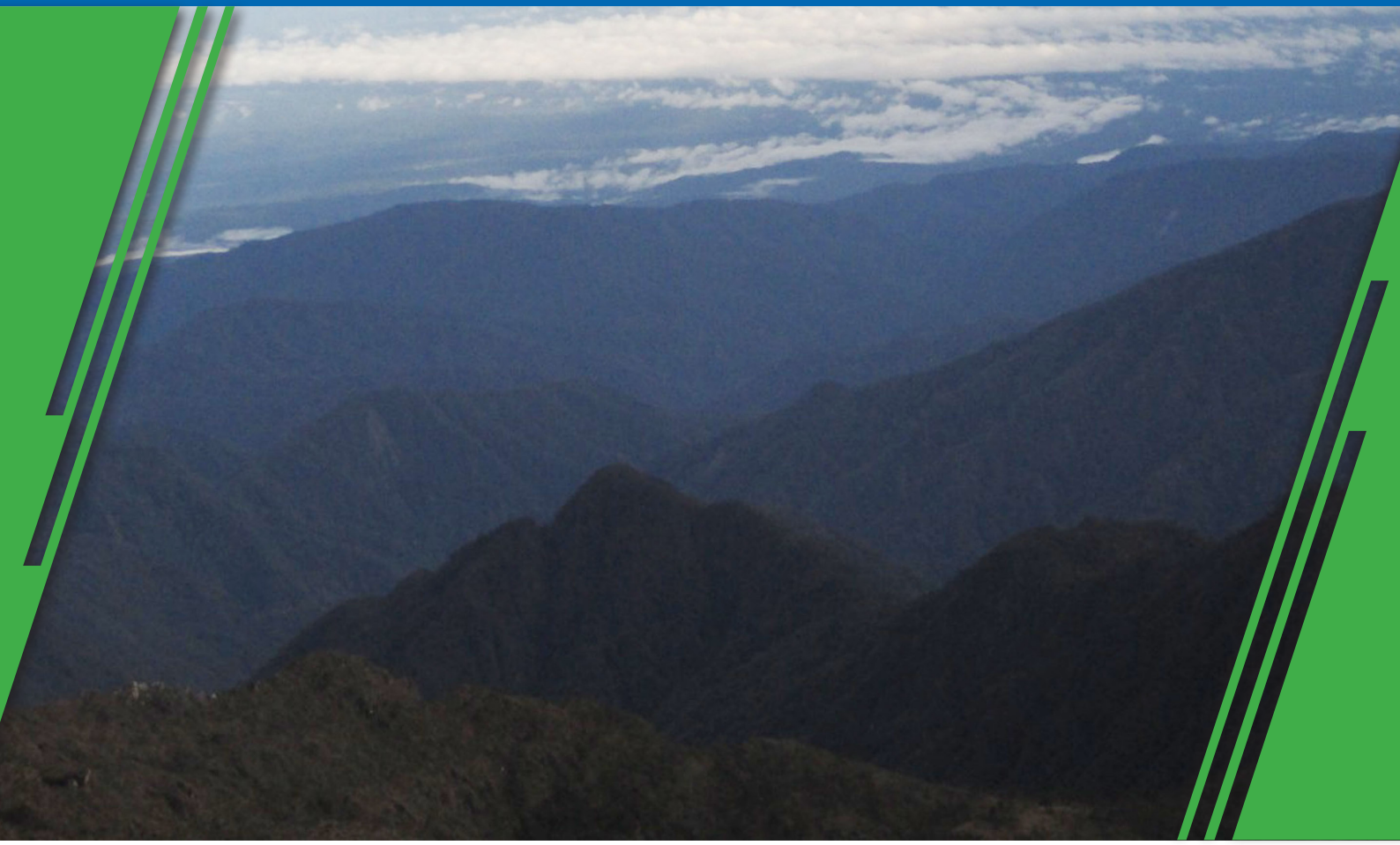
Government of Papua New Guinea

SECOND BIENNIAL UPDATE REPORT

TO

THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

2022



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Minister's Foreword

Honourable Wera Mori, MP

Minister for Environment & Conservation
and Climate Change

Nobody knew about this global disaster called climate change until in 1896, when the Swedish scientist Svante Arrhenius through his seminal paper first predicted that changes in atmospheric carbon dioxide levels could substantially alter the surface temperature through the greenhouse effect. After years of debate, it has been scientifically proven that extreme climatic events are direct causes of the increase in greenhouse gas (GHG) emissions driven by human activities with industrial processes, the burning of fossil fuels and the clearing of forests.

Combating climate change is one of the most significant challenges our generation is faced with. It is an unequivocal challenge and that any delay in reducing emissions significantly constrains opportunities to achieve lower stabilization levels and increases the risk of more severe climate change impacts. The Paris Agreement is a milestone where 196 countries adopted the first-ever universal, legally binding global climate deal. The agreement sets out a global action plan to put the world on track to avoid dangerous climate change events by limiting the global warming to the stabilization levels of well below 2°C. Furthermore, the Sustainable Development Goals adopted by 193 member nations of the UN also includes Climate Action, SDG13, where there is a need to take urgent action to combat climate change.

As a responsible member of the international community, Papua New Guinea (PNG) signed the United Nations Framework Convention on Climate Change (UNFCCC) in June 1992 in Rio de Janeiro, Brazil, and became a Party after its ratification in March 1993. On 21st September 2016, PNG ratified the Paris Agreement in New York during the 72nd Session of the United Nations General Assembly. Further, PNG has also taken an extra step to pass in Parliament the Paris Agreement Implementation Act. In addition, PNG has also agreed to the Sustainable Development Goals and has factored them into the National Goals.

PNG was the first country in the world to submit its National Determined Contribution (NDC) in 2016 before the 2020 review period where the country made its commitment to reduce its GHG emissions. PNG submitted its Enhanced NDC in 2020 which includes quantitative and action-based targets in the Energy and Agriculture, Forestry and Other Land Use (AFOLU) sectors that the country plans to achieve by 2030. In addition to this, the Enhanced NDC also outlines Adaptation targets. These targets are conditional to external support from the international community.

PNG has also developed an Enhanced NDC Implementation Plan (2021-2030) which outlines detailed activities and projects that will be implemented to achieve the targets in the Enhanced NDC. Furthermore, the country has also prepared the Electricity and AFOLU roadmaps which provides enabling environments to achieving the electricity and AFOLU targets.

With the above, I am pleased to present to you PNG's Second Biennial Update Report (BUR2) which provides an update of the First Biennial Update Report (BUR1) that was submitted in 2019 by describing our national circumstances, national greenhouse gas inventory, migration actions and their effects, as well as the support needed and received. The BUR2 also includes a REDD+ technical Annex which showcases the country's REDD+ results and a National Inventory Report.

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Honorable Wera Mori, MP
Minister for Environment, Conservation & Climate Change

Message from the Managing Director

Mr. William Lakain

Acting Managing Director
Climate Change and Development Authority

Climate Change is a major concern in Papua New Guinea (PNG). PNG like other developing countries is faced with the effects of climate change due to the increase in global temperatures. The country is the first in the world to have climate refugees, from the sinking Carteret atoll island in the Autonomous Region of Bougainville. It is the government's vision that immediate measures need to be taken to ensure that Papua New Guinea is sufficiently cushioned from this, and any other adverse impacts brought by climate change. Critical measures to prevent the erosion of climate security, including viable food production and personal health, need to be assured as well. Importantly, Papua New Guinea's natural resources and environment needs to be conserved and used for the benefit of all.

To achieve the government's vision, the Climate Change and Development Authority (CCDA), has taken a proactive role in carrying out climate change activities throughout the country. CCDA is the mandated agency in charge of coordinating climate change mitigation and adaptation efforts in PNG. In addition to this CCDA is also responsible for measuring and reporting PNG's mitigation and adaptation statues to the international community through the National Communications and Biennial Update Reports.

Greenhouse gas (GHG) inventory is one of the major activities that CCDA has focused on so that PNG's GHG emissions can be measured and reported. PNG's GHG emissions have increased over the years, driven mainly by socio economic activities. However, PNG's GHG emissions represent a very tiny fraction when compared to the global greenhouse gas emissions. Despite of this, PNG remained committed to reducing its GHG emissions to achieve its target of becoming a 'carbon neutral' country, as outline in the it's Sustainable Development Goal 13 Roadmap 30 by 30.

To achieve carbon neutrality, there is need for proactive actions, partnerships and ambitious ideas towards addressing climate change in order to be climate resilient and to work towards a sustainable economic development. PNG has been working hard to submit its GHG reports to the United Nations Framework Convention on Climate Change (UNFCCC). The country's First Biennial Update Report (BUR1) including a REDD+ Technical Annex was submitted in 2019. This is the submission of the Second Biennial Update Report (BUR2) which provides and update of the BUR1. The BUR2 submission also includes an updated REDD+ Technical Annex and National Inventory Report.

CCDA and stakeholders with technical support from the UN Food and Agriculture Organization and Japan International Cooperation Agency, and financial support from Green Climate Fund, Global Environment Facility-Capacity Building Initiative for Transparency and Global Green Growth Initiative, have worked hard to prepare all the components of the BUR2. It would not have been possible with the assistance from sister government agencies in the country and the important private sector companies from all GHG sectors that supported through providing most needed data and other relevant inputs throughout the preparation process.

We hereby submit to United Nations Framework Convention on Climate Change Papua New Guinea's Second Biennial Update Report.

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Mr. William Lakain
Acting Managing Director

Acknowledgement

The Government of Papua New Guinea through the Climate Change and Development Authority (CCDA) would like to thank the Food and Agriculture Organization of the United Nations for the financial and technical assistance provided through the Global Environmental Facility – Capacity Building Initiative for Transparency (GEF-CBIT) and Green Climate Fund Readiness Programme.

CCDA would also like to express our appreciation to the Japan International Cooperation Agency for providing technical assistance from 2017 to 2021.

CCDA would also like to acknowledge the Energy Sub-Technical Working Committee and AFOLU Sub-Technical Working Committee members for the technical inputs into the BUR2, NIR and REDD+ Technical Annex.

CCDA would like to express its gratitude to data providers. Following are the main data providers:

- Department of Agriculture and Livestock (DAL);
- PNG Forest Authority (PNGFA);
- National Energy Authority (NEA);
- PNG Power Limited (PPL);
- National Statistical Office (NSO);
- Water PNG (WPNG);
- National Capital District Commission (NCDC);
- Asia Pacific Energy Research Centre (APERC); and
- Private Companies

CCDA also acknowledges the following officers for their tireless effort in delivering this document.

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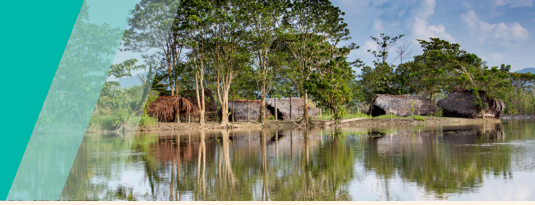

The Papua New Guinea Government submits PNG's Second Biennial Update Report (BUR2) under the United Nations Framework Convention on Climate Change (UNFCCC). The report follows the BUR guidelines for developing countries according to paragraphs 39 to 42 of decision 2/CP.17 and its Annex III.

This BUR2 provides an update of the BUR1 submitted in 2019 and presents an overview of PNG's national circumstances relevant to climate change, summary results of the inventory of anthropogenic emissions by sources and removals by sinks for years 2000 through to 2017. It also presents information related to identified mitigation actions including description of domestic MRV arrangements as well as support needed and received.

The BUR2 also includes the REDD+ Technical Annex referred to in decision 14/CP.19, paragraph 7, containing the results achieved from REDD+ activities by PNG. In addition to this, the BUR2 submission includes a stand-alone National Inventory Report.

1. National Circumstances

Papua New Guinea (PNG) is an independent state located in the equatorial region of Maritime Southeast Asia. It occupies the eastern part of the world's second largest island, and is the third largest island country. PNG shares a mainland border with Indonesia and maritime borders with Australia, the Federated States of Micronesia, the Solomon Islands, and New Caledonia. PNG's total land area is 461,000 km^2 and its Exclusive Economic Zone is 3,120,000 km^2.

PNG has a hot, humid tropical climate which is experienced all year round. Ocean temperature has a strong influence on average monthly temperatures. Changes in the temperature from season to season are small, but are more noticeable around Port Moresby when compared to other areas in PNG. Port Moresby and other towns on the coast are quite hot in the summer months whereas temperatures are considerably cooler in the highland regions. PNG has a wet season from November to April and dry season from May to October. However, these seasons are only discernible in Port Moresby where most of the yearly annual rainfall is in the wet season. Other areas tend to experience rainfall all year round.

PNG is one of the least densely populated countries in the world with a population density of 19.4 persons per square kilometer. The 2011 Census of Population and Housing estimated a total residential population of 7.28 million. The population was forecast to be 8.98 million in 2020 with 24% of this population estimated to live in PNG's urban centres. Most people living in PNG are Melanesian, but some are Micronesian or Polynesian. There are also over 800 known languages with English, Tok Pisin (Pidgin) and Hiri Motu the official languages of PNG.

PNG is the largest economy among the Pacific Islands which is dominated by resources, agriculture, forestry and fishing. The economy is small, open and export-orientated and is very dependent on commodity products, and economic growth is largely tied to foreign investment in the resources sector. The formal sector consists of extractive mining and petroleum industries, cash-crop agriculture production and a small import-substituting manufacturing sector. The informal sector is predominantly subsistence agriculture on which much of the PNG population derives their livelihood. While most of PNG's labour force is employed in the agriculture sector the vast majority of its export earnings is through the resources sector.

The resources sector is an influential factor in PNGs GDP and National accounts. In recent years PNG has experienced a steady GDP growth which reflects the performance of the resources sector. Lower LNG and oil prices, weakened demand and the COVID-19 global pandemic have collectively resulted in an estimated slowing of GDP growth in 2020. The economic forecast in the medium-term is positive with numerous new resource projects in the pipeline, such as the Papua LNG project, the Wafi-Golpu gold and copper mine, the P'nyang gas field and the Pasca A gas condensate field.

The rural region is generally a traditional village-based society which is dependent on subsistence and small cash-crop agriculture. Income is largely derived from growing and selling of coffee, cocoa, sugar, oil palm, rubber and fresh vegetables, and from harvesting of local crops. Sweet potato, banana, sago, taro, yams, cassava and sugar cane are the crops harvested while local livestock production include pigs, chickens, ducks, and occasionally fish.

Forestry is an important element of PNG's economy providing employment as well catering for a growing population in providing timber products and conversion to small cash crops. According to the PNG's Forest Reference Level 2001-2013 (FRL) the country has a total area of about 461,000 km^2, of which 77.9% (360,000 km^2) is forest. There are 14 types of forest in PNG comprising 13 vegetation types and a forest plantation. More than three-quarters of this forest is categorized as primary or as not being disturbed by human activities, whereas 11% is classified as disturbed by large scale logging, and 0.2% is disturbed by small scale logging using portable sawmill. Small scale temporary gardening cause 8% of forest disturbance.

According to the Asia-Pacific Economic Cooperation (APEC) energy balance table for PNG, the total primary energy supply in 2019 is estimated to be 4,795 kiloton of oil equivalent (ktoe) of which oil and petroleum products account for 47%, solid biomass 35%, natural gas 9% and 10% is from renewable energy sources (hydro and geothermal). A total of 1,320 ktoe of crude oil, comprising of both imports and domestic production was refined in 2019 producing about 1,117 ktoe of petroleum products. The final energy consumption was 3,367 ktoe of which 49% was solid biomass, 41% was petroleum product and 11 % electricity. The other subsector (residential and commercial) was the largest energy consuming subsector with 1,831 ktoe. This was followed by the manufacturing industries and construction subsector with 919 ktoe and the transport subsector with 616 ktoe.

The PNG government has taken the approach in revisiting all policies and plans against assumptions of sustainable growth and to manage the resources being exploited to sustain the economy hence, all polices have been developed for sustainable socio-economic growth of PNG and for climate change in particular, for both short term and long-term development. This includes the Vision 2050, Development Strategic Plan 2010-2030, National Strategy for Responsible Sustainable Development for Papua New Guinea, National Climate Compatible Development Management Policy, Climate Change (Management) Act and United Nations Paris Agreement (Implementation) Act. More recent policies that were developed includes: PNG's Sustainable Development Goal 13 Roadmap 30 action by 2030; PNG's Enhanced NDC; and Climate change (Management) (Nationally Determined Contribution) Regulation.

PNG has institutionalized the preparation and submission of the National Communications and Biennial Update Reports to the UNFCCC. The mandated entity to prepare and communicate the BURs and NCs as per the Climate Change (Management) Act is the Climate Change and Development Authority (CCDA). The responsible division within the CCDA structure is the MRV and National Communications division. Under this arrangement CCDA was able to prepare and submit PNG's BUR1 including REDD+ Technical Annex in 2019. For the current BUR2, CCDA has enhanced its institutional arrangement by establishing an Energy Sub Technical Working Committee (ESTWC) and Agriculture Forestry & Other Land Use Sub Technical Working Committee (AFOLU STWC). The STWCs consisting of key government agencies, private sector agencies and Non-Government Organisations from the energy and AFOLU sectors in PNG. The STWCs are responsible for providing technical inputs for the preparation of the BUR2.

2. GHG Inventory

PNG went from a net sink of (-12,436 kt CO_2 eq) to a net source in 2016 (6,897 kt CO_2 eq). Then in 2017 PNG became a net sink with a total GHG emissions of -1,958 kt CO_2 eq. The main driver for the increasing and decreasing trend is the LULUCF sector mainly from deforestation and degradation activities in the country.

Emissions from the energy sector amounted to 8,673 kt CO_2 eq in 2017, an increase of 1,913 kt CO_2 eq (28%) when compared to 2000. The CO_2 from liquid fuel combustion contributed 68% to the total GHG emissions in 2017, followed by CH_4 from fugitives (16 %), CO_2 from gaseous fuel combustion (12%), N_2O from fuel combustion (2%), CH_4 from fuel combustion (1%) and CO_2 from fugitive emissions (1%). 81% of total sector emissions are CO_2, while CH_4 contributed 17 % and N_2O 2%.

Total GHG emissions in the Industrial Process and Product Use sector for the latest inventory (2017) are estimated to be 153.3 kt CO_2 eq which is about 1% of the national total GHG emissions (excluding LULUCF). The relative contribution of individual GHGs is CO_2 (1%), HFC (98%) and N_2O (1%).

GHG emissions from the agriculture sector amounted to 935 kt CO_2 eq in 2017 which is about 9% cent of the country's overall emission in that year (excluding LULUCF). Total GHG emissions increased by 203 kt CO_2 eq (28%) in 2017 when compared with year 2000. The highest emitting category in 2017 was direct N_2O emissions from managed soils (3.C.4) which contributed 57% of the total sector emissions. After this is the enteric fermentation (3.A.1) category which contributed 18%, followed by manure management (3.A.2) with 17% and indirect N_2O emissions from managed soils (3.C.5) with about 7%. The least emitting category in the agriculture sector is indirect N_2O emissions from manure management (3.C.6).

