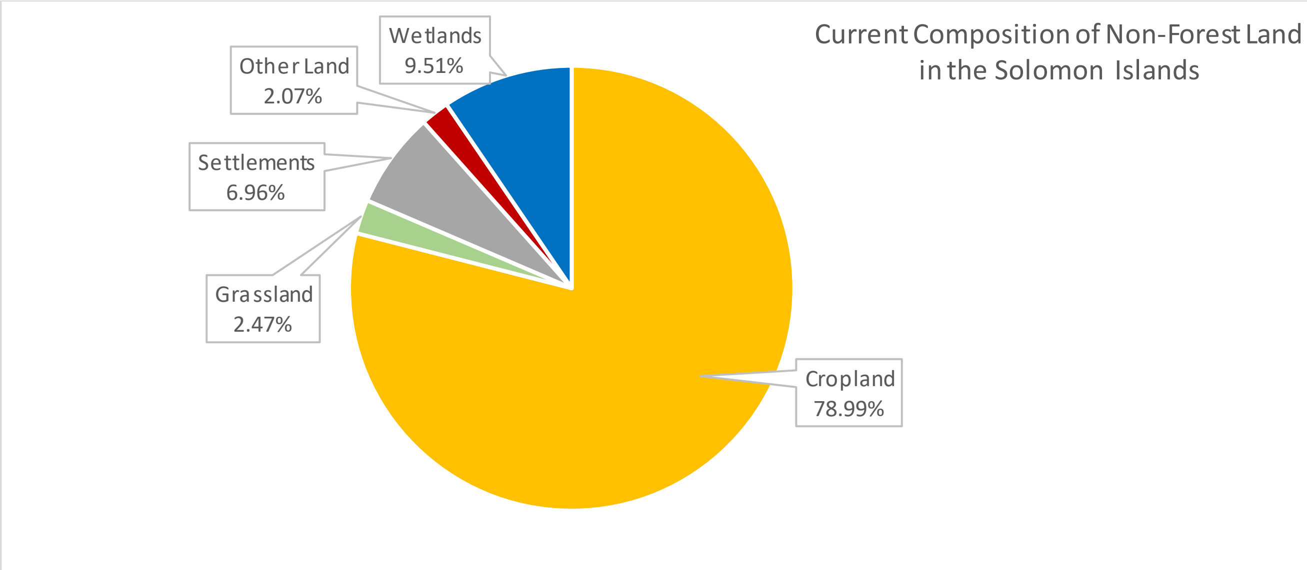


Figure 12: Current composition of non-forest land in the Solomon Islands (2017).

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
Total non-forest land	**281,760.24**

5.4 Forest Cover and Land Use Change 2001-2017

5.4.1 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 (initial 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%

There is a difference in forest areas reported for the year 2000 in the FRL submission and in the FAO Forest Resource Assessment (FRA) Report 2015. These are the result of different assessments methods and data sources: The FRA forest area is based on the Solomon Islands Forest Resources Inventory (SOLFRIS) 1993 as well as the 2003 and 2006 updates. FRA reporting for the year 2000 was derived by linear interpolation and extrapolation from the 2003 and 2006 datasets. The forest cover results presented in the FRL submission are based on the 2000-2017 historical annual forest cover change assessment using the Collect Earth tool. At present, the results from the Collect Earth assessment represent the most up to date and reliable forest cover estimates available in the Solomon Islands.

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.

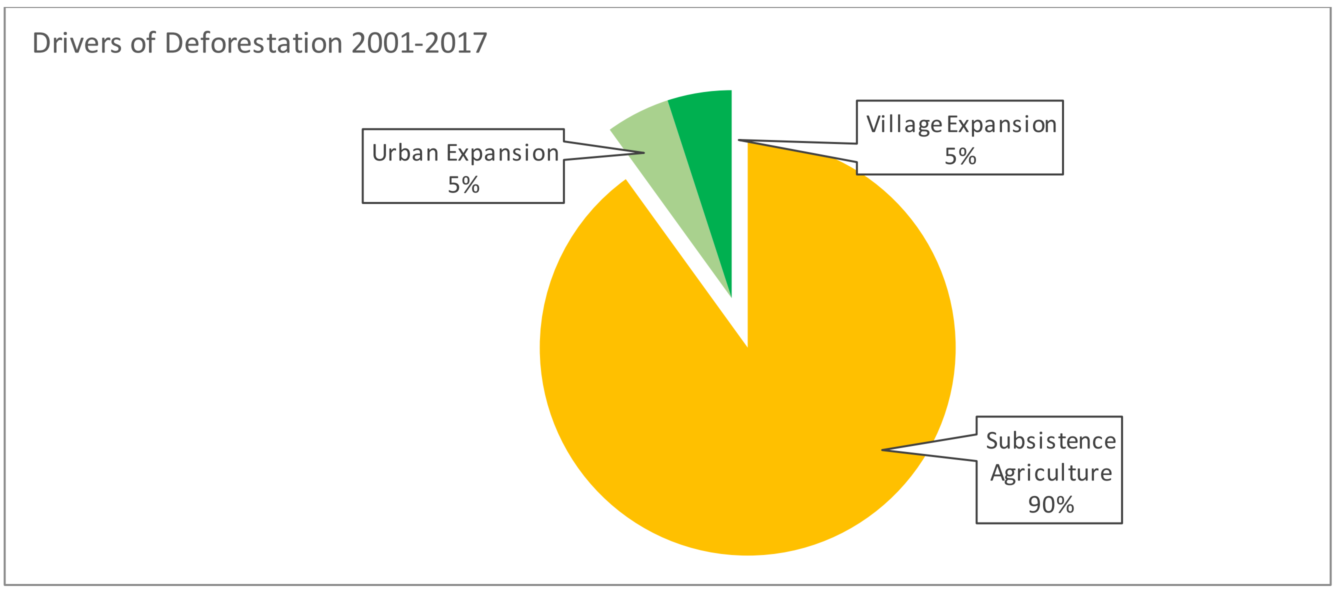


Figure 13: The main drivers of deforestation in the Solomon Islands.