The LULUCF sector in the country is the biggest sector among all sectors. Historically, this sector acted as a sink. However, over time, the sector has evolved into a smaller sink due to a decrease in forest lands because of increased logging and agriculture activities. In the years 2011, 2013, 2014 and 2015 the LULUCF sector was a net source. Then in 2016 and 2017 the LULUCF sector became a net sink due to the increase in forest lands because of a decrease in logging and agriculture activities. The net emissions from the LULUCF sector amounted to -12,724.94 kt CO_2 eq in 2017 compared to -20,488.12 kt CO_2 eq in 2000 which is a total decrease of removals amounting to −7, 763.18 kt CO_2 eq. This come back is after it reached 5,617.42 kt CO_2 eq in 2015.

In 2017, emissions from the Waste sector resulted in 1,006 kt CO_2 eq and accounted for 9% of PNG's total greenhouse gas emissions (excluding LULUCF). The emissions of the waste sector have increased in the whole time series (2000-2017). The increase is influenced by population growth, development, consumption rate, and rural-to-urban drift. Breakdown of 2017 emissions of the Waste sector by category shows that wastewater treatment and discharge contributed 67% to total sector emissions in 2017, followed by solid waste disposal (27%), incineration and Open Burning (6%) and biological treatment of solid waste (1%). The contribution of CO_2, CH_4 and N_2O for the total sector emissions are 3.5%, 79.1% and 17.4 % respectively.

3. Mitigation Actions

PNG recently submitted its Enhanced NDC in 2020 which outlines the country's mitigation commitment from the Energy and AFOLU sectors. Under the Energy sector, PNG is committing to a headline target of carbon neutrality within the energy industries sub sector. This would be achieved through;

(i) Enhance levels of renewables in the energy mix from 30% in 2015 to 78% by 2030 for on-grid connection (non-GHG quantitative target);

(ii) Reducing electricity demand through energy efficiency;

(iii) Fossil fuel off-setting from energy industries sub-sector through nature-based solutions; and

(iv) Enhanced data collection

Other potential mitigation measures under the energy sector are from the transport sub sector which involves the reduction of fuel consumption.

Under the AFOLU sector, the overarching target is that PNG will shift the upward trend of the GHG emission in the AFOLU sector due to increase of deforestation and forest degradation to a downward trend in the next 10 years (by 2030). This will be achieved through;

(i) By 2030, annual net emission from deforestation and forest degradation due to agriculture expansion and commercial logging is reduced by 10,000 Gg CO_2 eq compared to 2015 level. (GHG-Absolute target); and

(ii) The LULUCF will be converted from net GHG source (1,716 Gg CO_2 eq) in 2015 to net GHG sink (-8,284 Gg CO_2 eq) by 2030 to mitigate emissions from other sectors. (GHG-Relative target); and

(iii) The area of annual deforestation is reduced by 25%of 2015 level by 2030 (equating to a reduction of 8,300 ha of annual deforestation) (Non-GHG quantitative target); and

(iv) The area of forest degradation is reduced by 25% of 2015 levels by 2030 (equating to a reduction of 43,300 ha of annual degradation) (Non-GHG quantitative target); and

(v) The area of planted forest and forest restoration is increased (Non-GHG quantitative target); and

(vi) Non-GHG Action based targets which includes: Enhanced land use planning; promoting climate-friendly agriculture; enhancement of timber legality; promoting REDD+; promoting downstream processing; and promoting the Painim Graun Planim Diwai initiative and planting 10 million trees initiative.

To achieve these targets, PNG has developed an Enhanced NDC Implementation Plan (2021-2030) and two NDC Implementation Roadmaps for the Electricity and AFOLU sector which provides a list of actions or projects that will be implemented between 2021 and 2030. There are 15 actions to be implemented under the AFOLU sector while there are 41 actions or projects to be implemented under the Energy sector.

There are also 9 planned or existing mitigation projects outside of the scope of the enhanced NDC mostly from the private sectors. Some of these projects are registered under the international markets such as the Clean Development Mechanism or Gold Standards.

The current domestic MRV arrangement was formulated during the preparation of the Enhanced NDC in 2020. The domestic MRV arrangement is part of the governance structure that governs and monitors the progress of the activities and projects that will be implemented to achieve the mitigation and adaptation targets in the Enhanced NDC. The MRV arrangement consist of CCDA as the coordinating agency, two sub technical working committees (Energy and AFOLU) and Technical Advisory Committee.

4. Support needed and received

As a Small Islands Developing State, PNG will require external support to implement climate change activities in the country. Such support includes, financial needs, technology needs, technical and capacity building needs. These are outlined in the Enhanced NDC Implementation Plan (2021-2030), NDC Implementation Road Map for the Electricity Sector and NDC Implementation Road Map for the AFOLU Sector. It is estimated that an excess of USD 1 Billion is needed over the 10 years period to achieve the Enhanced NDC targets.

PNG has also received external support to implement climate change activities in the country. The country has benefited from a total of 25 projects since 2017. This support has been received through bilateral or multilateral agreements most of which are grants. The type of support received is either technology transfer, technical assistance or capacity building.

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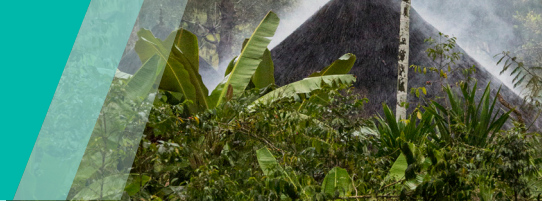


ANG	Air Niugini
APERC	Asia Pacific Energy Research Centre
BUR	Biennial Update Report
CCDA	Climate Change Development Authority
CEPA	Conservation and Environment Protection Agency
CSO	Civil Society Organizations
DAL	Department of Agriculture and Livestock
DMPGM	Department of Mineral Policy and Geohazards Management
DNPM	Department of National Planning and Monitoring
DoH	Department of Health
DPLGA	Department of Provincial and Local Government Affairs
DSP	Development Strategic Plan
FAO	United Nations Food and Agriculture Organisation
FPDA	Fresh Produce Development Agency
FREL	Forest Reference Emission Level
FRL	Forest Reference Level
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Giga gram
GHG	Greenhouse Gas
GHGi	Greenhouse Gas inventory
ha	Hectare
ICAO	International Civil Aviation Organization
IPP	Independent Power Producers
IPPU	Industrial Processes and Other Product Use
JICA	Japan International Cooperation Agency
K	Kina, monetary unit of Papua New Guinea
KCA	Key Category Analysis
km	Kilometer
ktoe	Kilo-tonne of oil equivalent
LNG	Liquefied Natural Gas
LULUCF	Land use, Land-Use Change and Forestry
MP-NFI	Multi-Purpose National Forest Inventory
MRA	Mineral Resources Authority
MRV	Monitoring, Reporting and Verification
MW	Megawatt
NC	National Communication
NCCDMP	National Climate Compatible Development Management Policy
NCDC	National Capital District Commission
NDA	National Designated Authority
NDC	National Disaster Centre
NEC	National Executive Council
NFA	National Fisheries Authority
NFI	National Forest Inventory
NSO	National Statistical Office
PACAM	Pacific American Climate Fund
PGRD	Partners for Global Research & Development
PNG	Papua New Guinea
PNGFA	Papua New Guinea Forest Authority
QA/QC	Quality Assurance and Quality Control
REDD+	Reducing Emissions from Deforestation and forest Degradation and the role of Conservation, Sustainable management of forest and enhancement of carbon stocks
STaRS	National Strategy for Responsible Sustainable Development
SWDS	Solid Waste Disposal Site
UNEP	United Nations Environment Programme
UPNG	University of Papua New Guinea

1. National Circumstances

1.1. Geographical Overview

Papua New Guinea is an independent state located in the equatorial region of Maritime Southeast Asia. It occupies the eastern part of the world's second largest island, and is the third largest island country. PNG shares a mainland border with Indonesia and maritime borders with Australia, the Federated States of Micronesia, the Solomon Islands, and New Caledonia. Its major islands include New Ireland, New Britain, Manus, Latangai and Bougainville, and its major towns are Port Moresby (capital), Lae, Mount Hagen and Madang.

PNG's total land area is 461,000 km^2 and its Exclusive Economic Zone is 3,120,000 km^2. It has a coastline of 21,000 km, more than 5,000 lakes, extensive river systems and wetlands. The species-rich mainland coastline includes more than 8,000 km of mangrove swamps, lagoons, wetlands, coral reefs and atolls, as well as island archipelagos and many offshore islands. PNG's geography is diverse that enables diversity in species, landscapes and ecosystems. The New Guinea Highlands extends the length of the main island of New Guinea and is predominantly tropical highland rainforest and alpine grassland. Dense rainforests, savannahs and grassland are in the lowland and coastal regions, as well as large wetland systems associated with the Sepik and Fly rivers.

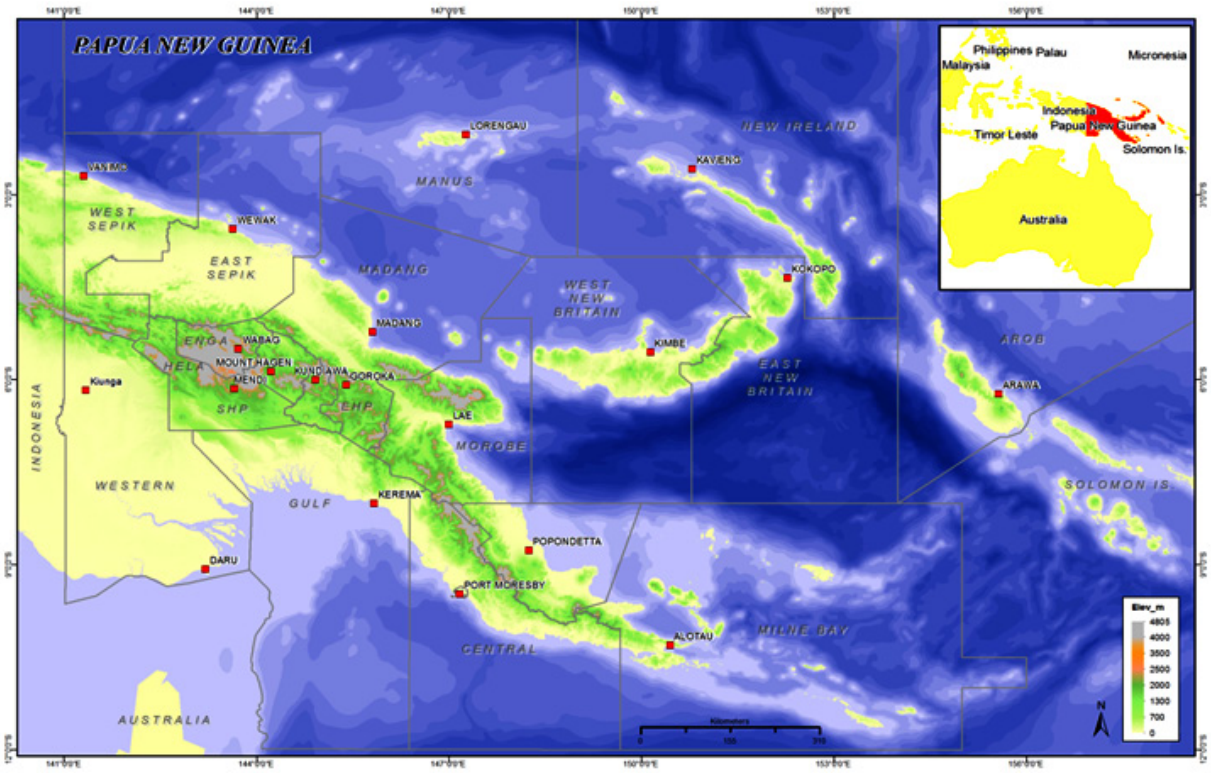


Figure 1-1: Map of Papua New Guinea

1.2. Climate and Weather

PNG has a hot, humid tropical climate which is characterised by high temperatures and humidity throughout the year. PNG has 2 monsoonal seasons, namely the northwest monsoons which occur from December to March, and the southwest monsoons which occur from May to October. PNG is known to possess one of the wettest climates in the world and rainfall in many areas can exceed 2,500mm per annum with the heaviest events occurring in the highland regions. Changes in the temperature from season to season are small, but are more noticeable around Port Moresby when compared to other areas in PNG. Port Moresby and other towns on the coast are quite hot in the summer months whereas temperatures are considerably cooler in the highland regions.

Average monthly rainfall ranges from 250mm – 350mm with and average monthly temperature range between 26°C - 28°C (see figure 1-2). More than 50% of PNG receive more than 2,500 mm per annum, but average annual rainfall in the drier regions is much lower including Port Moresby whose average annual rainfall is 1,190mm (BoM and CSIRO;2011:2). Relative humidity is quite high in PNG and ranges between 70 to 90%.

Due to PNG's location its climate and weather is governed by a number of factors. These include trade winds and the movement of the South Pacific Convergence Zone. Variability in the climate experienced year on year is strongly influenced by the El Nino conditions in the southeast Pacific. These conditions can result in drought conditions especially in the drier areas of PNG, and increased extreme weather such as frost, cyclones and flooding. Climate variability is predicted to accelerate the occurrence of these extreme weather events, and that these will have an increased impact on social, environmental and economic systems, including natural ecosystems, soil productivity through soil erosion and landslides, the agriculture and water resources sectors, food security and public health. The 2015 El Nino event seriously disrupted food production and livelihoods, and led to widespread food and water shortages, and in some regions this impact was experienced through to 2017.

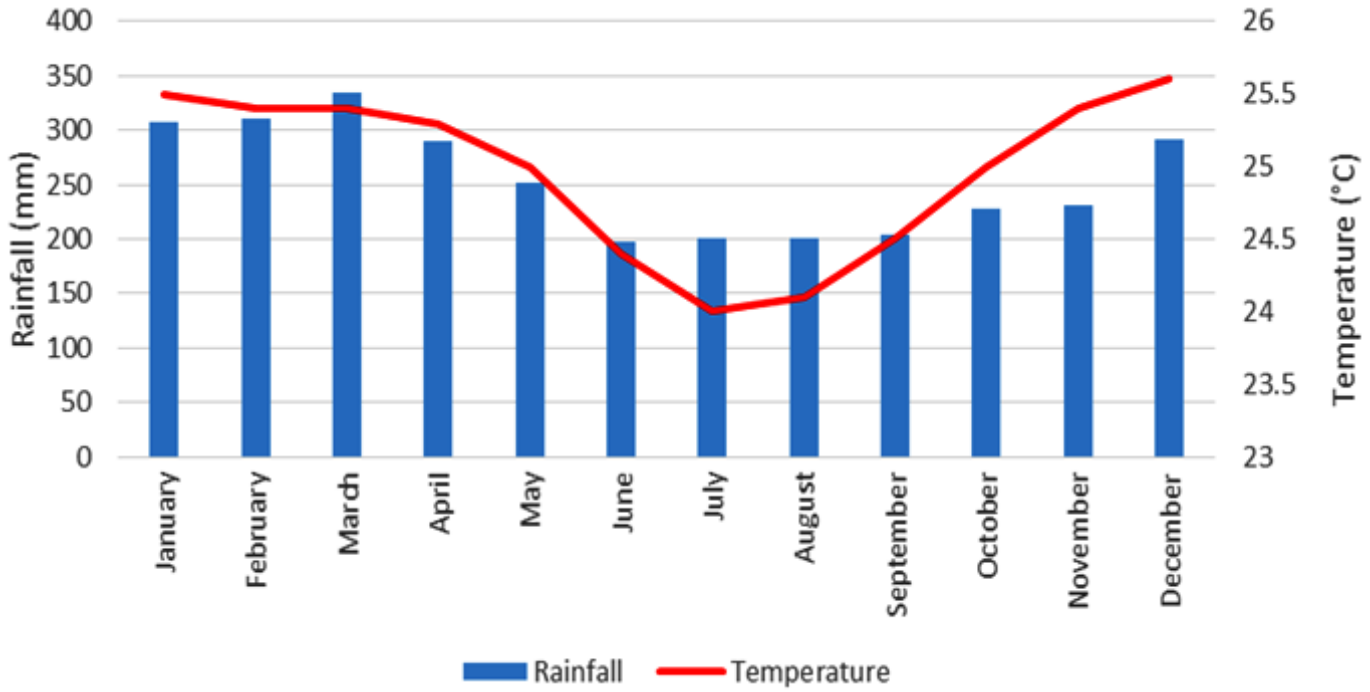


Figure 1-2: Average annual rainfall and temperature for Papua New Guinea 1901-2015 (Source: World Bank climate change knowledge portal)

There have been various assessments of PNG's vulnerability to extreme climate and weather. These assessments are predicting with various degrees in certainty the climate future in Oceania and the Pacific region (e.g. IPCC Sixth Assessment Report). Regional-scale vulnerability assessments undertaken in recent years have identified recent trend in climate and weather. These include an increase in both the surface and sea temperature, increase in the number and intensity of hot days and hot nights, the increase in severe weather events including the number and intensity of tropical cyclones and rain events, and increased El Nino weather events.

The 2015 El Nino event was a key driver in developing the National Disaster Risk Reduction Framework (2017 – 2030). This framework aims to reduce vulnerabilities and increase resilience in PNG's social, environmental and economic systems. Climate resilience is also a key consideration in related strategies and policies. The Medium-Term Development Plan III (2018 – 2022) sets out the investment priorities, and the National Climate Change Compatible Development Management Policy requires development of sector mitigation and adaptation policies to enable investment in climate resilient development and infrastructure, and integrated with improved disaster risk management and agricultural practices that is guided by climate change research. The National Strategy for Responsible Sustainable Development (STaRS) also seeks climate resilience through enabling conditions established by the Green Growth Plan (Department of National Planning and Monitoring, 2010)

1.3. Population

PNG is one of the least densely populated countries in the world with an estimated population density of 19.4 persons per square km^2 in 2018. The 2011 Census of Population and Housing estimated a total residential population of 7.28 million. The population was forecast to be 8.98 million in 2020 with 24% of this population estimated to live in PNG's urban centres, and more than 40% of the total population estimated to be under the age of 14. According to the 2011 Census data, 40% of the population in urban areas were not born there, indicating a major internal migration

to urban centres. Most people living in PNG are Melanesian, but some are Micronesian or Polynesian. There are also over 800 known languages with English, Tok Pisin (Pidgin) and Hiri Motu the official languages of PNG.

Population data provided in Table 1-1 by region and by province is based on the Census of Population and Housing. This Census is updated periodically with 2000 and 2011 the most recent Census years. The scheduled 2021 Census was deferred due to the Covid-19 pandemic. While PNG's population continues to increase, the annual population growth rate has declined steadily since 2010 from 2.4% down to the estimated 1.9% growth rate for 2020. Internal migration to the urban centres has increased steadily since 2013.

On many indicators, PNG's population growth is outpacing development progress, and service delivery across the country is in decline. Growing urbanisation is increasing the burden on service providers as people who move from rural areas generally lose access to their customary land and become less self-sufficient. The most recent Census identified over 40% of the population is under the age of 14. The growth in this demographic is outstripping very limited formal sector employment opportunities. PNG recognizes the needs of the private sector are evolving, and thereby skills development is critical. PNG is also experiencing a growth in immigrant groups which are taking over small and medium businesses that have typically been run by locals, adding further societal and employment pressures.

PNG's global Human Development Indicators (HDI) ranking dropped from 128 out of 175 countries in 1994 to 145 out of 179 countries in 2005. PNG's Vision 2050 noted "this reflects our worsening social indicators and marked improvements in other countries' socioeconomic indicators." The HDI has increased steadily since 2012 and in 2019 the indicator was 0.555 which places the country in the medium human development country (155 out of 189 countries). The key drivers underpinning this trend have been attributed to Government policy that has resulted in increased life expectancy at birth, and an increase in mean schooling years.

Table 1-1 Regional population distribution across PNG provinces in 2000 and 2011 (Source: National Statistical Office)

	Census Years									
	2000					2011				
	Urban	% Urban	Rural	Total Populatio	% Rural	Urban	% Urban	Rural	% Rural	Total Population
Papua New Guinea	622,160	12%	4,568,626	5,190,786	88%	854,951	12%	6,420,373	88%	7,275,324
Southern Region	313,409	30%	728,411	1,041,820	70%	441,838	30%	1,014,412	70%	1,456,250
Western Province	24,373	16%	128,931	153,304	84%	30,517	15%	170,834	85%	201,351
Gulf Province	5,124	5%	101,774	106,898	95%	5,885	4%	152,312	96%	158,197
Central Province	-	0%	183,983	183,983	100%	-	0%	269,756	100%	269,756
National Capital District	254,158	100%	-	254,158	0%	364,125	100%	-	0%	364,125
Milne Bay Province	9,888	5%	200,524	210,412	95%	11,857	4%	264,655	96%	276,512
Northern Province	19,866	15%	113,199	133,065	85%	29,454	16%	156,855	84%	186,309
Highlands Region	102,044	5%	1,871,952	1,973,996	95%	151,310	5%	2,703,564	95%	2,854,874
Southern Highlands Province	22,607	6%	337,711	360,318	94%	28,049	5%	482,196	95%	510,245
Hela Province	8,824	5%	177,123	185,947	95%	39,279	16%	210,170	84%	249,449
Enga Province	4,208	1%	290,823	295,031	99%	5,041	1%	427,004	99%	432,045
Western Highlands Province	27,877	11%	226,350	254,227	89%	32,830	9%	330,020	91%	362,850
Jiwaka Province	-	0%	185,798	185,798	100%	-	0%	343,987	100%	343,987
Chimbu Province	12,217	5%	247,486	259,703	95%	15,547	4%	360,926	96%	376,473
Eastern Highlands Province	26,311	6%	406,661	432,972	94%	30,564	5%	549,261	95%	579,825
Momase Region	151,535	11%	1,281,897	1,433,432	89%	176,523	9%	1,691,134	91%	1,867,657
Morobe Province	92,953	17%	446,451	539,404	83%	102,111	15%	572,699	85%	674,810
Madang Province	28,547	8%	336,559	365,106	92%	35,971	7%	457,935	93%	493,906
East Sepik Province	20,257	6%	322,924	343,181	94%	24,471	5%	426,059	95%	450,530
West Sepik Province	9,778	5%	175,963	185,741	95%	13,970	6%	234,441	94%	248,411
Islands Region	55,172	7%	686,366	741,538	93%	85,280	8%	1,011,263	92%	1,096,543
Manus Province	5,874	14%	37,513	43,387	86%	8,882	15%	51,603	85%	60,485
New Ireland Province	11,274	10%	107,076	118,350	90%	16,725	9%	177,342	91%	194,067
East New Britain Province	23,840	11%	196,293	220,133	89%	36,750	11%	291,619	89%	328,369
West New Britain Province	14,184	8%	170,324	184,508	92%	22,923	9%	241,341	91%	264,264
Autonomous Region of Bougainville	-	0%	175,160	175,160	100%	-	0%	249,358	100%	249,358

1.4. Economy

PNG is the largest economy among the Pacific Islands which is dominated by resources, agriculture, forestry and fishing. The economy is small, open and export-orientated and is very dependent on commodity products, and economic growth is largely tied to foreign investment in the resources sector. The formal sector consists of extractive mining and petroleum industries, cash-crop agriculture production and a small import-substituting manufacturing sector. Whereas the informal sector is predominantly subsistence agriculture on which much of the PNG population derives their livelihood. While most of PNG's labour force is employed in the agriculture sector the vast majority of its export earnings is through the resources sector.

The resources sector is an influential factor in PNG's GDP and National accounts. In recent years PNG has experienced a steady GDP growth which reflects the performance of this sector which is dependent on the export of commodities. Lower LNG and oil prices in 2020 and a decline in global economic activity due to COVID-19 have collectively resulted in a slowing of GDP growth in 2020. The progressive global slowdown of economic activity as a result of COVID-19 has put further downward pressure on PNG's export opportunities. The domestic response to the COVID-19 pandemic dulled local economic activity, particularly in Port Moresby.

PNG now seeks to consolidate its economic and budget position to return to a growth path, and to rebuild living standards for its people. To that end there is a focus on diversifying and growing the non-resources sector, to seek a greater share in royalties of resource projects, and to reform State-owned enterprises and the public sector. PNG plans to pursue these through ongoing investment in capital programs such as Connect PNG, the Micro Productivity Improvement Program for rural infrastructure and the Special Intervention Programs.

Investment in major economic infrastructure will improve transport connectivity and logistical support, enable access to secure and reliable power supply and to financial services, and lift capabilities and capacities in skilled labour. This infrastructure could enable connectivity and expansion of economic corridors, enable diversification in the economy including developing new non-resource sector industries, and to enhance prosperity and living standards in the community.

PNG acknowledges its national strategic priorities are embedded in part in continued economic growth, including in the resources sector. The medium-term economic forecast in the resources sector is positive with numerous new resource projects in the pipeline, such as the Papua LNG project, the Wafi-Golpu gold and copper mine, the P'nyang gas field and the Pasca A gas condensate field.

The rural region is generally a traditional village-based setting which is dependent on subsistence and small cash-crop agriculture. Income is largely derived from growing and selling of agriculture produce, and in some communities the local economy is supported by fishing and forestry activities. Forestry is an important element of PNG's economy providing employment as well catering for a growing population in providing timber products, and the conversion of forest land to enable local economies through small cash crops.

According to the latest National Accounts (2006 – 2019) current price GDP for 2019 was 83.8 billion Kina, representing a 5% increase on the previous year. The resources sector continues to be the key driver in GDP growth, along with agriculture, forestry and fishing, and wholesale and retail trade. PNG's 2021 budget outlined an anticipated drop in economic growth (GDP) of 3.8% in 2020 as a result of COVID-19 impacts on global markets and the domestic economy. It is acknowledged that in part the indefinite closure of the Porgera mine and lower gold output from the Lihir mine were also influential in the decline in GDP growth. PNG anticipates GDP to return to 2019 levels in 2022. Figure 1-3 shows the trend in GDP in recent years.

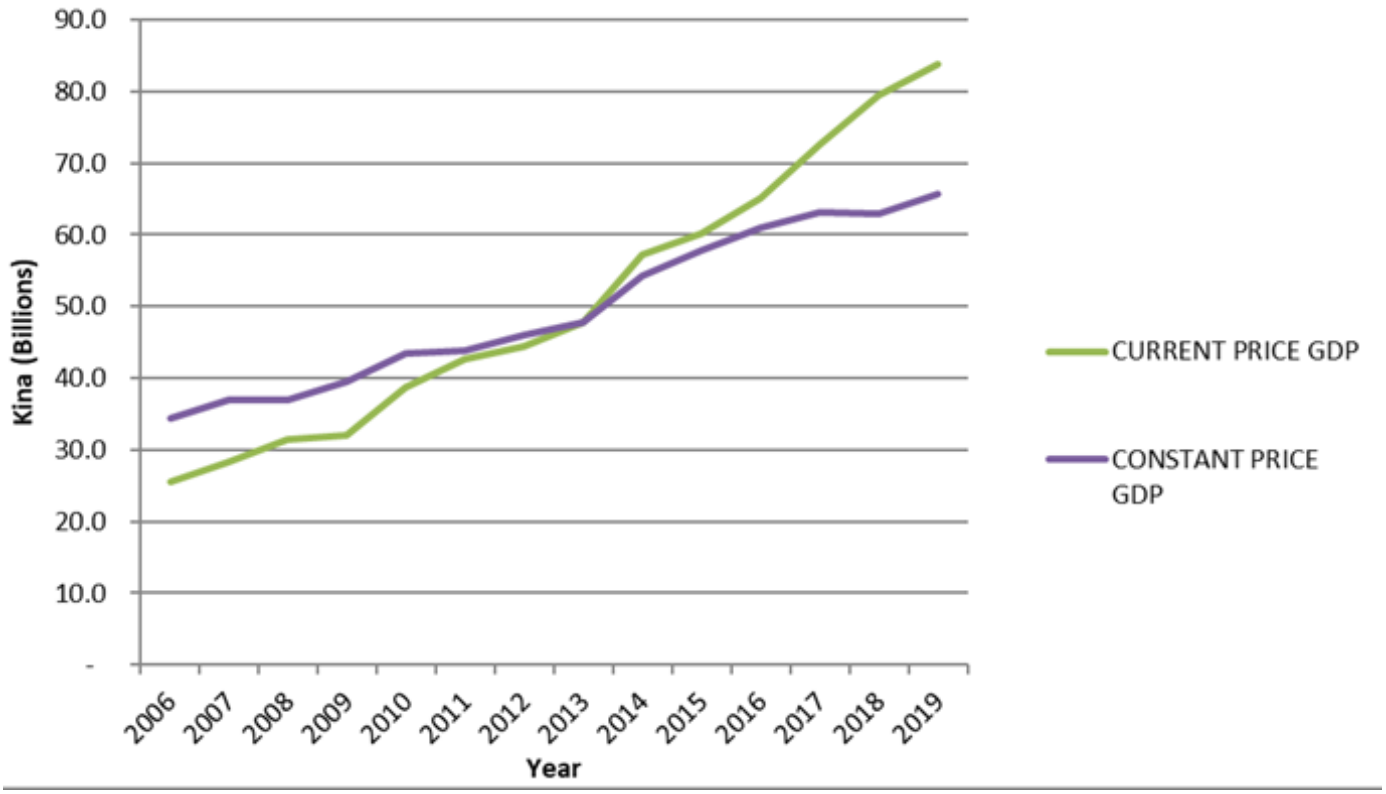


Figure 1-3: PNG's Constant and Current GDP from 2006 to 2019 (source: National Accounts 2013-2019)

1.5. Agriculture

Agriculture has an important role in PNG's economy and is an integral component of its labour force and export revenues. It accounts for about a quarter of its GDP and is the principal economic activity which supports the livelihood of much of the rural population that relies on subsistence farming (i.e. informal economy).

PNG's favourable climate and fertile soil provides ideal conditions for the cultivation of a range of cash crops. These cash crops are largely managed in large plantations but there are also smallholder production in rural communities. Cocoa, coffee, copra, palm oil, rubber and tea are the main exports.

Coffee, cocoa, sugar, copra, oil palm, rubber, fresh vegetables, and betel nut are grown by smallholders and provide income for 80 % of the population. Smallholder production of tree crops comprises 70 % of total output for the sub-sector. However, total production from commercial plantations has been on a decline since the 1980s because of rising labour and overhead costs, and fluctuating world prices. PNG acknowledges the promotion and support of smallholder agriculture system which is key to growth in this sector, and influential toward improving the livelihood of the rural population that rely on subsistence farming.

Subsistence gardeners cultivate about 0.01 to 0.1 ha of land, and smallholder farmers cultivate less than 5 ha units. Most gardens are planted with crops continuously for one or two years then fallowed for 5-15 years to allow development of soil fertility. Garden sites are cleared of vegetation by slash and burn method, without land cultivation and use of purchased input. Sweet potato, banana, sago, taro, yams, cassava, and sugarcane are the main crops harvested. The rural economy is supplemented by local livestock production that are consumed by the rural community, including pigs, chickens, ducks, and occasionally fish (Ministry of Agriculture and Livestock, 2001).

Intensive agriculture is practiced among 20% of rural people living in productive environments with high population densities. They continuously cultivate the land, and use land improvement practices such as composting, mounding, drainage, legume rotation, tree fallowing, soil retention barriers. Where alternative livelihood opportunities are limited, agricultural production is intensified through shorter fallow periods, extension of cropping periods, and planting of crops which do not require much inputs such as sweet potato, taro, cassava and bananas. PNG recognises improvement in agricultural practices is necessary to reduce the risk of soil degradation which may result in a decline in productivity.

Additional environmental challenges facing the agriculture sector include the impact of chemicals used in this sector (i.e. production and processing). Pesticides and herbicides used to manage infestations of insects and micro-organisms can be persistent in the soil. Over time these chemicals can leach into groundwater and waterways and result in environmental degradation.

1.6. Forestry

PNG's definition of forest is derived from the definition approved by the National Executive Council (NEC) in 2014 and is, "Land spanning more than 1 hectare, with trees higher than 3 meters and the canopy cover or more than 10 percent".

PNG together with West Papua (Island of New Guinea) represents one of the largest areas of intact tropical forest in the world. According to the PNG's Forest Reference Level 2001-2013 (FRL) the country has a total area of about 461,000 km^2, of which 77.9 % (360,000 km^2) is forest. There are 14 types of forest in PNG comprising 13 natural vegetation types and a forest plantation. Among those, three forest type (low altitude forest on plain and fans, low altitude forest on uplands, lower montane forest) amount to more than three-quarters of forest in PNG. Plantation forest (various plantations species; mono-type or mixed) account for only 0.15% of PNG forest.

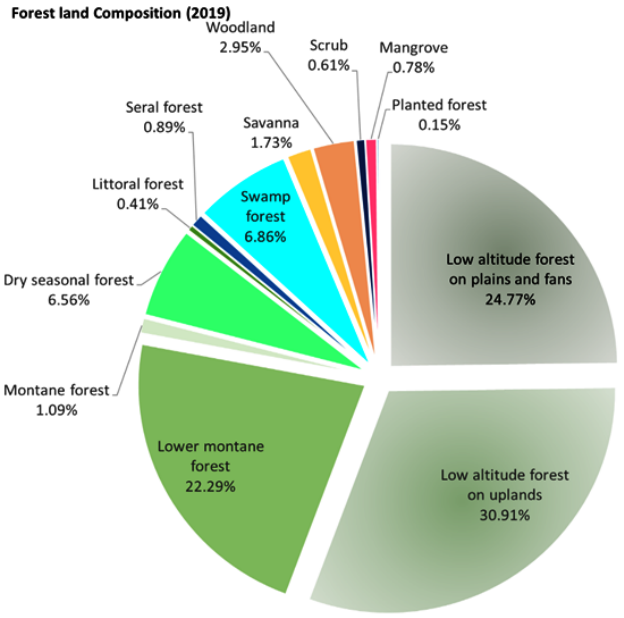


Figure 1-4: Distribution of forests by forest types (Source: PNG Forest Authority)

More than three-quarters of this forest is categorized as primary or as not being disturbed by human activities, whereas 11% is classified as disturbed by large scale logging, and 0.2% is disturbed by small scale logging using portable sawmill. Small scale temporary gardening cause 8 % of forest disturbance.

PNG's forest is critical to the livelihoods of its people and to its economy. PNG's forests provide access to clean water and suitable agricultural land for its predominantly rural population. Forest resources also help to protect key infrastructure, people and crops from natural disasters like flash flooding and landslides. Forests also play a direct role in supporting the livelihoods of rural communities, with more than 500 species of wild-growing plants identified as being used for food. The value of annual bush meat from the forest that is consumed is estimated to be equivalent to $26 million if alternative meats had to be sourced.

1.7. Fish Resources

According to the National Fisheries Authority (NFA), PNG's fisheries zone of 2.4 million km^2 is the largest in the South Pacific which includes an extended reef system, numerous islands and an extensive coastline. The country records an extensive and valuable fisheries sector ranging from inland river fisheries, aquaculture, coastal beche-de-mer and reef fisheries to the prawn trawl and large-scale deep-water tuna fisheries. The range of participants covers artisanal community to medium sized domestic prawn and tuna long line operators to large international purse seine fleets in the deep-water tuna fishery.

NFA also estimates its total market value of PNG catch is, "at K350 to K400 million on average although information on the true value of artisanal fisheries is difficult to obtain and cyclical factors and commodity price movements, especially tuna, because huge value swings from year to year". NFA believes that there is significant potential to increase the economic value and returns to PNG of these fisheries through better management and development programs. The importance of fisheries to the local markets and subsistence economy is also of major importance to the PNG people.

1.8. Energy

According to the Asia-Pacific Economic Cooperation (APEC) energy balance table for PNG, in 2019 the natural gas production was 11,068 kiloton of oil equivalent (ktoe) with 10,629 ktoe exported. Most crude oil produced in PNG is also exported, and to meet domestic demand crude oil is imported. The total primary energy supply in 2019 was estimated to be 4,795 ktoe of which oil and petroleum products account for 47%, solid biomass 35%, natural gas 9% and 10% was from renewable energy sources (Hydro and Geothermal).

A total of 1320 ktoe of Crude Oil, comprising of both imports and domestic production was refined in 2019 producing about 1117 ktoe of petroleum products. From this, 460 ktoe was naphtha, 116 ktoe kerosene, 433 ktoe gas/diesel oil, 77Ktoe fuel oil, 16Ktoe LPG and 15 ktoe other products. In 2019 the total final energy consumption was 3,367 ktoe of which 49% was solid biomass, 41% was petroleum product and 11% electricity. The other subsector (residential and commercial) was the largest energy consuming subsector with 1831 ktoe. This is followed by the manufacturing industries and construction subsector with 919 ktoe and the transport subsector with 616 ktoe.

1.9. Transport

a. Road Transport

The total number of vehicles including motor cycles was estimated at approximately 46,000 in 2010, or one vehicle per 147 people. Official statistics on the total number of vehicles in PNG are poor due to the fragmentation of responsibility for vehicle licensing since devolution of responsibility to provincial governments. Growth over the past decade appears to have been low, less than 1% which is below the growth rate in population and appears to be at variance with common observation. This total will also include cars owned by businesses, public agencies and taxis, so that vehicle ownership by private households and village groups will be even lower, possibly only 50 % of the total. This is a very low level of motor vehicle ownership in comparison with other Pacific states and internationally. The extent of use in vehicles is difficult to ascertain due to the relatively few roadside traffic counts. Historical data on traffic composition counts shows that heavy vehicles account on average for one third of the traffic on rural highways, although this can vary between 20 and 50%. Passenger motor vehicles account for about 20% of traffic with a typical range of variation between 10 to 30%, government vehicles with a range of 10 to 15 %, and private vehicles 65% with a typical range between 55 to 75%.

b. Maritime and Inland Water Transport

There are 22 declared ports, of which 16 are operated by PNG Ports Corporation, either directly or through agents. Other than the declared ports, there are a number of private port facilities on the PNG coast, mainly established to support specific industries, such as mining, oil palm and logging. There are a large number of minor port facilities, including small wharves, jetties, ramps and landings.