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 >> Cropland	Hill Forest	1,964.13		

Forest >> Cropland	Montane Forests	491.03		
Forest >> Settlement	Lowland Forest		490.17	491.03
Total		8858.38	490.17	491.03

5.4.2 Deforestation per Forest Types

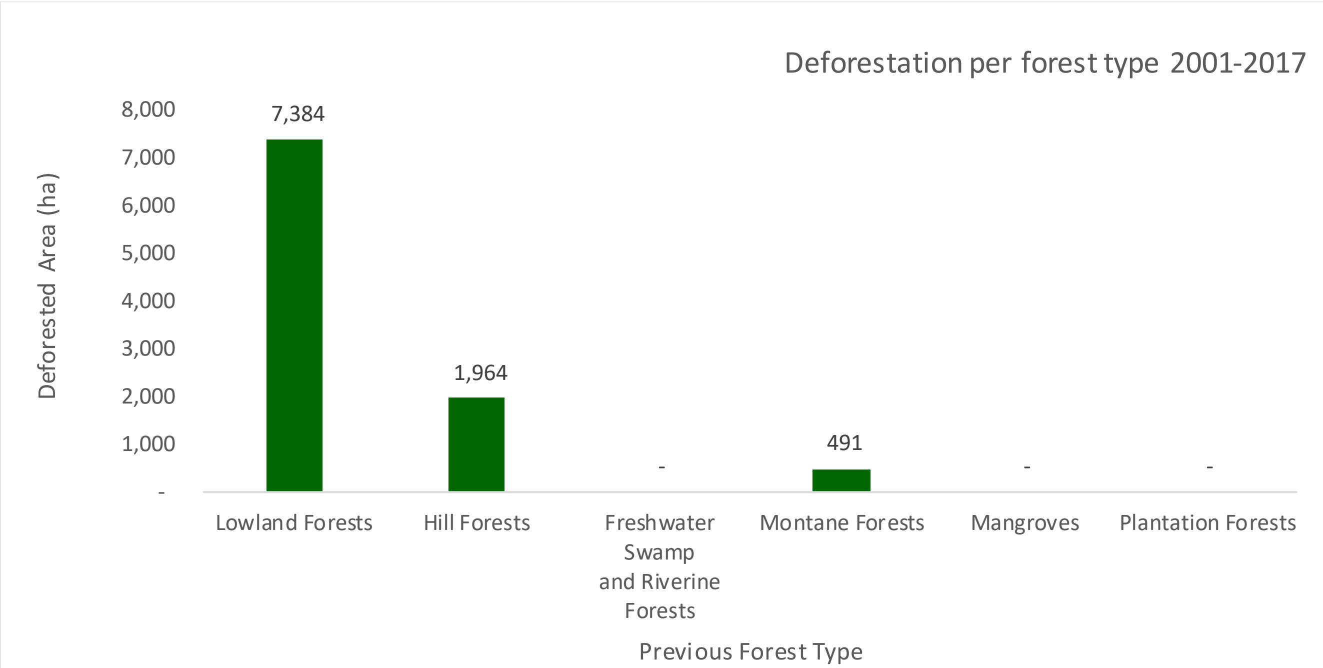


Figure 14: Deforested Area per forest type in the Solomon Islands.

5.4.3 Forest Disturbance

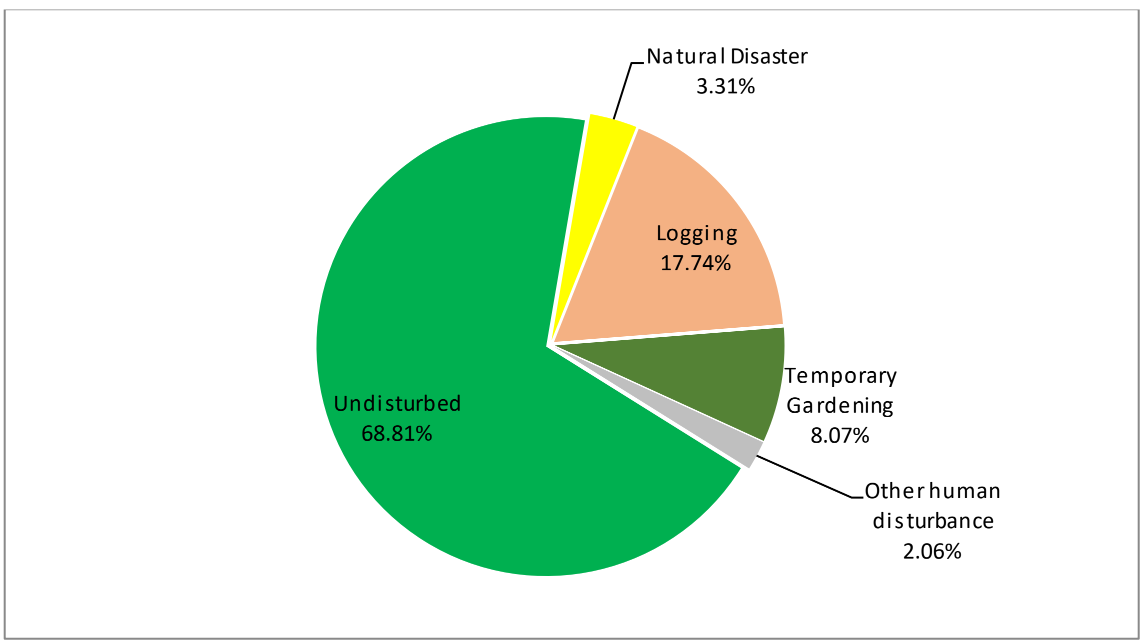


Figure 15: Main drivers of forest disturbance in the Solomon Islands.

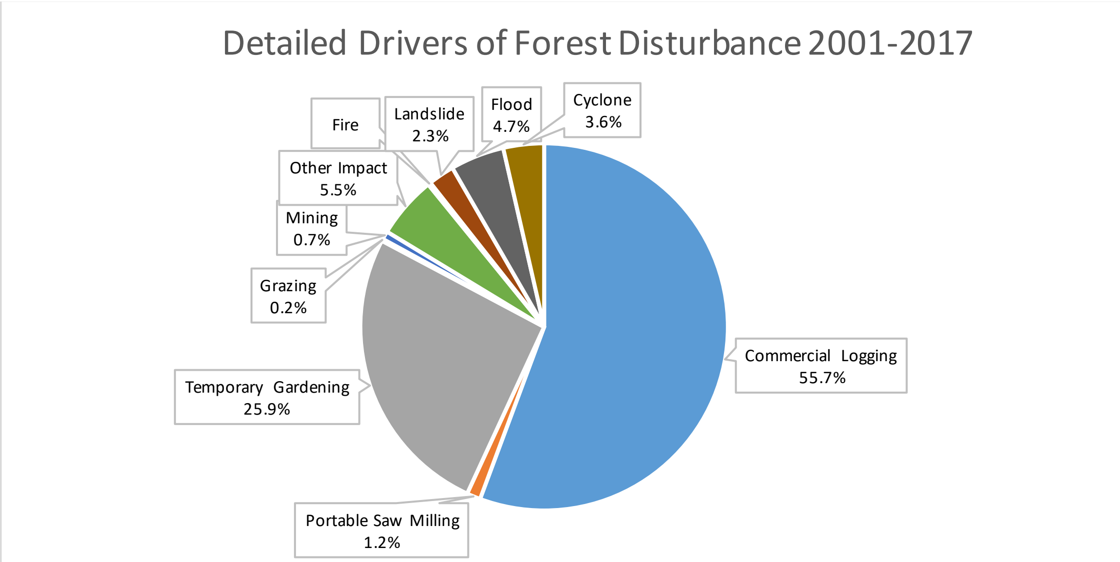


Figure 16: Detailed drivers of forest disturbance in the Solomon Islands.