Total cargo grew at 3.8% over the 2005-2009 period, international cargo at 3.0 % and coastal cargo at 5.3 %. In 2010, the total ship calls at the declared ports were 6,330. From this a total of 6.8 million revenue tons of cargos was handled, of which 60% was international cargo. The total twenty foot equivalent unit containers, including empty ones, handled was 265,000.

Papua New Guinea is comparatively well served by international shipping lines mainly in north-south services between Asia and Australasia. There are approximately 3,000 voyages per year and 300 voyage rotations between PNG, the Australian east coast ports and Asia. The traffic is mainly general/container cargo vessels and bulk carriers for petroleum, mineral and log exports.

c. Air Transport

Port Moresby International Airport is currently the only airport in PNG supporting international regular scheduled passenger services. The international airport and a further 20 national airports are operated by the National Air Corporation. A further 6 airports are certified in accordance with the International Civil Aviation Organization Annex 14 and PNG Civil Aviation Rules; these include three airports associated with mining and oil & gas and three ex-national airports now operated by provincial governments. There are also a large number of smaller airports, ranging in strip length from as long as 1,700m down to small rural airstrips as short as 450m. The number currently listed as "active" from provincial data sources is 424.

There are about 259 registered planes. Air Niugini (ANG) and Airlines PNG operate domestic services primarily based in Port Moresby. ANG flies point-to-point services to 11 main domestic airports. Airlines PNG operates first and second level services using mainly Dash-8, competing

against ANG but also serving smaller airports from hubs. The largest third level operator is Mission Aviation Fellowship, a church-sponsored airline, based in Mount Hagen, with a fleet of 16 mainly DHC-6, Cessna 206 and GA8 Airvans with which it serves remote rural airstrips throughout PNG.

The main international carrier is the government-owned ANG which operates the bulk of international services and routes. ANG currently operates B767-300AR, Fokker F100 and Bombardier Q400 aircraft on its international services.

1.10. Domestic Climate Change Policy

The PNG government has taken the approach in revisiting all policies and plans against assumptions of sustainable growth and to manage the resources being exploited to sustain the economy hence, all polices have been developed for sustainable socio-economic growth of PNG and for climate change in particular, for both short term and long-term development. The BUR1 provides an overview of the climate change policies in PNG which includes the Vision 2050, Development Strategic Plan 2010-2030, National Strategy for Responsible Sustainable Development for Papua New Guinea, National Climate Compatible Development Management Policy, Climate Change (Management) Act and United Nations Paris Agreement (Implementation) Act.

Since the submission of the BUR1 the PNG government has developed additional climate change policies. An overview of these policies is as below:

a. Papua New Guinea's Sustainable Development Goal 13 Roadmap 30 actions by 2030;

b. Papua New Guinea's Enhanced Nationally Determined Contribution; and

c. Climate change (Management) (Nationally Determined Contribution) Regulation.

1.10.1. Papua New Guinea's Sustainable Development Goal 13 Roadmap 30 Actions by 2030

Papua New Guinea's Sustainable Development Goal 13 Roadmap 30 action by 2030 was endorsed by the National Executive Council in 2020. The Roadmap maps out a path towards climate compatible development which will reduce PNG's vulnerability to climate change and contribute to global action on reducing GHG emissions. By utilizing the guiding framework of the Sustainable Development Goals and SDG 13, the Roadmap includes 30 sets of actions that must be completed between 2030 an 2030 in order for PNG to meet SDG 13 and make progress across all 17 of the SDGs. The 30 by 30 Roadmap is structed by nine sectors, with one cross-sectorial category called Climate Change Governance and Knowledge. The nine sectors include:

i. Energy;

ii. Forestry;

iii. Infrastructure;

iv. Agriculture;

v. Minerals;

vi. Health;

vii. Tourism;

viii. Fisheries;

ix. Biodiversity.

1.10.2. Papua New Guinea's Enhanced Nationally Determined Contribution

PNG prepared and submitted it Enhanced Nationally Determined Contribution (NDC) in 2020 to the UNFCCC as part of its commitment to address climate change. The Enhanced NDC outlines PNG's mitigation contribution and adaptation actions that it plans to achieve by 2030. Under the mitigation contribution, targets have been established for the two largest GHG emitting sectors which are the energy and Agriculture, Forestry and Other Land Use sectors. Details of these targets are provided in Chapter 3 Mitigation Actions.

Under adaptation actions, PNG has established adaptation targets for four development sectors which includes agriculture, health, transport and infrastructure. The adaptation targets are as follow:

i. Agriculture: 10% of the total population (0.8 million beneficiaries (25% are women)) have increased resilience with respect to food and waste security, health and well-being in PNG;

ii. Health: 100% of the population benefits from improved health measures to respond to malaria and other climate-sensitive disease in PNG;

iii. Transport: USD 1.3 billion value of transport (air, sea, and land) infrastructure and assets built/rehabilitated according to climate-resilient codes and standards;

iv. Infrastructure: 6 million people (70% of the population) benefit from improved early warning systems/information to respond to extreme climate events. USD 172 million value of building and utility infrastructure assets built/rehabilitated according to climate-resilient codes and standards.

1.10.3. Climate change (Management) (Nationally Determined Contribution) Regulation

The Climate Change (Management) (Nationally Determined Contribution) Regulation was endorsed by the National Executive Council in 2021. The purpose of the Regulation is to provide a legal framework for the implementation of PNG's Enhanced NDC under the Paris Agreement. Among other things, the regulation provides for the establishment of a Technical Advisory Committee and Sub Technical Working Committee, formal recognition of targets contained in the NDCs; development implementation plan; Implementation Measures; and Monitoring, Reporting and Verification.

1.11. Institutional Arrangement for Development of the Biennial Update Report and National Communication

Previous reports to the UNFCCC from PNG which includes the Initial National Communications and Second National Communications were prepared on project basis. Currently PNG has institutionalised the process of preparing Biennial Update Reports and National Communications. The designated entity for preparing and communicating the BURs and National Communications to the UNFCCC is the Climate Change and Development Authority. This is as per its mandate under the Climate Change (Management) Act 2015. CCDA is also responsible for the following BUR and NC elements:

- Identify constraints and gaps, and related financial, technical and capacity-building needs, including a description of support needed and received,
- Keep any management committees and working groups informed of progress and emerging issues,
- Develop and implement Quality Assurance and Quality Control strategies for the entire BUR and NC,
- Manage the overall budget for the preparation of the BUR and NC,
- Compile and integrate all sections of the BUR and NC into a cohesive document,
- Develop and maintain an archiving system to ensure institutional memory and to fully and systematically document all the activity data and the methods used,
- Collect and maintain statistical records,
- Conduct an evaluation exercise to identify key lessons learned and areas for improvement,
- Consider results of the International Consultation and Analysis (ICA) process.

The responsible division within the CCDA structure is the MRV and National Communications division. Under this arrangement CCDA was able to prepare and submit PNG's BUR1 including REDD+ Technical Annex in 2019. This also includes the current preparation of the BUR2 including the REDD+ Technical Annex and National Inventory report. Development partners have also provided financial and technical support to CCDA for the preparation of these reports. This includes the Japan International Cooperation Agency (JICA) and the UN Food and Agriculture Organisation (FAO).

For the current BUR2, CCDA has enhanced its institutional arrangement by establishing an Energy Sub Technical Working Committee (ESTWC) and Agriculture Forestry & Other Land Use Sub Technical Working Committee (AFOLU STWC). The STWCs consisting of key government agencies, private sector agencies and Non-Government Organisations from the energy and AFOLU sectors in PNG. The STWCs are responsible for providing technical inputs for the preparation of the BUR2. In addition to this there are also other institutions from other sectors that have provided information to CCDA for the preparation of this report.

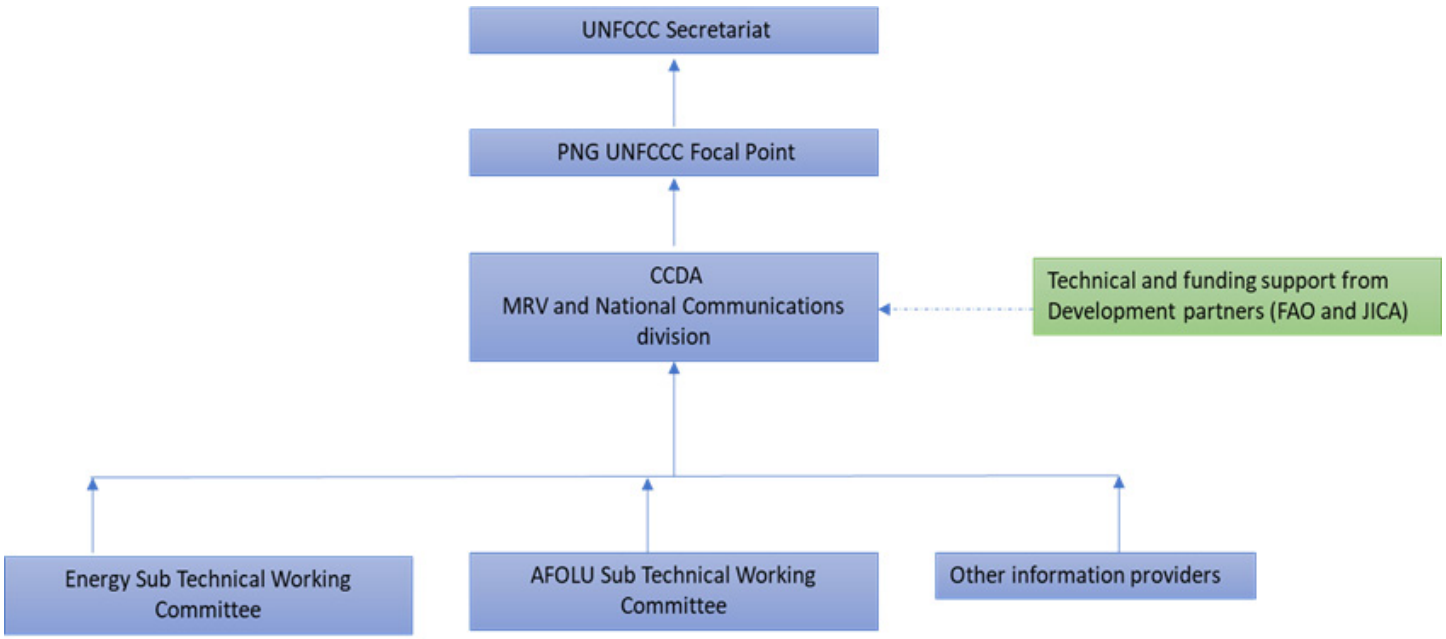


Figure 1-5 General Institutional Arrangement for the preparation of the BUR2, REDD+ TA and NIR

2. GHG Inventory

2.1. National GHG Inventory Arrangements

CCDA has been tasked with managing the preparation of the National GHG inventory in addition to the preparation of BUR's. Key CCDA functions include planning, preparation and management of the GHG inventory.

CCDA collaborates with the designated sector lead agencies to compile the GHG inventory. Through this collaboration CCDA received activity data and emission factors to enable estimation of GHG emissions. Private companies provide this data when sector lead agencies are unable.

As shown in figure 2-1, for the Energy Sector the Department of Petroleum and Energy (DPE) was involved but the data used was from the energy balance table compile by the Asia Pacific Energy Research Centre (APERC) by using the Oil and Natural Gas data provided by the DPE. For the Industrial Process and Product Use sector, two private companies were involved one is an importer of products containing N_2O and the other imports and uses lubricants. Data on the import of bulk HFCs in refrigeration and air-conditioning equipment was provided via a consultancy and used to validate corresponding data provided by PNG Customs. For the Agriculture, Forestry and Other Land Use Sector, the Department of Agriculture and Livestock, lead agency for agriculture sector, and the PNG Forest Authority, lead agency for the forestry sector was involved. And for the Waste Sector, three government agencies namely Water PNG, National Statistical Office and the National Capital District Commission were involved.

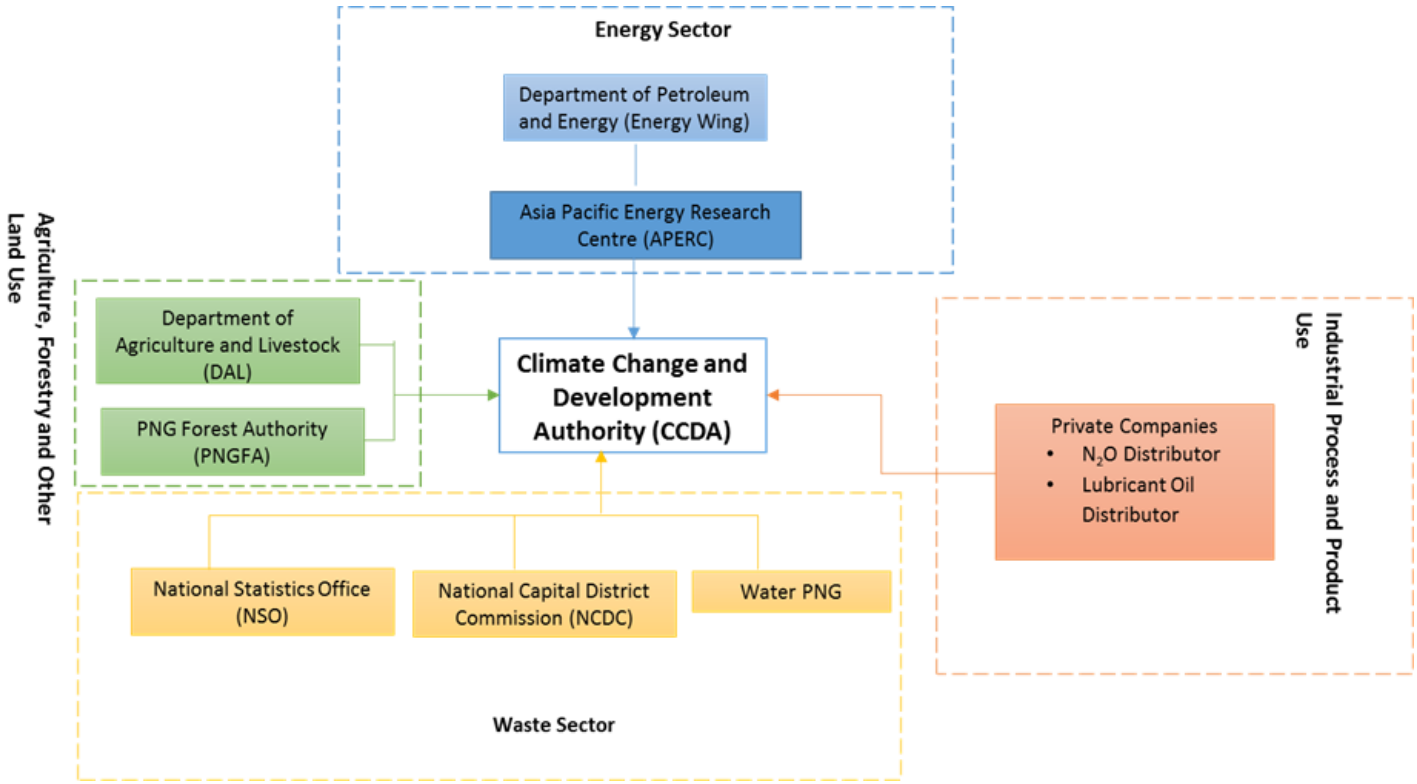


Figure 2-1 National system for inventory planning, preparation and management

The GHG inventory preparation schedule is as shown in table 2-1.

Table 2-1 GHG inventory preparation schedule

Milestone	Time
GHG inventory improvement planning	5 months
Project approval by GEF/UNDP/PNG	6 months
Kickoff meeting/workshop	1.5 months
Data collection - Stakeholder identification/stakeholder identification and engagement - Sub technical working committee meetings, as needed - Sending official data request letters including data sheets - Data collection and analysis - Update database	8 months
GHG emission/removal estimation	0.5 months
Compilation of the GHG inventory - Linking all sector files to the summary table files and producing the national total GHG emissions/removals. - updating the key category analysis - updating the uncertainty assessment	0.5 months
Updating the NIR	1 month
Updating the BUR chapter on GHG inventories	0.5 months
Quality control of the inventory products (estimation files and inventory report)	0.5 month
Validation meeting/workshop	1 month
Revision of the GHG inventory, as needed	0.5 months
Quality Assurance activities	1 month
Submission to the Climate Change Board and Minister for Environment and Climate Change	1 month
Submission to the UNFCCC	
GHG inventory preparation process	~24 months*

2.2. Methodology

2.2.1. Reporting Guidelines and IPCC Guidelines

PNG has followed the National communications guidelines and the BUR guidelines as contained in decision 17/CP.8 and decision 2/CP.17, respectively. The 2006 IPCC Guidelines for National Greenhouse Gas Inventories were used to estimate emissions and all sectors of removals for the BUR2 inventory.

2.2.2. Methods and Global Warming Potentials (GWP) used

Emissions and removals from most categories of the BUR2 inventory have been estimated with tier 1 methods with exception of some categories in the LULUCF, IPPU (HFC emissions) and waste sectors which were estimated using the tier 2 method. The BUR2 inventory uses the global warming potentials as contained in the Second Assessment Report (SAR) of the IPCC.