Figure 15 shows that the largest portion of Solomon Islands forests remains undisturbed. Between 2001 and 2017, 447,500 ha of forest were degraded by commercial logging and 208,046 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.

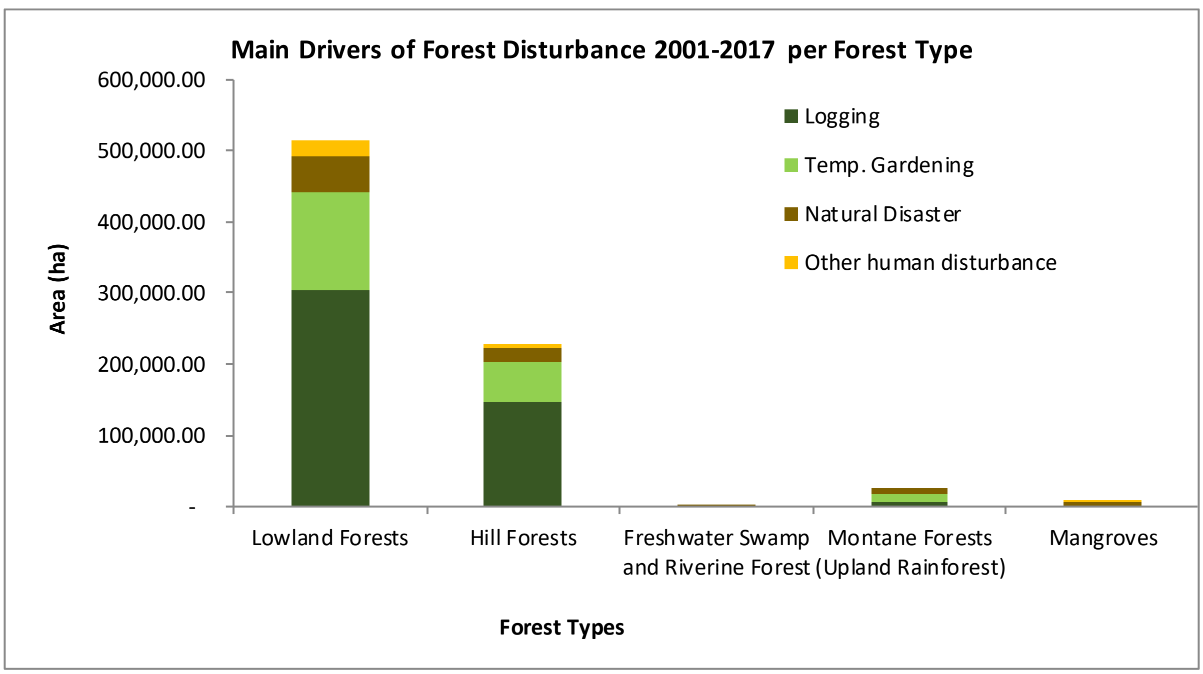


Figure 17: Main drivers of forest disturbance in the Solomon Islands.

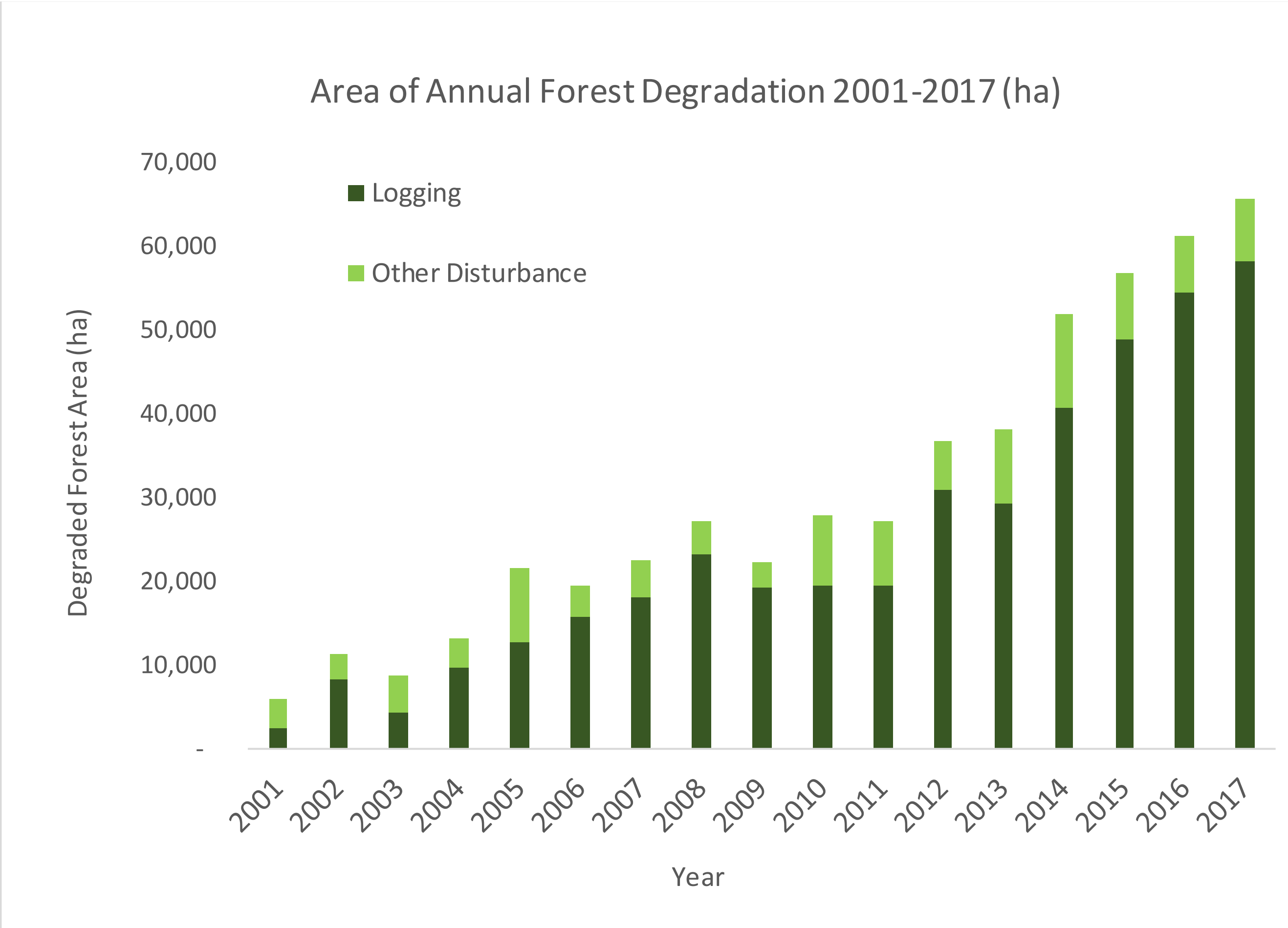


Figure 18: Annual area of forest degradation in the Solomon Islands 2001-2017.