Table 2-2 Methods and emission factors used in the GHG inventory

	CO_2		CH_4		N_2O		HFCs		PFCs		SF_6	
	method	EF	method	EF	method	EF	method	EF	method	EF	method	EF
1 ENERGY												
1.A Fuel Combustion Activities												
1.A.1 Energy Industries	1	D	1	D	1	D						
1.A.2 Manufacturing Industries and Construction	1	D	1	D	1	D						
1.A.3 Transport	1	D	1	D	1	D						
1.A.4 Other Sectors	1	D	1	D	1	D						
1.A.5 Non-Specified												
1.B Fugitive Emissions from Fuels	1	D	1	D	1	D						
2 INDUSTRIAL PROCESSES AND PRODUCT USE												
2.A Mineral Industry												
2.B Chemical Industry												
2.C Metal Industry												
2.D Non-Energy Products from Fuels and Solvent Use	1	D										
2.E Electronics Industry												
2.F Product Uses as Substitutes for Ozone Depleting Substances							1	D				
2.G Other Product Manufacture and Use					1	D						
2.H Other (please specify)												
3 AGRICULTURE, FORESTRY AND OTHER LAND USE												
3.A Livestock			1	D	1	D						
3.B Land	1, 2	D, CS										
3.C Aggregate Sources and Non-CO2 Emissions Sources on Land			1	D	1	D						
3.D Other												
4 WASTE												
4.A Solid Waste Disposal			2	D								
4.B Biological Treatment of Solid Waste			1	D	1	D						
4.C Incineration and Open Burning of Waste	1	D	1	D	1	D						
4.D Wastewater Treatment and Discharge			1	D	1	D						

The following notation keys have been used to specify the method applied:

D (IPCC default) T2 (IPCC Tier 2) CS (Country Specific)
T1 (IPCC Tier 1) T3 (IPCC Tier 3) OTH (Other)

Use the following notation keys to specify the emission factor used:

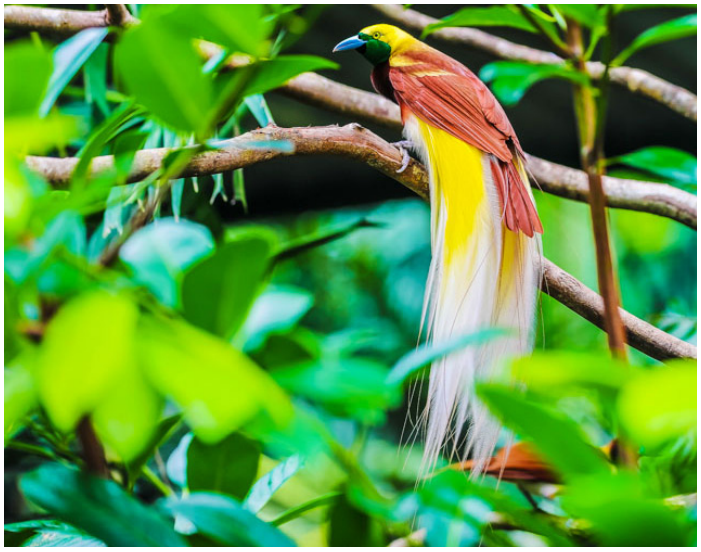
D (IPCC default) CS (Country Specific OTH (Other)
CR (CORINAIR) PS (Plant Specific)

2.2.3. Years Covered

The BUR Guidelines require GHG inventory data for 4 years before year of submission. However, due to the COVID-19 pandemic that had an impact on the workplan activities and intended submission year of the BUR2 which is 2021, PNG has reported GHG emissions in BUR2 for years 2000 to 2017.

2.2.4. Activity Data and Emission Factors

Various sources were used for activity data such as data provided from government agencies, companies, in addition to international sources such as the FAO. Most emission factors and other parameters used in the estimation were taken from the 2006 IPCC Guidelines though certain country specific emission factors were used for the LULUCF sector.



2.3. Emission and Removal Trends

2.3.1. Overview

PNG went from a net sink of (-12,436 kt CO_2 eq) to a net source in 2016 (6,897 kt CO_2 eq). Then in 2017 PNG became a net sink with a total GHG emissions of -1,958 kt CO_2 eq. The main driver for the increasing and decreasing trend is the LULUCF sector mainly from deforestation and degradation activities in the country.

Without the LULUCF sector the total net emissions increased from 8,052 kt CO_2 eq in 2000 to 10,767 kt CO_2 eq in 2017. An increase 34% and the main driver is the increasing fossil fuel consumption from the manufacturing industries and construction followed road transportation.

The figures and table below show the total GHG emissions including and excluding LULUCF for each inventory year.

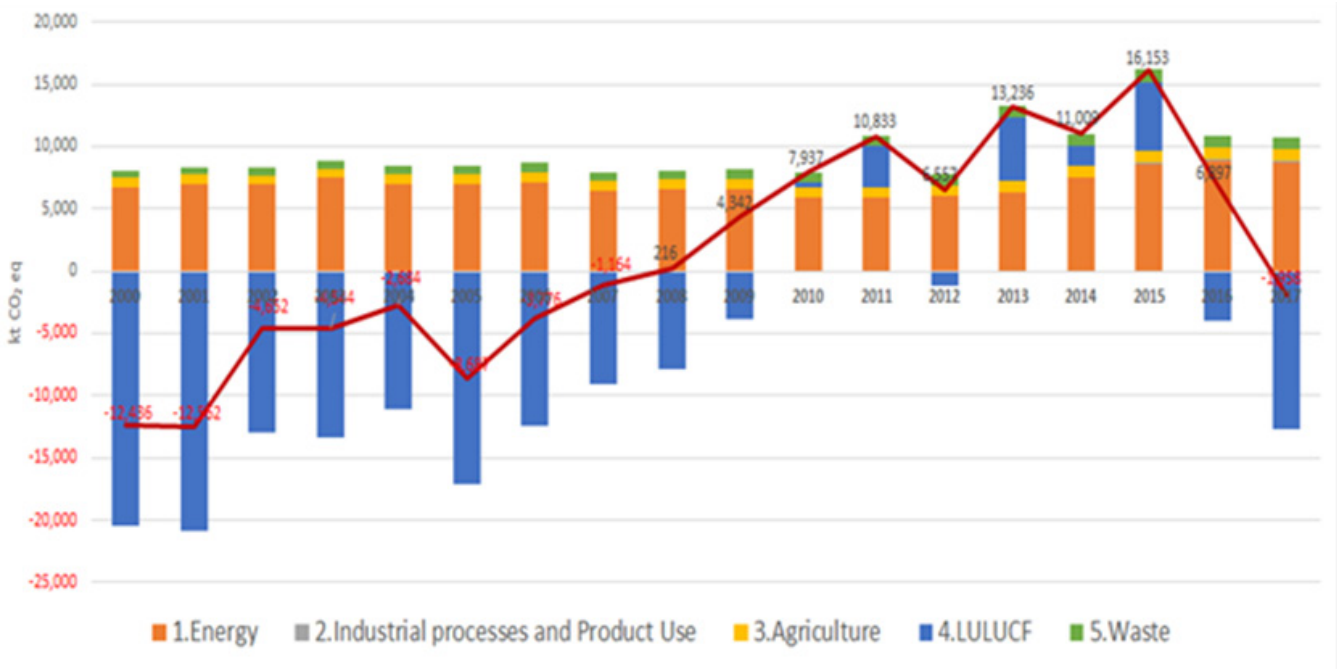


Figure 2-2: Total GHG emissions with LULUCF (in kt CO_2 eq)

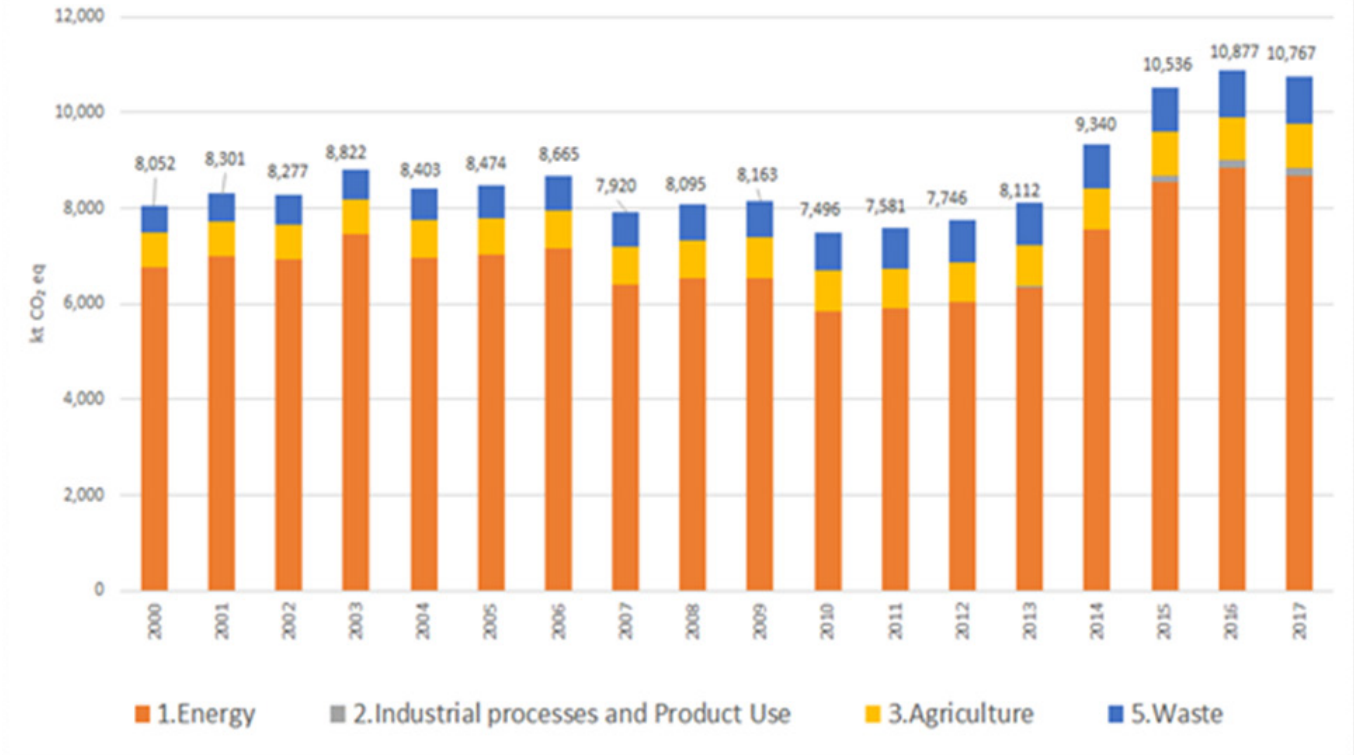


Figure 2-3 Total GHG emissions without LULUCF (in kt CO_2 eq)

Table 2-3 Trend of GHG emissions and removals

Trend by sector — unit: kt-CO_2 eq

	2000	2001	2002	2003	2004	2005	2006	2007	2008
1.Energy	6,760	6,984	6,940	7,448	6,956	7,015	7,168	6,401	6,537
2.Industrial processes and Product Use	1	1	1	2	3	3	3	3	3
3.Agriculture	732	735	731	739	785	774	786	783	795
4.LULUCF	-20,488	-20,864	-12,929	-13,366	-11,087	-17,161	-12,441	-9,083	-7,879
5.Waste	560	582	605	634	659	683	708	733	760
total (with LULUCF)	-12,436	-12,562	-4,652	-4,544	-2,684	-8,687	-3,776	-1,164	216
total (without LULUCF)	8,052	8,301	8,277	8,822	8,403	8,474	8,665	7,920	8,095

	2009	2010	2011	2012	2013	2014	2015	2016	2017
1.Energy	6,531	5,844	5,919	6,035	6,352	7,553	8,551	8,846	8,673
2.Industrial processes and Product Use	3	3	3	3	2	2	142	161	153
3.Agriculture	845	838	821	842	865	865	896	894	935
4.LULUCF	-3,821	442	3,252	-1,190	5,124	1,668	5,617	-3,981	-12,725
5.Waste	785	811	838	867	892	920	948	977	1,006
total (with LULUCF)	4,342	7,937	10,833	6,557	13,236	11,009	16,153	6,897	-1,958
total (without LULUCF)	8,163	7,496	7,581	7,746	8,112	9,340	10,536	10,877	10,767

2.3.2. Table 1/Table 2 of Decision 17/CP8 for the most recent year

Table 2-4: Total emissions for 2017

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs	PFCs	Unspecified mix of HFCs and PFCs	SF_6	NF_3	NO_x	CO	NMVOC	SO_2
	(kt)			(kt CO_2 equivalent)			(kt)					
Total national emissions and removals	-5,753.57	126.51	3.19	0.00	0.00	150.62	0.00	0.00	0.00	0.00	29.57	0.00
1. Energy	7,047.38	69.76	0.52						0.00	0.00	29.57	0.00
A. Fuel combustion	7,002.46	2.49	0.52						0.00	0.00	0.00	0.00
1. Energy industries	829.45	0.04	0.00						NE	NE	NE	NE
2. Manufacturing industries and construction	3,764.01	0.23	0.04						NE	NE	NE	NE
3. Transport	1,946.46	0.24	0.09						NE	NE	NE	NE
4. Other sectors	462.54	1.99	0.38						NE	NE	NE	NE
5. Other	NE	NE	NE						NE	NE	NE	NE
B. Fugitive emissions from fuels	44.91	67.27	0.00						0.00	0.00	29.57	0.00
1. Solid fuels	NO	NO	NO						NO	NO	NO	NO
2. Oil and natural gas and other emissions from energy production	44.91	67.27	0.00						NE	NE	29.57	NE
C. CO_2 Transport and storage												
2. Industrial processes and product use	1.75	0.00	0.00	NE	NE	150.62	NE	NE	NE	NE	NE	NE
A. Mineral industry	NE								NE	NE	NE	NE
B. Chemical industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C. Metal industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Non-energy products from fuels and solvent use	1.75	NE	NE						NE	NE	NE	NE
E. Electronic industry				NE	NE	NE	NE	NE				
F. Product uses as substitutes for ODS				NE	NE	150.62	NE	NE				
G. Other product manufacture and use	NE	NE	0.003	NE	NE	NE	NE	NE	NE	NE	NE	NE
H. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Agriculture	0.00	15.10	1.99						0.00	0.00	0.00	0.00
A. Enteric fermentation		8.23										
B. Manure management		6.87	0.06								NE	
C. Rice cultivation		NE									NE	
D. Agricultural soils		NE	1.93						NE	NE	NE	
E. Prescribed burning of savannas		IE	IE						NE	NE	NE	
F. Field burning of agricultural residues		IE	IE						NE	NE	NE	
G. Liming	NE											
H. Urea application	NE											
I. Other carbon-contining fertilizers	NO											
J. Other	NO	NO	NO						NO	NO	NO	NO
4. Land use, land-use change and forestry	-12837.68	3.74	0.11						0.00	0.00	0.00	0.00
A. Forest land	-23617.38	3.74	0.11						NE	NE	NE	
B. Cropland	9397.82	NE	NE						NE	NE	NE	
C. Grassland	323.36	NO	NO						NE	NE	NE	
D. Wetlands	NE	NE	NE						NE	NE	NE	
E. Settlements	NE	NE	NE						NE	NE	NE	
F. Other land	1058.52	NE	NE						NE	NE	NE	
G. Harvested wood products	NE											
H. Other	NE	NE	NE						NE	NE	NE	NE
5. Waste	34.99	37.91	0.57						0.00	0.00	0.00	0.00
A. Solid waste disposal	NO	12.98							NE	NE	NE	
B. Biological treatment of solid waste		0.16	0.01						NE	NE	NE	
C. Incineration and open burning of waste	34.99	0.84	0.01						NE	NE	NE	NE
D. Wastewater treatment and discharge		23.94	0.54						NE	NE	NE	
E. Other	NO	NO	NO						NO	NO	NO	NO
6. Other *(please specify)*	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

2.3.3. Key Category Assessment

A tier 1 key category analysis was conducted for the newest year (2017). Below is the result of the key category analysis carried out for all categories with and without the LULUCF categories. 19 categories were identified as key without the LULUCF categories. While 14 categories were identified as key with the LULUCF sector. The results of the key category assessments are shown below (key categories in yellow)

Table 2-5 Key category assessment without LULUCF

2006 IPCC code	category	Gas	Absolute value of 2017 emissions	Level assessment	cumulative total
1.A.2.	Manufacturing industries and construction	CO_2	3,764.01	34.96%	34.96%
1.A.3.b	Road transportation	CO_2	1,519.16	14.11%	49.07%
1.B.2.a.2	Production	CH_4	855.57	7.95%	57.01%
1.A.1.c	Manufacture of solid fuels and other energy industries	CO_2	575.45	5.34%	62.36%
3.C.4	Direct N2O emission on managed soils	N_2O	528.79	4.91%	67.27%
5.D.1	Domestic wastewater	CH_4	503.40	4.68%	71.94%
1.A.3.a	Domestic aviation	CO_2	398.14	3.70%	75.64%
1.B.2.a.2	Production	CH_4	394.87	3.67%	79.31%
1.A.4.c	Agriculture/forestry/fishing	CO_2	313.20	2.91%	82.22%
5.A.1	Unmanaged waste disposal sites	CH_4	272.55	2.53%	84.75%
3.A.1	Enteric fermentation	CH_4	172.92	1.61%	86.36%
5.D.1	Domestic wastewater	N_2O	167.83	1.56%	87.91%
2.F.1	Refrigeration and air conditioning	HFC	150.62	1.40%	89.31%
3.A.2	Manure management	CH_4	144.28	1.34%	90.65%
1.A.1.a	Public electricity and heat production	CO_2	131.53	1.22%	91.88%
1.A.1.b	Petroleum refining	CO_2	122.46	1.14%	93.01%
1.A.4.b	Residential	CO_2	89.53	0.83%	93.84%
3.C.5	Indirect N2O emission on managed soils	N_2O	70.09	0.65%	94.49%
1.A.4.b	Residential	N_2O	69.27	0.64%	95.14%
1.A.4.a	Commercial/institutional	CO_2	59.81	0.56%	95.69%
1.B.2.b.3	Processing	CH_4	55.45	0.51%	96.21%
1.B.2.b.4	Transmission and storage	CH_4	47.34	0.44%	96.65%
1.A.4.c	Agriculture/forestry/fishing	N_2O	37.49	0.35%	97.00%
1.A.4.b	Residential	CH_4	35.16	0.33%	97.32%
5.C.2	Open burning of waste	CO_2	34.99	0.32%	97.65%
1.B.2.c.i	Oil	CO_2	30.40	0.28%	97.93%
1.A.3.d	Domestic navigation	CO_2	29.15	0.27%	98.20%
1.B.2.c.ii	Gas	CH_4	27.51	0.26%	98.46%
1.A.3.b	Road transportation	N_2O	24.06	0.22%	98.68%
1.B.2.b.5	Distribution	CH_4	19.01	0.18%	98.86%
5.C.2	Open burning of waste	CH_4	17.68	0.16%	99.02%
3.A.2	Manure management	N_2O	14.41	0.13%	99.15%
1.A.4.a	Commercial/institutional	N_2O	12.30	0.11%	99.27%
1.A.2.	Manufacturing industries and construction	N_2O	12.03	0.11%	99.38%
1.B.2.c.ii	Gas	CO_2	11.86	0.11%	99.49%
1.B.2.c.i	Oil	CH_4	11.25	0.10%	99.60%
1.A.4.a	Commercial/institutional	CH_4	6.22	0.06%	99.65%
1.A.3.b	Road transportation	CH_4	4.93	0.05%	99.70%
1.A.2.	Manufacturing industries and construction	CH_4	4.75	0.04%	99.74%
3.C.6	Indirect N2O emissions from manure management	N2O	4.26	0.04%	99.78%
5.C.2	Open burning of waste	N_2O	3.73	0.03%	99.82%
5.B.1	Composting	N_2O	3.61	0.03%	99.85%
1.A.3.a	Domestic aviation	N_2O	3.45	0.03%	99.88%
5.B.1	Composting	CH_4	3.26	0.03%	99.91%
2.D.1	Lubricant use	CO_2	1.75	0.02%	99.93%
1.B.2.a.2	Production	CO_2	1.35	0.01%	99.94%
1.A.1.c	Manufacture of solid fuels and other energy industries	N_2O	0.99	0.01%	99.95%
2.G.3	N2O from product uses	N_2O	0.93	0.01%	99.96%
1.B.2.b.3	Processing	CO_2	0.84	0.01%	99.97%
1.B.2.a.4	Refining/storage	CH_4	0.76	0.01%	99.97%
1.A.1.c	Manufacture of solid fuels and other energy industries	CH_4	0.56	0.01%	99.98%
1.B.2.c.i	Oil	CH_4	0.39	0.00%	99.98%
1.A.4.c	Agriculture/forestry/fishing	CH_4	0.37	0.00%	99.99%
1.A.1.b	Petroleum refining	N_2O	0.37	0.00%	99.99%
1.B.2.b.2	Production	CO_2	0.32	0.00%	99.99%
1.B.2.a.3	Transport	CH_4	0.26	0.00%	100.0%
1.A.3.d	Domestic navigation	N_2O	0.23	0.00%	100.0%
1.B.2.c.ii	Gas	CH_4	0.16	0.00%	100.0%
1.B.2.c.i	Oil	N_2O	0.15	0.00%	100.0%
1.A.1.b	Petroleum refining	CH_4	0.12	0.00%	100.0%
1.A.1.a	Public electricity and heat production	N_2O	0.12	0.00%	100.0%
1.B.2.c.	Venting	CO_2	0.09	0.00%	100.0%
1.A.1.a	Public electricity and heat production	CH_4	0.08	0.00%	100.0%
1.B.2.c.i	Oil	CO_2	0.07	0.00%	100.0%
1.A.3.a	Domestic aviation	CH_4	0.06	0.00%	100.0%
1.B.2.c.ii	Gas	N_2O	0.06	0.00%	100.0%
1.A.3.d	Domestic navigation	CH_4	0.06	0.00%	100.0%
1.B.2.b.5	Distribution	CO_2	0.05	0.00%	100.0%
1.B.2.c.ii	Gas	CO_2	0.02	0.00%	100.0%
1.B.2.b.4	Transmission and storage	CO_2	0.01	0.00%	100.0%
1.B.2.a.3	Transport	CO_2	0.00	0.00%	100.0%

Table 2-6 Key category assessment with LULUCF

2006 IPCC code	category	Gas	2017 values	Absolute value of 2017 emissions	Level assessment	cumulative total
3.B.1	Forest land remaining forest land	CO_2	-23617.38	23,617.38	52.16%	52.16%
3.B.2.b	Land converted to cropland	CO_2	8493.36	8,493.36	18.76%	70.92%
1.A.2.	Manufacturing industries and construction	CO_2	3764.01	3,764.01	8.31%	79.23%
1.A.3.b	Road transportation	CO_2	1519.16	1,519.16	3.36%	82.59%
3.B.5	Settlements	CO_2	1058.52	1,058.52	2.34%	84.93%
3.B.2.a	Cropland remaining cropland	CO_2	904.46	904.46	2.00%	86.92%
1.B.2.a.2	Production	CH_4	855.57	855.57	1.89%	88.81%
1.A.1.c	Manufacture of solid fuels and other energy industries	CO_2	575.45	575.45	1.27%	90.09%
3.C.4	Direct N2O emission on managed soils	N_2O	528.79	528.79	1.17%	91.25%
5.D.1	Domestic wastewater	CH_4	503.40	503.40	1.11%	92.37%
1.A.3.a	Domestic aviation	CO_2	398.14	398.14	0.88%	93.24%
1.B.2.a.2	Production	CH_4	394.87	394.87	0.87%	94.12%
3.B.3	Grassland	CO_2	323.36	323.36	0.71%	94.83%
1.A.4.c	Agriculture/forestry/fishing	CO_2	313.20	313.20	0.69%	95.52%
5.A.1	Unmanaged waste disposal sites	CH_4	272.55	272.55	0.60%	96.12%
3.A.1	Enteric fermentation	CH_4	172.92	172.92	0.38%	96.51%
5.D.1	Domestic wastewater	N_2O	167.83	167.83	0.37%	96.88%
2.F.1	Refrigeration and air conditioning	HFC	150.62	150.62	0.33%	97.21%
3.A.2	Manure management	CH_4	144.28	144.28	0.32%	97.53%
1.A.1.a	Public electricity and heat production	CO_2	131.53	131.53	0.29%	97.82%
1.A.1.b	Petroleum refining	CO_2	122.46	122.46	0.27%	98.09%
1.A.4.b	Residential	CO_2	89.53	89.53	0.20%	98.29%
3.C.1.a	Emissions from biomass burning in forest land	CH_4	78.61	78.61	0.17%	98.46%
3.C.5	Indirect N2O emission on managed soils	N_2O	70.09	70.09	0.15%	98.62%
1.A.4.b	Residential	N_2O	69.27	69.27	0.15%	98.77%
1.A.4.a	Commercial/institutional	CO_2	59.81	59.81	0.13%	98.90%
1.B.2.b.3	Processing	CH_4	55.45	55.45	0.12%	99.02%
1.B.2.b.4	Transmission and storage	CH_4	47.34	47.34	0.10%	99.13%
1.A.4.c	Agriculture/forestry/fishing	N_2O	37.49	37.49	0.08%	99.21%
1.A.4.b	Residential	CH_4	35.16	35.16	0.08%	99.29%
5.C.2	Open burning of waste	CO_2	34.99	34.99	0.08%	99.37%
3.C.1.a	Prescribed burning of Forest	N_2O	34.13	34.13	0.08%	99.44%
1.B.2.c.i	Oil	CO_2	30.40	30.40	0.07%	99.51%
1.A.3.d	Domestic navigation	CO_2	29.15	29.15	0.06%	99.57%
1.B.2.c.ii	Gas	CH_4	27.51	27.51	0.06%	99.63%
1.A.3.b	Road transportation	N_2O	24.06	24.06	0.05%	99.69%
1.B.2.b.5	Distribution	CH_4	19.01	19.01	0.04%	99.73%
5.C.2	Open burning of waste	CH_4	17.68	17.68	0.04%	99.77%
3.A.2	Manure management	N_2O	14.41	14.41	0.03%	99.80%
1.A.4.a	Commercial/institutional	N_2O	12.30	12.30	0.03%	99.83%
1.A.2.	Manufacturing industries and construction	N_2O	12.03	12.03	0.03%	99.85%
1.B.2.c.ii	Gas	CO_2	11.86	11.86	0.03%	99.88%
1.B.2.c.i	Oil	CH_4	11.25	11.25	0.02%	99.90%
1.A.4.a	Commercial/institutional	CH_4	6.22	6.22	0.01%	99.92%
1.A.3.b	Road transportation	CH_4	4.93	4.93	0.01%	99.93%
1.A.2.	Manufacturing industries and construction	CH_4	4.75	4.75	0.01%	99.94%
3.C.6	Indirect N2O emissions from manure management	N_2O	4.26	4.26	0.01%	99.95%
5.C.2	Open burning of waste	N_2O	3.73	3.73	0.01%	99.96%
5.B.1	Composting	N_2O	3.61	3.61	0.01%	99.96%
1.A.3.a	Domestic aviation	N_2O	3.45	3.45	0.01%	99.97%
5.B.1	Composting	CH_4	3.26	3.26	0.01%	99.98%
2.D.1	Lubricant use	CO_2	1.75	1.75	0.00%	99.98%
1.B.2.a.2	Production	CO_2	1.35	1.35	0.00%	99.99%
1.A.1.c	Manufacture of solid fuels and other energy industries	N_2O	0.99	0.99	0.00%	99.99%
2.G.3	N2O from product uses	N_2O	0.93	0.93	0.00%	99.99%
1.B.2.b.3	Processing	CO_2	0.84	0.84	0.00%	99.99%
1.B.2.a.4	Refining/storage	CH_4	0.76	0.76	0.00%	99.99%
1.A.1.c	Manufacture of solid fuels and other energy industries	CH_4	0.56	0.56	0.00%	100.00%
1.B.2.c.i	Oil	CH_4	0.39	0.39	0.00%	100.00%
1.A.4.c	Agriculture/forestry/fishing	CH_4	0.37	0.37	0.00%	100.00%
1.A.1.b	Petroleum refining	N_2O	0.37	0.37	0.00%	100.00%
1.B.2.b.2	Production	CO_2	0.32	0.32	0.00%	100.00%
1.B.2.a.3	Transport	CH_4	0.26	0.26	0.00%	100.00%
1.A.3.d	Domestic navigation	N_2O	0.23	0.23	0.00%	100.00%
1.B.2.c.ii	Gas	CH_4	0.16	0.16	0.00%	100.00%
1.B.2.c.i	Oil	N_2O	0.15	0.15	0.00%	100.00%
1.A.1.b	Petroleum refining	CH_4	0.12	0.12	0.00%	100.00%
1.A.1.a	Public electricity and heat production	N_2O	0.12	0.12	0.00%	100.00%
1.B.2.c.	Venting	CO_2	0.09	0.09	0.00%	100.00%
1.A.1.a	Public electricity and heat production	CH_4	0.08	0.08	0.00%	100.00%
1.B.2.c.i	Oil	CO_2	0.07	0.07	0.00%	100.00%
1.A.3.a	Domestic aviation	CH_4	0.06	0.06	0.00%	100.00%
1.B.2.c.ii	Gas	N_2O	0.06	0.06	0.00%	100.00%
1.A.3.d	Domestic navigation	CH_4	0.06	0.06	0.00%	100.00%
1.B.2.b.5	Distribution	CO_2	0.05	0.05	0.00%	100.00%
1.B.2.c.ii	Gas	CO_2	0.02	0.02	0.00%	100.00%
1.B.2.b.4	Transmission and storage	CO_2	0.01	0.01	0.00%	100.00%
1.B.2.a.3	Transport	CO_2	0.00	0.00	0.00%	100.00%

2.3.4. General Uncertainty Assessment

A tier 1 uncertainty analysis was conducted for the newest year which is 2017 and all uncertainties were taken from the 2006 IPCC Guidelines. The total uncertainty in 2017 is 259% which is quite high and the largest uncertainty comes from fugitive emissions and domestic waste water. Detailed results are captured in the National Inventory Report.

2.4. Sectors

2.4.1. Energy

2.4.1.1. **Overview**

Emissions from the energy sector consist of two main categories: fuel combustion (1.A.), and fugitive emissions from fuels (1.B.). Fuel combustion includes emissions released into the atmosphere when fossil fuels (e.g., coal, oil products, and natural gas) are combusted. Fugitive emissions are intentional or unintentional releases of gases from fossil fuels by anthropogenic activities.

In PNG, fossil fuels are used to produce energy for a wide variety of purposes (e.g., energy industry, transportation, and manufacturing) and CO_2 (Carbon Dioxide), CH_4 (Methane), N_2O (Nitrous Oxide) are emitted in the process. PNG also produces oil and gas including refining of petroleum products which leads to fugitive emissions of CO_2, CH_4 and N_2O.

Emissions from the energy sector amounted to 8,673 kt CO_2 eq in 2017, an increase of 1,913 kt CO_2 eq (28 %) when compared to 2000. The CO_2 from liquid fuel combustion contributed 68 % to the total GHG emissions in 2017, followed by CH_4 from fugitives (16 %), CO_2 from gaseous fuel combustion (12 %), N_2O from fuel combustion (2%), CH_4 from fuel combustion (1%) and CO_2 from fugitive emissions (1%). 81 % of total sector emissions are CO_2, while CH_4 contributed 17 % and N_2O 2%. In PNG, the consumption of solid fuel and other fossil fuels has not been reported, so their emissions are reported as "NO", which means no emission activity is occurring. All activities with a value of 0 in the energy balance table are reported as "NO".

The decreasing GHG emissions trend between 2006 and 2013 is due to the decrease in oil production in the country. The increasing GHG emissions trend between 2000-2003 is due to increasing energy demand and an increase in oil production. Furthermore, the increase in GHG emissions between 2014 to 2017 is due to the increase in energy demand and increase in the production of Liquid Natural Gas.

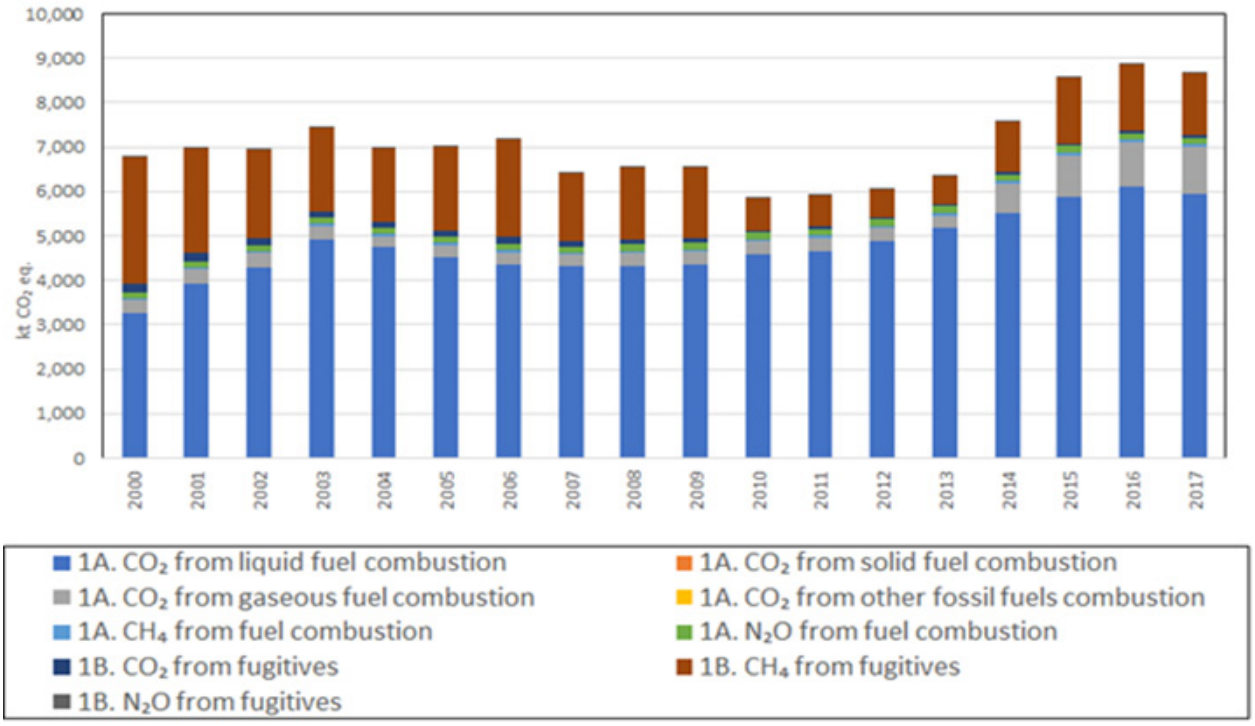


Figure 2-4 Time-series of total GHG emissions from the energy sector by category (in kt CO_2 eq)

2.4.1.2. **Reference versus Sectoral Approaches for Estimating the CO_2 Emissions Level**

The reference approach is to calculate the CO_2 emissions from combustion, using a country's energy supply data. The CO_2 emissions estimated by the reference approach are not included in the national total and used for verification purpose.
The graph below shows the estimated emissions using the reference approach and sectoral approach.

The estimate of CO_2 emissions showed that the estimations using reference approach balances with the estimation from the sectoral approach. In 2004 there was a high discrepancyy of 16% and was due to the statistical discrepancy in crude oil data. For years after 2005, CO_2 level discrepancies ranged from -2% to 6%.

Figure 2-5: Time-series of reference versus sectoral approach (in %)

2.4.1.3. Tiers, Methods, source of activity data, emission factors

GHG emissions presented in the GHG emissions inventory were estimated using Tier 1 method of IPCC 2006 GL with default value emission factors. The activity data was taken exclusively from the Energy Balance Table developed by the APERC and converted from one energy unit (ktoe) to another (TJ). All GHG estimations were carried out using Microsoft Excel Spread Sheets.

2.4.1.4. Improvements made, challenges, areas for further improvement in the future

The following improvements were made in the Energy sector compared to the BUR1:

- Updated APEC energy balance table for 2000-2017 was used;
- Non energy use of fuels has been reflected;
- Emissions from auto production have been correctly allocated to manufacturing industries (correction of BUR1);
- NMVOC emissions have been estimated for fugitive emissions.

In this inventory the Energy Sector has the following challenges:

- Lack of a national energy balance table;
- Inability to disaggregate activity data into specific categories under the manufacturing industries and construction as well as international transport; and
- Lack of country specific emission factors

This may be improved by contacting the relevant stakeholder to check whether there is available data.

2.4.2. Industrial Process and Other Product Use (IPPU)

2.4.2.1. Overview

PNG's economy is dominated by resources, agriculture, forestry and fishing, and also includes a small import-substituting manufacturing sector. A number of these activities involve an industrial process or a product use that result in GHG emissions including lubricant use (2.D.1) and refrigeration and air-conditioning (2.F.1). A number of import-substituting manufacturing result in the emission of non-GHGs (CO, NOx, NMVOC) and include food, beverage and tobacco manufacturing. The import of N_2O used in products (2.G.3) also gives rise to GHG emissions.

Total GHG emissions in the IPPU sector for the latest inventory (2017) are estimated to be 153.3 kt CO_2 eq which is about 1% of the national total GHG emissions (excluding LULUCF). The relative contribution of individual GHGs is 1% (CO_2), 98% (HFC) and 1% (N_2O). This ratio is largely consistent through the time series with exception to HFCs that are estimated only for years 2015 through to 2017. It is acknowledged that the IPPU inventory remains largely incomplete.