The current forest area degraded by logging can be expected to have been underestimated in some areas where no high resolution imagery was available for the assessment year (minor logging disturbance is challenging to detect on the low resolution Landsat 7 and 8 imagery). This follows a conservative approach in estimating forest emissions. In the light of the current analysis results, it appears that previous national forest resource assessments (Solomon Islands Forest Resource Assessments 2003, 2006, 2011) may have significantly underestimated the remaining undisturbed commercial forest areas, and in consequence, the future potential of Solomon Islands timber resources.

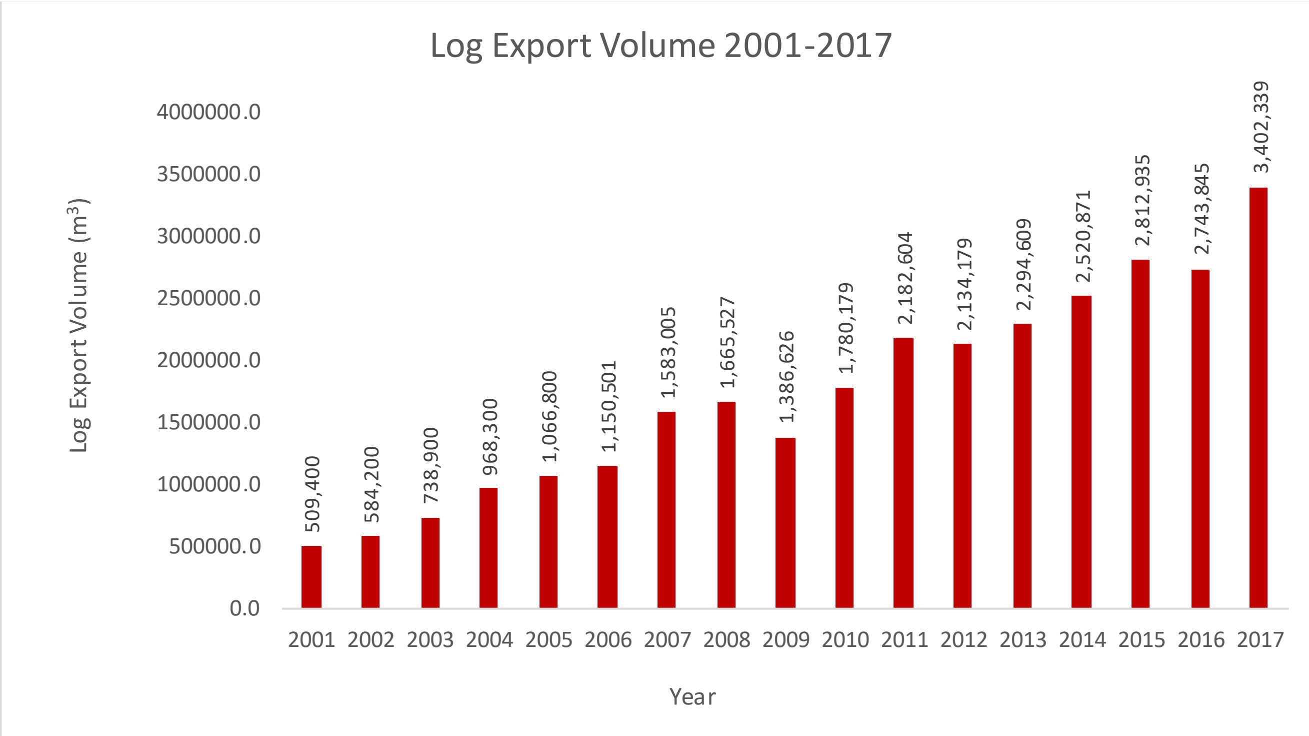


Figure 19: Annual round log export volumes in the Solomon Islands 2001-2017[8].

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. Outliers in some years (e.g. 2011, 2016) can likely be attributed to sampling errors as well as incorrect/incomplete log volume records.

5.5 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.

5.5.1 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 4.2: 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.

[8] 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).

5.5.2 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 ±1.96 times the standard error of A_i divided by A_i.

The standard error[9] of an area estimate is obtained as:

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

Where:
p_i 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_i is the number of points under a particular land-use category.

Equation 4: Standard Error of mean[10].

[9] The standard error is the standard deviation of the sampling distribution

[10] 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 ±1.98%, ±8.83%, ±43.13%, ±5.33%, and ±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.

5.5.3 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.

6 Forest Emissions and Removals

6.1 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_{2e}		
	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
Total	6,771,946	101,146,092	24,357,417

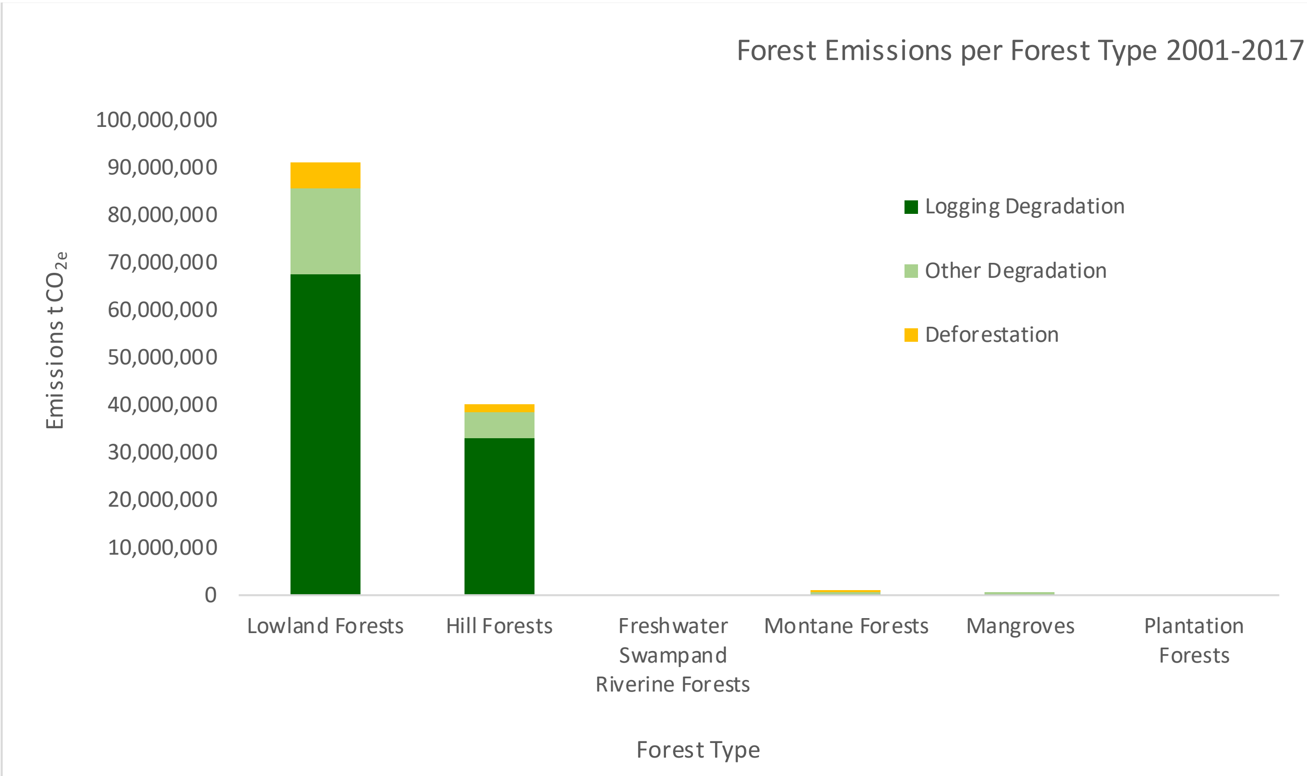


Figure 20: Emissions from different forest types in the Solomon Islands between 2001-2017.

6.2 Annual Forest Emissions 2001-2017

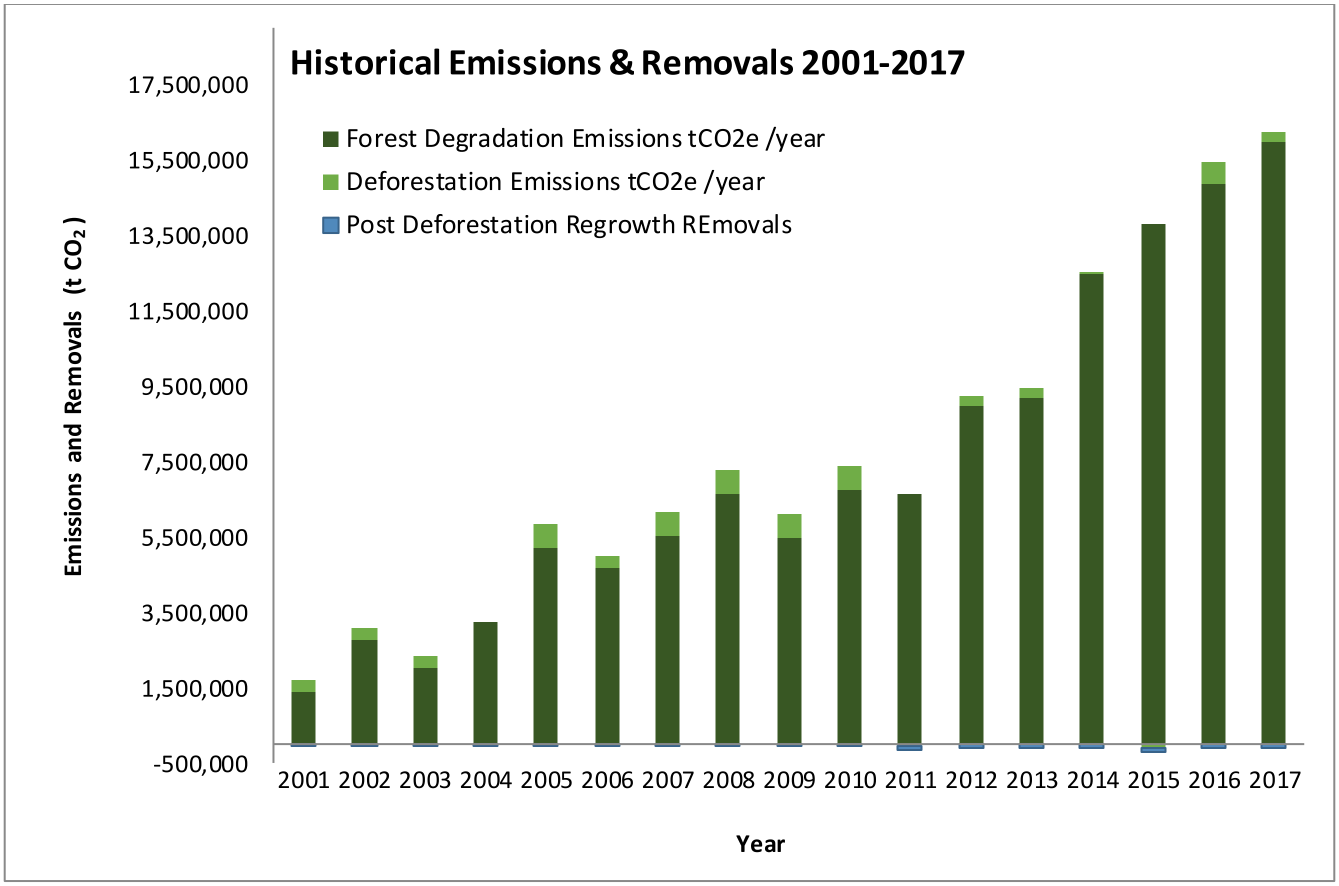


Figure 21: Historical annual forest emissions and removals in the Solomon Islands 2001-2017.

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

Year	Deforestation Emissions	Forest Degradation Emissions	Post-Deforestation Regrowth Removals	Total Emissions & Removals
		t CO_{2e}		
2001	347,793	1,364,555	-5435.3	1,706,913
2002	361,942	2,750,971	-11091.7	3,101,821
2003	347,793	2,015,674	-16527	2,346,941
2004	0	3,235,295	-16527	3,218,768
2005	696,418	5,191,826	-27410.6	5,860,833
2006	347,793	4,680,854	-32845.9	4,995,801
2007	694,979	5,495,402	-43707	6,146,674
2008	696,418	6,651,573	-54590.6	7,293,400
2009	695,587	5,460,763	-65461.1	6,090,889
2010	691,303	6,765,858	-76264.8	7,380,897
2011	0	6,652,156	-76264.8	6,575,891

Year	Deforestation Emissions	Forest Degradation Emissions	Post-Deforestation Regrowth Removals	Total Emissions & Removals
2012	348,625	8,967,249	-81713.1	9,234,161
2013	348,625	9,179,502	-87161.4	9,440,965
2014	150,457	12,474,871	-92596.7	12,532,731
2015	0	13,778,464	-92596.7	13,685,867
2016	695,587	14,855,862	-103467	15,447,982
2017	348,625	15,982,635	-108916	16,222,344
Total	6,771,946	125,503,509	-992,576	131,282,879

Error! Reference source not found.