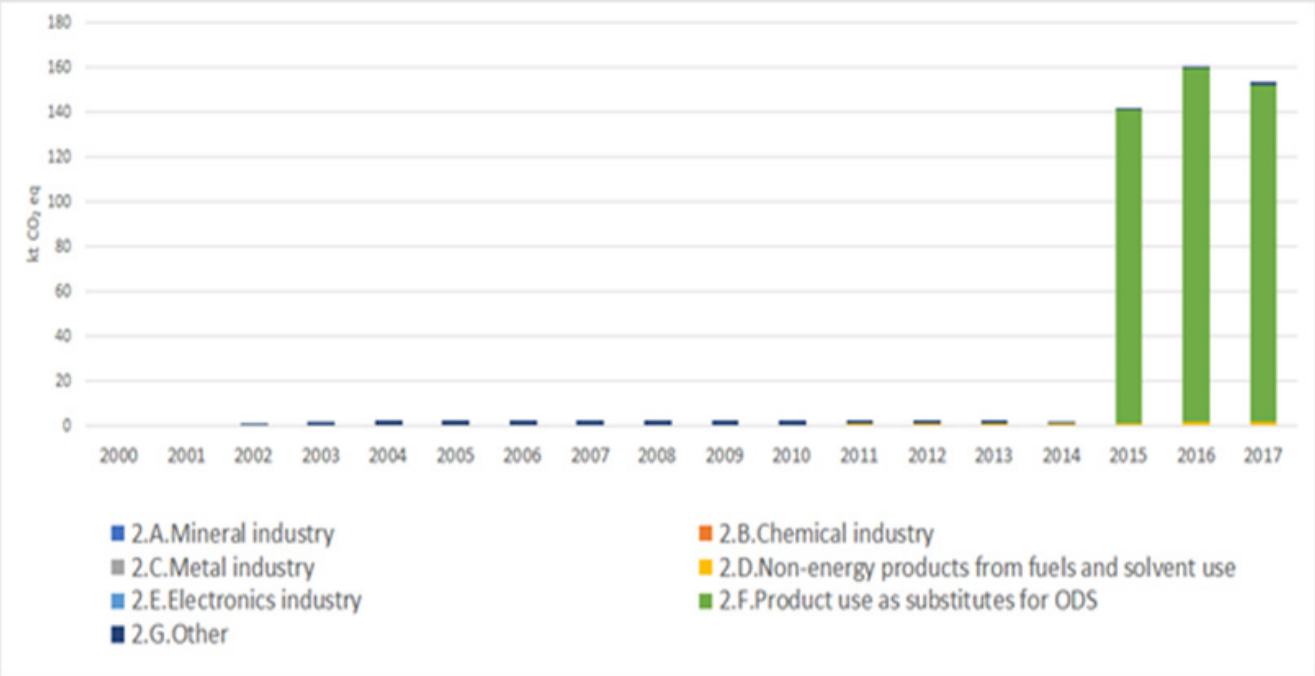


Figure 2-6 Time series of GHG emissions from the IPPU sector (in kt CO_2 eq)

2.4.2.2. Tiers, Methods, source of activity data, emission factors

Tier 2 methodology was used for HFC emissions from product use as substitutes for ODS. For other categories, the tier 1 method was used with default emissions factors.

2.4.2.3. Improvements made, challenges, areas for further improvement in the future

CCDA has included HFC emissions for the first time in the GHG inventory. These emissions are estimated on the basis of the quantities of bulk HFCs imported into PNG. Further improvement is required to estimate emissions by end-use which requires data on pre-charged equipment type and the 'refrigerant bank'. CCDA will collaborate with CEPA and PNG Customs to establish a data framework to provide the data and information necessary to provide end-use emissions of fluorinated gases.

2.4.3. Agriculture

GHG emissions from the agricultural sector are generally linked to the management of agricultural soils, livestock, rice production and biomass burning. The main agricultural sources of GHG emissions are the following:

- enteric fermentation, part of the digestive process for many ruminants such as cattle, sheep and goats, which produces methane (CH_4) emissions;
- soil nitrification and denitrification, which produces nitrous oxide (N_2O) emissions; and
- manure decomposition, which produces both methane and nitrous oxide emissions.

In general, GHG emissions from agriculture are influenced by a number of factors such as farm management practices and trends in the number of ruminant animals.

2.4.3.1. Overview

GHG emissions from the agriculture sector amounted to 935 kt CO_2 eq in 2017 which is about 9 % cent of the country's overall emission in that year (excluding LULUCF). Total GHG emissions increased by 203 kt CO_2 eq (28 %) in 2017 when compared with year 2000. The highest emitting category in 2017 was direct N_2O emissions from managed soils (3.C.4) which contributed 57 % of the total sector emissions. After this is the enteric fermentation (3.A.1) category which contributed 18 %, followed by manure management (3.A.2) with 17 % and indirect N_2O emissions from managed soils (3.C.5) with about 7 %. The least emitting category in the agriculture sector is indirect N_2O emissions from manure management (3.C.6). The following emitting sub categories with associated gas were included in the estimation:

- 3.A.1 Enteric fermentation (CH_4)
- 3.A.2 Manure management (CH_4 and N_2O)
- 3.C.4 Direct N_2O emissions from managed soils

(N2O)

- 3.C.5 Indirect N_2O emissions from managed soils (N_2O)
- 3.C.6 Indirect manure management (N_2O)

Biomass burning in forest (3.C.1) is captured under the LULUCF sector emissions and thus not included in the Agriculture emission totals.

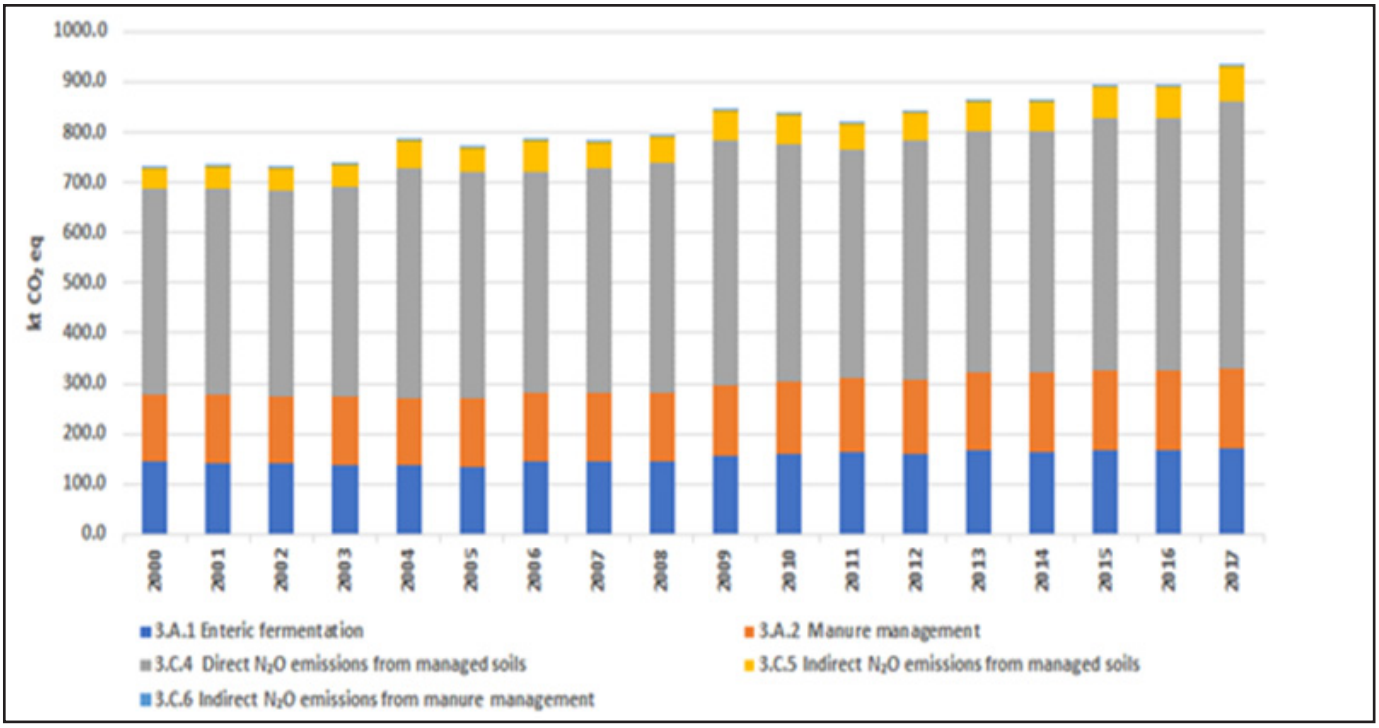


Figure 2-7 Time series of GHG emissions from the agriculture sector

GHG emitting categories with a limited availability of activity data for calculation such as liming and urea application were not included in the GHGI estimation. The category rice cultivation was assumed to be not source of methane since cultivated in upland and without the irrigation practice of flooding.

2.4.3.2. Tiers, Methods, source of activity data, emission factors

GHG emissions for the agriculture sector have been estimated using Tier 1 method of the IPCC 2006 GL. The use of the 2006 IPCC guidelines was to ensure that the GHG emission estimates were as much as transparent, complete, consistent and accurate (TCCCA) through time and comparable with those inventories produced in other countries with similar national circumstances. Default emission factors and other parameters were taken from IPCC 2006 GL when possible.

The inventory was prepared using data from a combination of sources namely national and international institutions. During the inventory data collection, priority was given to data that have been generated in the country. In cases where the required data were not available in the country, the data from international organizations such as FAO were used.

The activity data values used for the categories enteric fermentation and manure management were country specific. Data on mules, asses and buffaloes were not reported since the amount of these animal species is not relevant in the country. Up to 80 % of the livestock data were collected or provided by the National Department of Agriculture and Livestock (DAL) through the four regional offices. The remaining 20 percent were collected or provided by the private sector, particularly the private agriculture business industries. For the years 2000 to 2015 the same data used for the BUR1 was also used but the years 2016 and 2017 the data was extrapolated using the trend extrapolation method. This is because updated data for 2016 and 2017 wasn't available from the data source.

In the context of the manure management, the availability of information on different manure management systems (MMS) used in the country as well as on the fraction of the manure in MMS was very limited. For the latter, default parameter in the IPCC 2006 GL were used. Some expert judgment was also necessary to complete the estimation of GHG emissions for this category.

Some activity data for managed soil which includes synthetic fertilizers, annual crop area harvested and crop production data was taken from FAOSTAT database because data were not available at a national level. The crops include rice, maze, cassava, potato, sweet potato, taro, yam and sugar cane.

Data on cultivated areas of organic soil has been taken from the Collect Earth assessment and are the same data used in the LULUCF sector.

Emissions from rice cultivation were not included for this BUR2 because from the BUR1 experts stated that, in general, rice fields in the country are not flooded or are cultivated in uplands. In fact, methane emissions are produced when rice fields are flooded during cultivation.

Livestock data collected by the country were available on hard copy only. FAO provided support to the country to digitalize the data, facilitating then their analysis as well as the archiving.

As per a quality assurance (QA) procedure, national livestock data were compared with data of FAOSTAT Database and numerous differences were highlighted. FAOSTAT data derive from questionnaires compiled directly by the countries and discrepancies between these two data sources will require further investigation. A summary of collected activity data and relative sources and gaps are reported in the table below.

Table 2-7 Summary of collected activity data and relative sources and gaps is reported

Category codes	GHG source/sink category	Data type	Data source	Gaps and constraints
3.A.1-3.A.2	• Enteric fermentation • Manure management	• Animal population • MMS • Fractions of manure in MMS	• DAL • Private sector (Trukai Industries , Ramu Agri - Industry Limited, Zenag Chickens, Niugini Table Birds, Rumion (Leron) Piggery and New Britain Palm Oil Limited)	• Large difference with FAOSTAT livestock figures • Unavailability of data from national data providers • Data collection design
3.C.2-3.C.3	• Urea application and Liming	• Urea and Lime application	None	• National data availability
3.C.4-3.C.5	• Direct and indirect N_2O emissions from managed soils	• Synthetic N fertilizer consumption • Organic fertilizers • Crop production • urine and dung N deposited by grazing animals	• FAOSTAT • PNGFA (Collect Earth) (for Cultivation OS) • Livestock data estimated from 3A1 and 3A2	• Fertilizer consumption data • Mineral soils data • Other N sources of organic fertilizers.
3.C.6	• Indirect N_2O emissions from manure management	Same as 3.A-1/2	Same as 3.A-1/2	Same as 3.A.1/2

2.4.3.3. Improvements made, challenges, areas for further improvement in the future

Due to the COVID 19 pandemic restrictions which prevented data collection activities not much improvements were made on data accuracy for this BUR2 compared to the BUR1. Some improvements were made on managed soils which involves the inclusion of significant crops grown in PNG including potato, sweet potato, yam, taro and cassava. Though this data was from the FAOSTAT.

Some improvements were also made on the methodology applied, including the choice of emission factors and other relevant parameters, have been clearly documented, with a consequent increase of transparency of the overall process. Other improvements were also done on the estimation files.

Data collection for the agriculture sector has been major challenge to the inventory compilers in previous and current inventories due to unavailability of data and proper data management systems in place, despite large evidence of agriculture activities occurring in the country. The other challenge encountered was data accessibility from the private agriculture business industries due to their data confidentiality company policies, which became a constraint in collecting reliable data needed for GHGI. Accessing reliable data from one province to another was difficult due to geographical and transport constraints. Reaching the various locations to collect data involved a lot of cost and that was seen as a barrier that hindered effective and reliable data collection. Moreover, the absence of a national policy on data management for all sectors through the responsible agencies in managing relevant data is a real limit for the inventory compilers.

Despite of the constraints and challenges, the CCDA officers in collaboration with the funding and technical support from the FAO successfully covered almost all sector emissions categories. Nonetheless, there is still room for more improvement of the estimation of emissions from agricultural sector. In particular, big effort should be dedicated to the collection of all for urea and liming in which estimation from this sub category are not included in the BUR1 and BUR2.

In addition to this, missing data has to be collected for managed soils such as such as mineral soils and other sources of organic fertilizers. Also, country specific data for managed soils that for this inventory have been taken from FAOSTAT. Awareness and consultation workshops as well as agreed technical support to data providers is necessary for the development of a national statistical system from which the GHGI can benefit.

2.4.4. LULUCF

The Land Use Land-Use Change and Forest (LULUCF) sector contains the emissions and removals from carbon stock changes due to land uses and forest management in the country. The land use categories to be estimated are forest land (3.B.1), cropland (3.B.2), grassland (3.B.3), wetlands (3.B.4), settlements (3.B.5), and other land (3.B.6). Non-CO_2 emissions from biomass burning (3.C.1) in forest land are also included under this sector. The following subsections provide the details on the general emissions and removals of the sector, the methodologies and data and the future improvements to the sector.

2.4.4.1. **Overview**

The LULUCF sector in the country is the biggest sector among all sectors. Historically, this sector acted as a sink. However, over time, the sector has evolved into a smaller sink due to a decrease in forest lands because of increased logging and agriculture activities. In the years 2011, 2013, 2014 and 2015 the LULUCF sector was a net source. Then in 2016 and 2017 the LULUCF sector became a net sink due to the increase in forest lands because of a decrease in logging and agriculture activities.

Most of the emissions in the LULUCF sector in the country occurred when forest changed to degraded and deforested. The annual area of forest degradation (primary forest becoming degraded forest) increased more than two-fold from 2001 (87,618 ha) to 2011 (200,052 ha) then slightly decreased in subsequent years (figure 2-8). Area of deforestation also significantly increased during the reporting period. Average annual area of deforestation between 2011 and 2015 (30,667 ha) was more than three times higher than the average between 2001 and 2005. Logging was the major driver of forest degradation responsible for up to 90% of the degradation occurred during the reporting period. Almost the entire (99.3%) of deforestation of this change was due to land use conversion from forest land to cropland. Subsistence agriculture is the most significant (69.8%) driver of deforestation followed by oil palm plantation development (24.4%). For 2016 and 2017 there was a slow down on logging activities or forest degradation (forest land converted to other land use) due to policy intervention on the cancellation of Special Agriculture Business Leases.

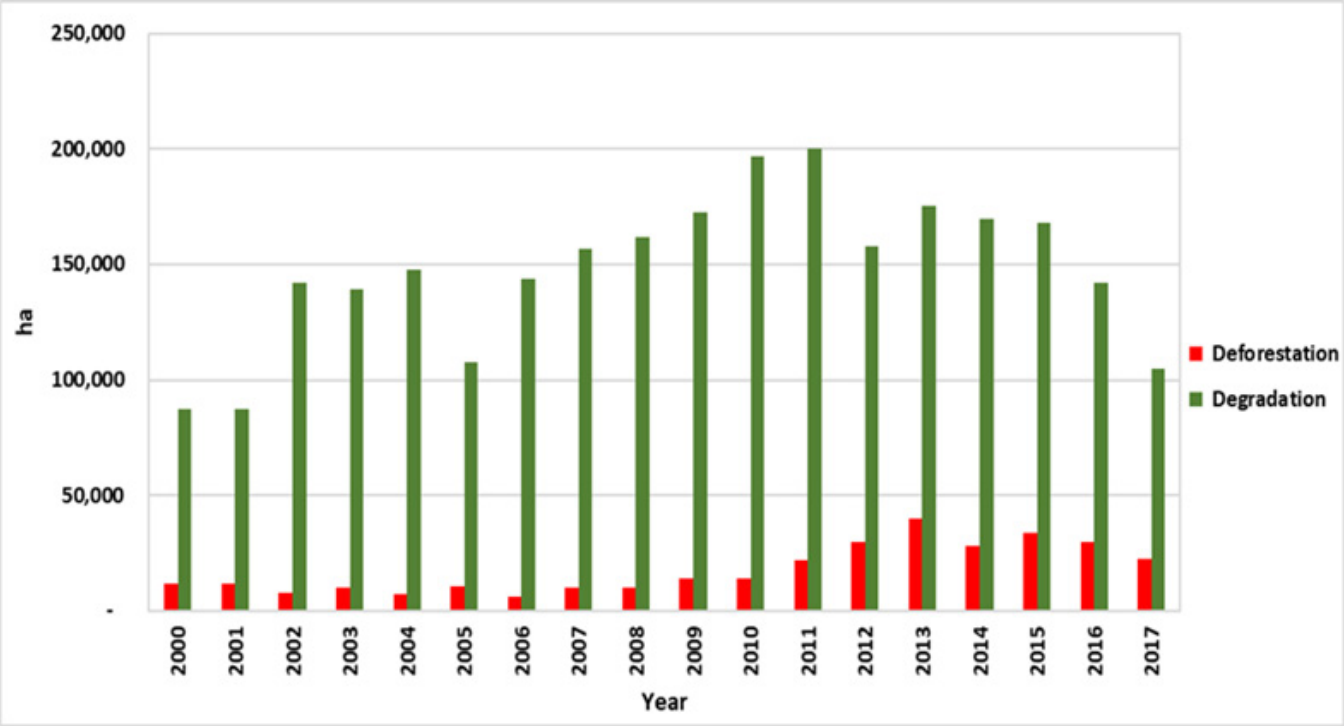


Figure 2-8 Annual area of deforestation and forest degradation in PNG from 2000 to 2017 (in ha)

The net emissions from the LULUCF sector amounted to -12,724.94 kt CO_2 eq in 2017 compared to -20,488.12 kt CO_2 eq in 2000 which is a total decrease of removals amounting to −7, 763.18 kt CO_2 eq. This come back is after it reached 5,617.42 kt CO_2 eq in 2015.Removals are decreasing since these are applied to the area of degraded forest directly taken from the Collect Earth assessment, for which each next year an area deforested is lost. For forest that is degraded during the reference level period, the consistency with FRL is maintained since the net of losses from disturbance and gains from subsequent recovery are reflected in the emission factor, reflecting long term average carbon loss.

Gross emissions from LULUCF, which are mainly coming from cropland (forest land converted to cropland), amounted to 9,397.82 kt CO_2 eq in 2017 and are almost 2 times higher than the emissions in 2000, which amounted to 5,886.90 kt CO_2 eq. Figure 2-9 showcases the trend of increasing emissions and decreasing removals over time.