Table 19 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_{2e} 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_{2e} 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.

7 Forest Reference Level

Solomon Islands is a HFLD country with historically low and recently steeply increasing forest emissions driven mainly by logging degradation. . During the analysis, the SI FRL assessment team compared the projections based on a linear regression and the average of historical emissions during the reference period. Historical average were compared in 3 scenarios: (a) Whole reference period 2000-2017, (b) 10-year reference period 2008-2017 and (c) 5-year reference period 2013-2017 (see Figure 22 below).

Additionally, SI FRL assessment team carried out a simulation to validate which trend line gave the best fit for the years 2013-2017 based on annual average emissions from the reference periods 2001-2012 and 2008-2012:

1. A historical average of 2001-2012 emissions underestimates the historical average of 2013-2017 emissions by 60%,
2. A historical average of 2008-2012 emissions underestimates the historical average of 2013-2017 emissions by 46%,
3. A linear projection average of 2001-2012 emissions underestimates the historical average of 2013-2017 emissions by 58%
4. A linear projection average of 2008-2012 emissions underestimates the historical average of 2013-2017 emissions by 36%
5. A linear projection average of 2013-2017 emissions underestimates the historical average of 2013-2017 emissions by 5%

The simulation shows that the a linear regression of 2001-2017 emissions best describes the trend of historically low and recent steeply increasing forest emissions in the Solomon Islands, as is underlined by a high correlation coefficient R^2=0.91. Therefore, the linear 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 historical emissions 2001-2017, used for the projection of the Forest Reference Level Results Period 2018-2021:

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

Equation 5: Linear Regression of Solomon Islands FRL.

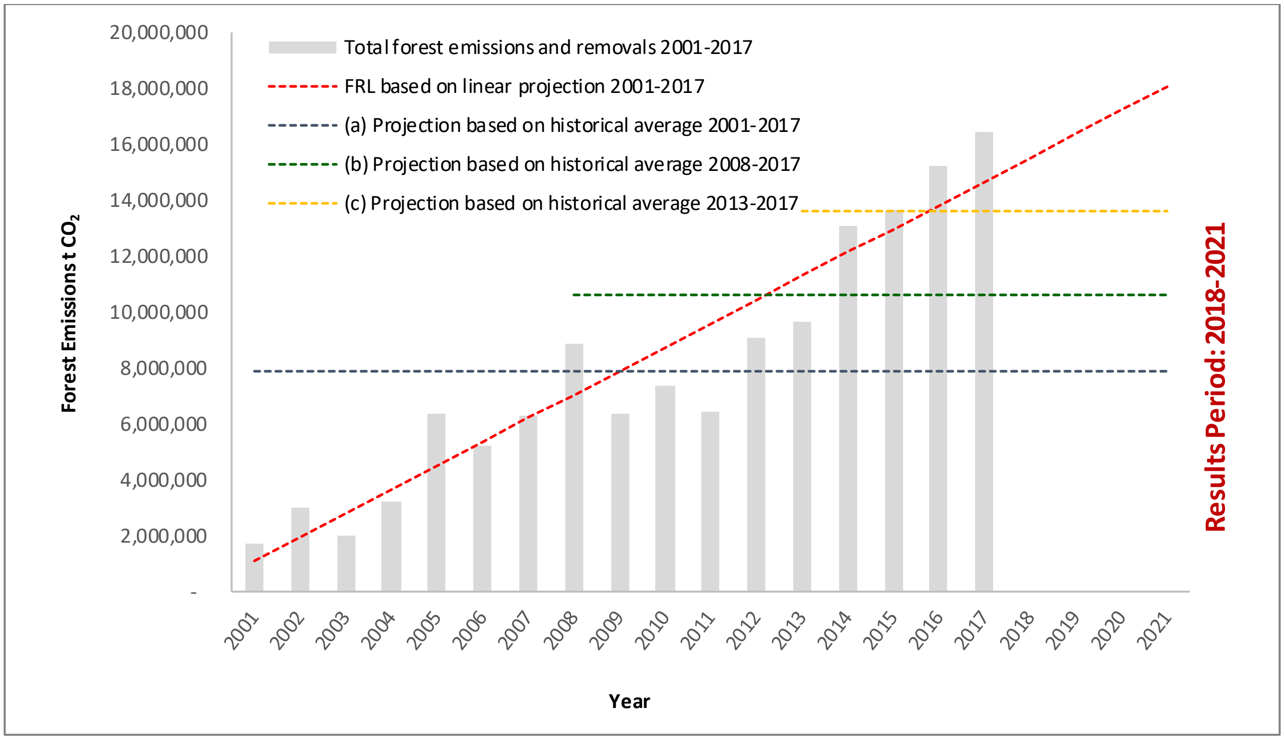


Figure 22: Solomon Islands National Forest Reference Level (FRL), based on linear projection of historical emissions, and compared to alternative scenarios of historical averages during three different reference periods.

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 according to linear projection of historical

Results Period (Year)	Estimated Emissions (t CO_2)
2018	15,335,717
2019	16,181,627
2020	17,027,538
2021	17,873,448

8 Expected Future Trends of Deforestation and Forest Degradation

8.1 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.

8.2 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^3/a, whereas from 2012 onwards the volumes shave consistently surpassed the 2 million, and more recently, the 3 million m^3/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)
		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: 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. 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. 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. Considering the information above, **the following logging trend can be expected for the results period:** 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 well 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. After the national elections in Aril 2019, a new government came into power, and it remains to be seen whether sustainability reforms in the forest sector will be prioritized. 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.
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 **Error! Reference source not found.**). Fires from slash and burn agriculture are expected to increase.

9 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 **Error! Reference source not found.**)

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.

10 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:

a) 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 on additional carbon pools. Solomon Islands is currently preparing for National Forest Inventory (NFI) to be implemented from 2020-2023, funded under the National Medium-term Development Plan. Funding of the NFI will furthermore become available through the extension of the SPC/GIZ REDD+ II project (until end of 2020), which has identified support to the NFI in Solomon Islands as one of its priority targets. Preliminary (subnational) results regarding these carbon pools could already become available earlier and be used to improve the accuracy of the subsequent FRL submission in 2022. Full NFI implementation will likely require additional external funding and technical support. Currently, a proposal to the Green Climate Fund (GCF) for REDD+ Readiness support is being prepared under the SPC/GIZ REDD+ II project.

b) 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. As a result, one common emission factor (EF= 244.6 t.d.m.ha^{-1}) is applied to all drivers of degradation (cp. Chapter 4.3.3), which is based on the biomass ratio between intact and degraded forest in PNGCountry-specific EFs for forest degradation will be established once data becomes available after the NFI is implemented.

c) 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.

d) 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.

e) 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.

f) 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.

g) A comparative analysis of log export volumes and estimated annual degraded forest area (as per Collect Earth assessment) shows a slower increase of log exports than the degraded area. It is assumed that this trend is caused by the loss of commercial timber potential due to repeated re-entry logging, as well as the increase of domestic timber consumption. It is currently not possible however to substantiate these assumptions with reliable data on log export volumes, domestic timber consumption and the extent of the annual net harvested forest areas. Solomon Islands is currently planning a real-time timber monitoring system and the assessment of the net annual harvested areas. When reliable data becomes available, it will become possible to realistically assess the correlation between these variables and establish harvested timber as a proxy to estimate the extent of forest degradation.

h) Inclusion of the Greenhouse gases NO_2 from fire and CH_4 from drainage of mangrove soils into the FRL: Fire is commonly used in the Solomon Islands for clearing forest vegetation for shifting cultivation (temporary gardening). Therefore, the NO_2 emissions from the burning of vegetation are likely significant. Likewise, NO_2/CH_4 emissions from the drainage of mangrove soils for agriculture may be significant. Solomon Islands currently does not possess sufficiently reliable data to support the inclusion of these GHG into the FRL calculations. This will be considered a future improvement, once such data becomes available.

i) Due to the systematic, 0.02 degree sampling grid used in the historical annual land use and forest cover change assessment, less extensive forest types like freshwater swamp forest (0.3% of forest area) and mangrove forest (1% of the forest area) may have been underrepresented and their emissions from deforestation/degradation underestimated. The combined use of forest cover/type wall-to-wall mapping and stratified sampling will be a consideration for future improvements to the accuracy of the FRL.

j) The current forest area degraded by logging can be expected to have been underestimated in some areas where no high resolution imagery was available for the assessment year. A complete coverage of the assessed area with high resolution images is considered a future improvement to increase the accuracy of the FRL.

11 Capacity Building Needs for future FRL

a) One of the urgent needs is to strengthen the capacity for implementation of a ground truthing survey for verification of current land-use composition in the FRL. The national level ground truthing survey SI is costly and time-demanding, but it is necessary to estimate the uncertainty of land use change assessment and emissions and removals.
b) One of the major needs of capacity building is to prepare and implement the National Forest Inventory (NFI) and to develop the country specific emission factors (based on carbon stocks of intact and degraded forest as well as forest growth data). The basic design was initially supported by UN-REDD/FAO and the NFI piloting is currently underway with support from SPC/GIZ but there is no confirmed work plan/budget to implement NFI yet.
c) Another capacity building need is the collection and analysis of forest cover change and related emission and removal data. This will will enable Solomon Islands to work on improving the accuracy of the future FRL.
d) There is also the need for capacity building in National Greenhouse Gas reporting to the UNFCCC, especially on the inclusion of ecosystem and forest sector results into the Biannual Update Report (BUR), and the updating and improvement of the FRL with country-specific data.
e) Moreover, additional technical officers are necessary to be responsible for national forest monitoring and to improve MoFR capacity to absorb the measures as described above.
f) The Capacity needs to be built for Solomon Islands FRL assessment team to carry out land use/forest cover wall-to-wall mapping and stratified sampling for the future improvement of the FRL accuracy. Initial capacity building using the FAO SEPAL tool for this methodology has taken place recently and needs to be intensified in the short term.

12 References

Central Bank of Solomon Islands (CBSI), 2017: Annual Report, 2017. website: http://www.cbsi.com.sb/cbsi-annual-report-2017/

FAO, 2007: Forest and Climate Change Working Paper 5. Definitional issues related to reducing emissions from deforestation in developing countries.

FAO, 2012: Forest Resources Assessment Working Paper 180: FRA 2015 Terms and Definitions.

FAO, 2012a: Global Ecological Zones for FAO forest reporting: 2010 update.

FAO, 2014: Global Forest Resources Assessment 2015 Country Report Solomon Islands.

FAO, 2015: Emerging Approaches to Forest Reference Emission Level and/or Forest Reference for REDD+.

FAO, 2015: Technical considerations for Forest Reference Emission Level and/or Forest Reference Level construction for REDD+ under the UNFCCC.

FAO, 2017: From reference levels to results reporting: REDD+ under the UNFCCC

FAO, 2018: From reference levels to results reporting: REDD+ under the UNFCCC 2018 update

Global Facility for Disaster Reduction and Recovery GDFRR (2011) Vulnerability, Risk Reduction and Adaptation to Climate Change, Solomon Islands.

Hansell, J.R.F. and Wall, J.R.D., 1976: Land Resources of the Solomon Islands Volumes 1-8. Land Resources Division, Ministry of Overseas Development, Surrey, England.

Hansen et al., 2013: Global Forest Change Dataset

IPPC, 2013: Supplement to 2006 IPPC Guidelines for National GHG Inventories: Wetlands.

IPCC, 2006: Guidelines for National Greenhouse Gas Inventories.

IPCC, 2003: Good Practice Guidance for Land Use, Land Use Change and Forestry.

IPCC, 2018: Emission Factor Database. https://www.ipcc-nggip.iges.or.jp/EFDB/main.php

Green Climate Fund, 2018: Terms of reference for the pilot programme for REDD+ results-based payments

Ministry of Forests, Environment and Conservation, 1995: Solomon Islands National Forest Resources Inventory The Forests of Solomon Islands Volume 1: National Overview and Methods.

PNG, 2017: Papua New Guinea's National REDD+ Reference Level. Modified Submission for UNFCCC Technical Assessment 2017.

Mozambique, 2018: Mozambique's Forest Reference Emission Level for Reducing Emissions from Deforestation in Natural Forests.

Mongolia, 2018: Mongolia's Forest Reference Level submission to the UNFCCC.

Solomon Islands Government, 2014: Global Forest Resources Assessment 2015 Country Report

Solomon Islands Government, 2015: Intended Nationally Determined Contribution.

Solomon Islands Government, 2018a: Logging Sustainability Report- Background Information

Solomon Islands Government, 2018b: National Forest Policy

Solomon Islands Government, 2008: National Adaptation Programmes for Action. Honiara, Solomon Islands.

Solomon Islands Government, 2012: National Climate Change Policy. Honiara, Solomon Islands.

Solomon Islands Government, 2014: Solomon Islands National REDD+ Readiness Roadmap (2014-2020) Honiara, Solomon Islands.

Solomon Islands Government, 2015: Intended National Determined Contribution, Sept 2015.

Solomon Islands Government, 2017: Solomon Islands Second National Communication Honiara Solomon Islands.

Solomon Islands National Forest Resource Assessment 2003. Solomon Islands Forestry Management Project (SIFMP) 2003.

Solomon Islands National Forest Resource Assessment Update 2006. Forestry Management Project (SIFMP) II 2006:

Solomon Islands National Forest Resource Assessment Update 2011. RAMSI Economic Governance Pillar.

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: *Calophyllum kajewskii, C. vitiense, Campnosperma brevipetiolata, Dillenia salomonensis, Elaeocarpus sphaericus*. The understory of the lowland rain forest contains a variety of short, thick-stemmed, low-statures trees such as *Barringtonia papeh, Leea indica* and *Tapeinosperma spp.*, as well as palms (*Areca catechu, Licuala lauterbachii* and *Strongylocaryum latius*), *Pandanus spp.* 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 *Casuarina papuana* 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 *Ardisia* and *Rhododendron*, *Metrosideros collina*, *M. salomonensis*, several species of *Ficus, Psychotria*, and *Schefflera*, and the gymnosperms *Dacrydium cf. xanthandrum* and *Podocarpus pilgeri*. 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 *Camnosperma brevipetiolata* or *Terminalia brassii*, or by a mix of species; *Inocarpus fagifer* and *Syzygium tierneyana* are generally restricted to these poorly drained sites, but other species, such as *Barringtonia racemosa*, *Calophyllum vexans*, *Campnosperma brevipetiolata*, *Intsia bijuga, Pterocarpus indicus* and *Teminalia brassii* 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 *Rhizophora apiculata*; the other is up to 25 m tall and composed of *Bruguiera parviflora*, *B. sexangula*, *Rhizophora apiculata* and *R. stylosa*, with local populations of *Dolichandrone spathacea*. Other mangrove species include *Ceriops tagal* and *Lumnitzera littorea*, the latter sometimes forming pure stands. The palm *Nypa fruticans* 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
Cropland	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 (*Ananas comosus*) is a tropical plant with an edible multiple fruit consisting of coalesced berries, and the most economically significant plant in the *Bromeliaceae* 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 Tetere 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.
Grassland	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.
Settlements	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.
Other Land	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 course 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)
Wetlands	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.
No Data	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

The table below shows sampling size (plot count) and area per IPCC land use categories. The results were derived from the historical annual land-use and forest cover change assessment 2000-2017 using the Collect Earth tool.
Current land use refers to the most recent year of the assessment (2017), initial land use refers to the baseline year (2000), before land use and forest cover changes were assessed. For all the other years between "current" and "initial", only the annual changes were assessed.

	Initial Land Use (2000)		Current Land Use (2017)	
IPCC Land Use Category	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
Total	5,777	2,801,562	5,777	2,801,562

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%
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 %
Cropland (Commercial)	87	42,701	0.015	42,190.7	0.001603	4,489.5	± 8,799.5	± 20.61%
Grassland (Grassland)	14	6,946	0.002	6,789.3	0.000647	1,812.5	± 3,552.5	± 51.14%
Wetlands	62	26,800	0.011	30,067.0	0.001356	3,798.3	± 7,444.7	± 27.78%
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%
All Classes	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 %
Stable Forest (Primary)	3,630	1,767,630	0.628	1,760,372.2	0.006358	17,813.7	± 34,914.8	± 1.98%
Stable Forest (Secondary)	452	219,788	0.078	219,197.9	0.003534	9,899.5	± 19,403.0	± 8.83%
Deforestation (Primary)	20	9,840	0.003	9,699.0	0.000773	2,165.2	± 4,243.8	± 43.13%
Forest Degradation	1,099	532,384	0.190	532,961.2	0.005164	14,468.2	± 28,357.6	± 5.33%
Stable Non-Forest	576	271,921	0.100	279,331.8	0.003942	11,044.3	± 21,646.9	± 7.96%
All Classes	5,777	2,801,562						

Annex 4: Sample Plot Count according to Land Use and Imagery

Previous Land Use Stratification	Current Land Use Stratification	Satellite Type/Name	Plot Count
Forest (Primary)	Forest (Primary)	Digital Globe	2,119.00
		Bing Maps	1,053.00
		Landsat(GEE)	154.00
		CNES/Astirum	307.00
	Forest (Degraded)	Digital Globe	464.00
		Bing Maps	251.00
		Landsat(GEE)	60.00
		CNES/Astirum	71.00
	Forest (Plantation)	Digital Globe	2.00
	Cropland	Digital Globe	1.00
		Bing Maps	10.00
		Landsat(GEE)	9.00
		CNES/Astirum	1.00
	Settlements	Digital Globe	2.00
Forest (Degraded)	Forest (Degraded)	Digital Globe	28.00
		Bing Maps	39.00
		Landsat(GEE)	3.00
		CNES/Astirum	3.00
Forest (Plantation)	Forest (Plantation)	Digital Globe	47.00
		Bing Maps	2.00

Satellite Observation Date - Year	Satellite Type/Name	Plot Count
2001	Landsat(GEE)	1.00
2002	Digital Globe	86.00
	Landsat(GEE)	3.00
2003	Digital Globe	142.00
	Bing Maps	5.00
	Landsat(GEE)	1.00
2004	Digital Globe	33.00
	Landsat(GEE)	1.00
2005	Digital Globe	56.00
	Bing Maps	3.00
2006	Digital Globe	40.00
	Bing Maps	1.00
2007	Digital Globe	49.00
	Bing Maps	1.00

Satellite Observation Date - Year	Satellite Type/Name	Plot Count
	Landsat(GEE)	1.00
2008	Digital Globe	75.00
	Bing Maps	3.00
2009	Digital Globe	78.00
	Landsat(GEE)	2.00
2010	Digital Globe	61.00
	Bing Maps	148.00
2011	Digital Globe	130.00
	Bing Maps	853.00
	Landsat(GEE)	15.00
2012	Digital Globe	228.00
	Bing Maps	498.00
	Landsat(GEE)	89.00
2013	Digital Globe	568.00
	Bing Maps	260.00
	Landsat(GEE)	39.00
	CNES/Astirum	17.00
2014	Digital Globe	302.00
	Bing Maps	5.00
	Landsat(GEE)	45.00
	CNES/Astirum	73.00
2015	Digital Globe	566.00
	Bing Maps	20.00
	Landsat(GEE)	18.00
	CNES/Astirum	9.00
2016	Digital Globe	445.00
	Bing Maps	11.00
	Landsat(GEE)	46.00
	CNES/Astirum	164.00
2017	Digital Globe	233.00
	Bing Maps	16.00
	Landsat(GEE)	45.00
	CNES/Astirum	248.00
2018	Digital Globe	17.00
	Bing Maps	2.00
	Landsat(GEE)	5.00
	CNES/Astirum	25.00

23