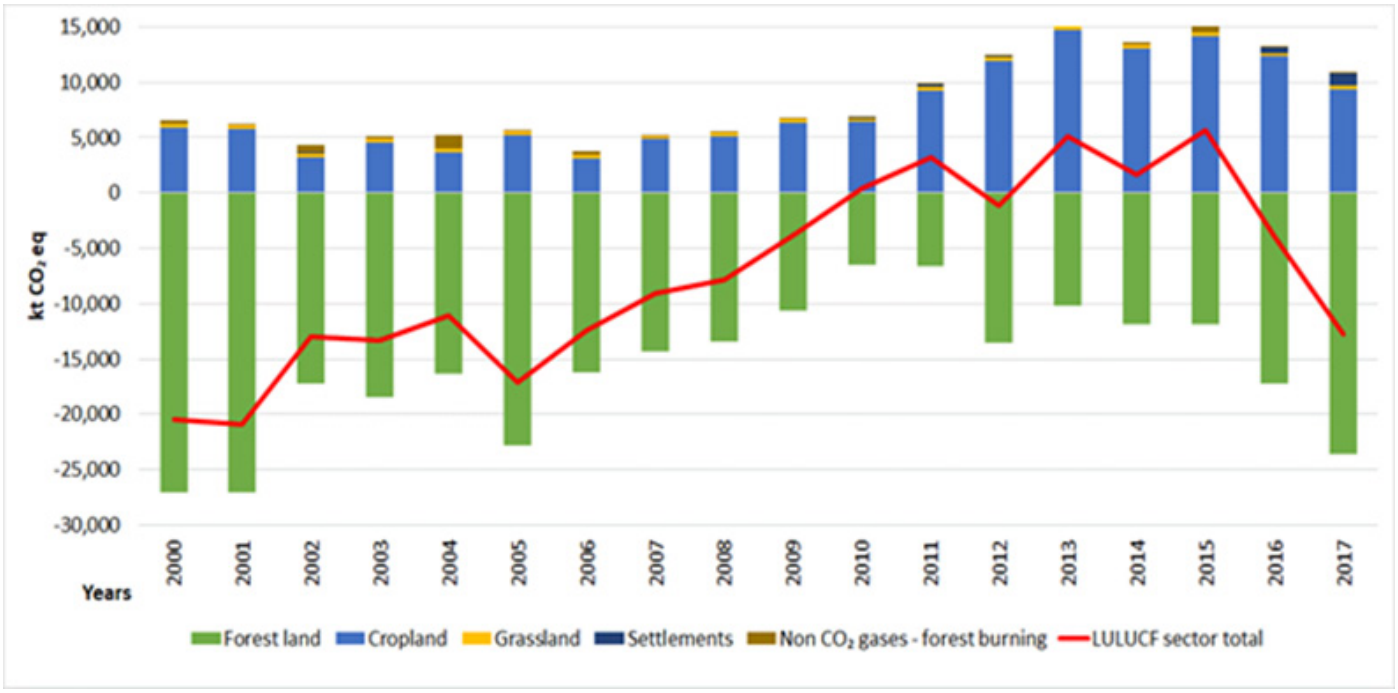


Figure 2-9 Time-series of total GHG emissions and removals from the LULUCF sector by category (in kt CO_2 eq)

The category cropland (3.B.2) contributed 86 % to the total sector gross emission in 2017, followed by settlements (3.B.5) with 10% and the category grassland with 3 %. Emissions from Non-CO_2 from forest burning (3.C.1.a) is 1% of the total gross emissions. Non-CO_2 gases include biomass burning in forest land. Most emissions in forest land (3.B.1), cropland (3.B.2) and grassland (3.B.3) are from losses of above ground and below ground biomass and all removals in forest land (3.B.1) are from gains of below and above ground biomass. In the case of a land conversion from forest land to any other land, emissions are also estimated for loss of dead organic matter. Emissions from organic soils are estimated for grassland (grassland remaining grassland (3.B.3.a), cropland (Cropland remaining cropland (3.B.2.a) and for degraded forest lands (forest land remaining forest land (3.B.1.a). There was no deforestation on organic soils, so therefore those emissions are zero.

Figure 2-10 Shows the total net emissions/removals by gas. The figure shows that CO_2 turned from a net sink into a net source between 2000 and 2015 and that they are significantly larger than the emissions from CH_4 and N_2O. CO_2 then became a net sink between 2016 and 2017. From the absolute emissions and removals in 2017 in the LULUCF sector 75 % are CO_2 gas from forest land use and land use change, whereas 17 % is CH_4 and 8 % is N_2O gases from forest burning.

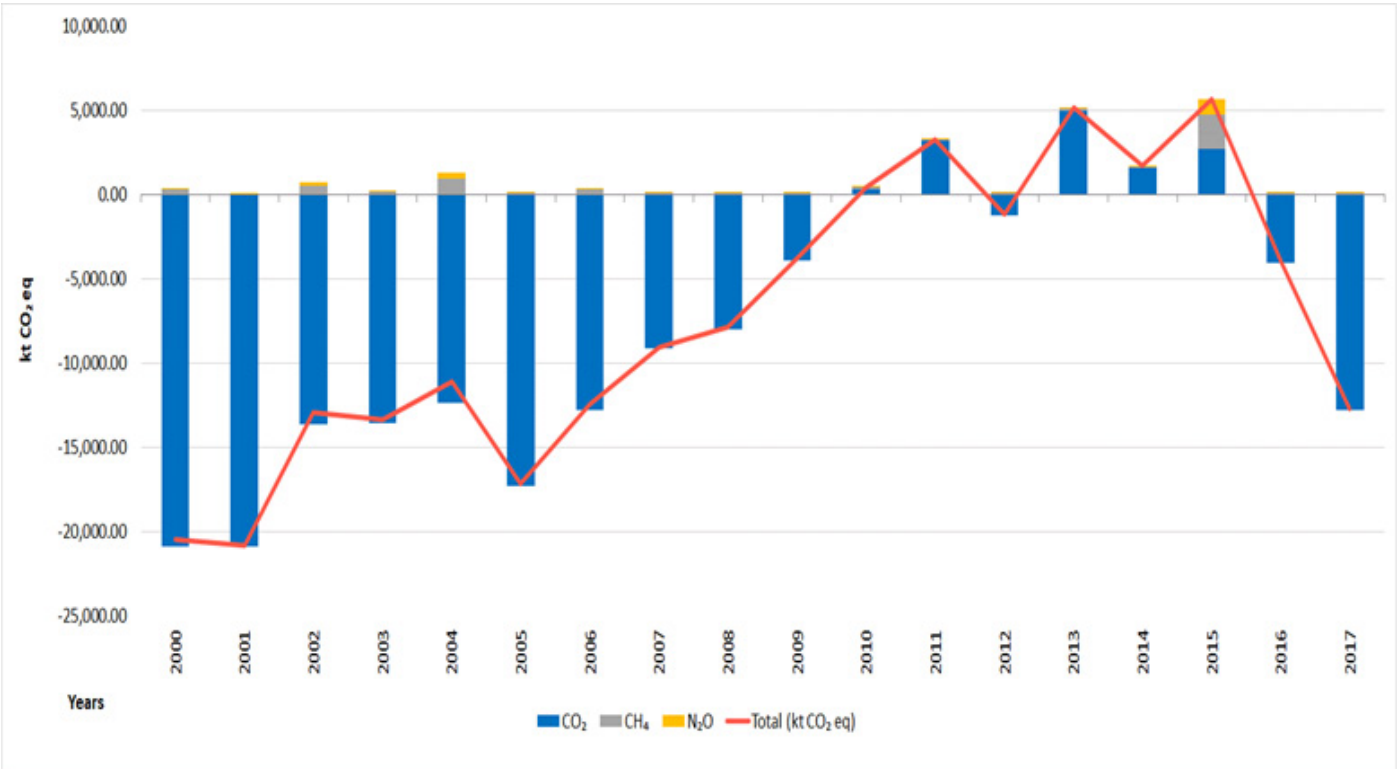


Figure 2-10 Time-series of total GHG emissions from the LULUCF sector by gas (in kt CO_2 eq)

The GHG inventory includes emissions from deforestation that are accounted under forest land converted to cropland and settlements. The main driver of deforestation is agriculture land use.

The inventory also includes emissions from forest degradation which is accounted under the category forest land remaining forest land. The emission calculations are based on multiplying degradation area from primary forest to degraded forest by the difference of carbon stocks between primary forest and degraded forest. The emission calculation corresponds to a modified version of the IPCC methodology, volume 4, chapter 2 (equation 2.15 and 2.16[1]). Therefore, it is assumed that implicitly the estimation also includes losses from timber and fuel wood harvest and disturbances, which is mainly driven by commercial logging. The same methodology has also been applied in the REDD+ technical annex.

GHG Emissions and removals have been estimated for all categories except those that are not occurring in PNG or are not estimated, mainly due to data limitations. Land converted to forest land, land converted to grassland, land converted to wetlands, land converted to other land did not occur in PNG during the reporting period (2000 – 2017).

GHG Emissions in living biomass and dead organic matter of grassland remaining grassland, wetlands remaining wetlands and settlements remaining settlements are not estimated since they are not mandatory to report its carbon stock change at tier 1.

GHG Emissions from organic soils have been estimated for degraded forest land in forest land (forest land remaining forest land (3.B.1.a)), cropland (cropland remaining cropland (3.B.2.a)) and grassland (grassland remaining grassland (3.B.3.a)). They were not occurring for other remaining land uses, such as wetlands, settlements, and other land. The amount of peatlands as part of organic soils has not been analysed so far despite the fact peatlands exist in PNG.

The carbon stock changes in mineral soils have not been estimated for all sub-categories. It should have been estimated at tier 1 for all land use conversions. It had not been estimated due to a lack of country specific data. Carbon pools for which the tier 1 assumption of no carbon stock change or instant oxidation that was used are:

- Dead organic matter and mineral soil in forest land remaining forest land;
- Dead organic matter in land converted to cropland;
- All the carbon pools for grassland remaining grassland, wetlands remaining wetlands and settlements remaining settlements;
- And harvested wood products.

2.4.4.2. Tiers, Methods, source of activity data, emission factors

GHG emissions/removals were estimated mostly using a Tier 1 method and using approach 1 for land representation of the IPCC 2006 Guidelines. Only for emissions in living biomass after forest conversions and forest degradation the Tier 2 method was used.

GHG estimations were out carried using the 2006 IPCC worksheets with modification where appropriate and final estimates reported with the UNFCCC reporting sheets. Emissions/removals in forest land remaining forest land (except for degradation, see further) and cropland remaining cropland have been estimated using the gain-loss method (default tier 1 method[2]). The tier 2 method was used when estimating emissions and removals in living biomass[3] due to immediate conversions and degradation in forest land remaining forest land and dead organic matter[4] in conversion categories. Emissions from organic soils and biomass burning in forest land have also been estimated using the default tier 1 method. Emissions from harvested wood products are considered zero, since instantaneous oxidation is assumed.

Activity data were taken from the land use and land use change assessment (Collect Earth) conducted by PNG Forest Authority (refer Technical Annex of this report for methodology details). The same activity data and estimation methods have also been used for PNG Forest Reference Level for REDD+. The activity data from the land use assessment are used to estimate above ground biomass, below ground biomass, dead organic matter, and soil organic carbon from organic soil for all land use categories. The area burned was taken from the FAOSTAT database[5].

PNG stratified the land according to the six IPCC Land use categories for preparing the land representation. Forest land and cropland were further disaggregated into subcategories, see table 2-8. The Collect Earth survey was customized so that activity data were classified by their carbon stocks in function of the ecological characteristics and agricultural land uses. IPCC ecological zones, i.e. tropical wet, tropical moist, dry and montane forests, were used as forest strata to which also mangroves and plantations were added. Except for plantations, all strata were sub-categorized into primary and degraded/logged forest types. The difference between primary forest and degraded forest was made based on visual interpretation in Collect Earth[6]. For croplands, subcategories are oil palm, coconut, cocoa, tea, and coffee, shifting cultivation and permanent crop systems.

The distinction between managed and unmanaged lands has not been carried out yet and it is assumed that all land areas in PNG are managed. However, primary forests are assumed under very little human disturbances. Therefore, it is assumed that primary forests are in equilibrium, and it also assumed that their net removals are close to zero.

1. In the case of a forest land remaining forest land a modified version of the equation 2.16 is used B_{BEFORE} where B_{AFETR} and represent respectively the carbon stock in the degraded land and the carbon stock in the primary intact forest land
2. 2006 IPCC Guidelines, equation 2.7
3. 2006 IPCC Guidelines, equation 2.15 and equation 2.16
4. 2006 IPCC Guidelines, equation 2.23
5. FAOSTAT Burned area for humid tropical forest (area code 168, item code 6796) and Burned area other forest (Area code 168, item code 6797)
6. Use of high resolution imagery, ab Bing Maps and with combination of use of the Google Earth Engine platform looking at Landsat 7 and 8 for change detection

Table 2-8 Land categories by land cover and use types of the GHG inventory

Categories	Land use stratification
Tropical rain forest	Primary forest, Degraded forest
Tropical dry forest	Primary forest, Degraded forest
Tropical shrubland	Primary forest, Degraded forest
Tropical mountain system	Primary forest, Degraded forest
Mangrove	Primary forest, Degraded forest
Plantation	Deforested, Degraded
Cropland	Oil palm, coconut, cocoa, tea, andcoffee, shifting cultivation and permanent crop systems
Grassland	No further stratification
Wetlands	No further stratification
Settlements	No further stratification
Other land	No further stratification

The results generated from Collect Earth are set of annual land use change matrices between 2000 and 2017. High resolution imageries before 2000 are limited and therefore an approach 1 was applied for land representation. Nevertheless, annual land area changes like approach 2 have been used to estimate immediate loss due to forest land conversion and forest degradation.

Mostly default emission factors and some country specific factors have been used. Forest growth factors in Table 2-10 have been taken from the IPCC 2006 guidelines for degraded forest which were considered more than 20 years old. Primary forests are mostly undisturbed, and therefore a growth rate of zero has been applied. This is a conservative assumption since much of the primary forest may continue to sequester carbon; a global comparison study from 2008 suggests undisturbed old forests absorb significant quantities of carbon (Luyssaert et al 2008). PNG's SNC did not use a zero value and as a result estimated removals in forest land remaining forest land to amount up to 180 million tCO_2. The average annual growth rate of regrowth on cropland is consistent with the FRL submission.

National forest carbon stocks and root to shoot ratios in table 2-10 have been derived from literature (Fox et al. 2010) and completed with defaults from the IPCC Guidelines (2006). The carbon fraction selected from IPCC 2006 Guidelines is 0.47 tC /t d.m. Long term stock factors for the two major perennial crops, croplands for oil palm and cocoa and coconut have been taken from the IPCC 2006 Guidelines (table 5.3) and are consistent with the product of the annual increment and maturity cycle (years). Other crop types, such as tea and coffee have not been included yet separately and this is justified since their area is insignificant compared to the two major crops.

PNG will update most emission factors for forestlands and include them in the BTR when data from the NFI becomes available.

Table 2-9 Average annual growth rates by forest types

Categories	Land use stratification	Average annual growth rates (t d.m. ha^{-1} yr^{-1})
All types	Primary	zero
Tropical rain forest	Degraded forest	3.4
Tropical dry forest	Degraded forest	2
Tropical shrubland	Degraded forest	2
Tropical mountain system	Degraded forest	1
Mangrove	Degraded forest	9.9
Plantations	Plantations	5
Regrowth cropland		8.11[7]

7. Based on an average growth rate from different perennial crop types (consistent with the value calculated in the FRL)

Table 2-10 Average annual above ground biomass and ratio of below and above ground biomass

Categories	Land use stratification	Ratio below and above ground (-)	Average annual above ground biomass (t d.m. ha^{-1})
Tropical rain forest	Primary forest	0.37	223
Tropical dry forest	Primary forest	0.28	130
Tropical shrubland	Primary forest	0.4	70
Tropical mountain system	Primary forest	0.27	140
Mangrove	Primary forest	0.49	192
Tropical rain forest	Degraded forest	0.37	146
Tropical dry forest	Degraded forest	0.2.8	85
Tropical shrubland	Degraded forest	0.4	46
Tropical mountain system	Degraded forest	0.27	92
Mangrove	Degraded forest	0.49	126
Plantations	Deforested	0.37	150
Plantations	Degraded	0.37	98
Cropland	By Crop types	see table 2-11	see table 2-11
Grassland	No further stratification	-	16.1[8]
Wetlands	No further stratification	-	zero
Settlements	No further stratification	-	zero

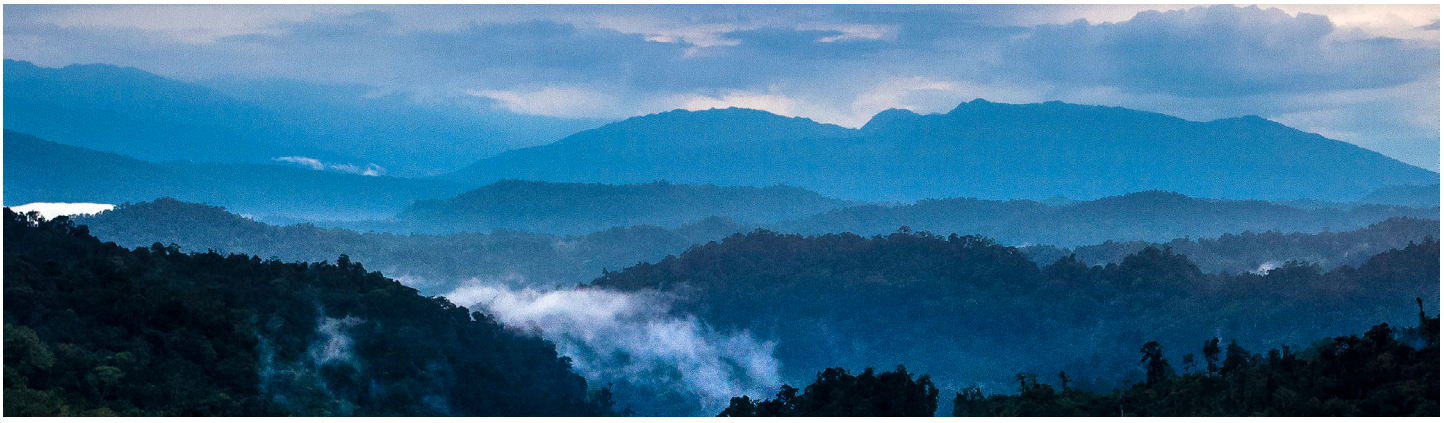
Table 2-11 Average long term carbon stocks and mean increment for the crop types to calculate gains and losses in croplands

Categories	Average long term carbon stock (t dm ha^{-1})	Mean increment (tonnes C ha^{-1} yr^{-1})
Oil palm	136	6.8
Cocoa and coconut	196	9.8

2.4.4.3. Improvements made, challenges, areas for further improvement in the future

The improvements made in this reporting cycle includes the updated GHG emissions from biomass burning due to the updates made in the activity data source. Furthermore, in the BUR1 an human error was made by not including organic soils into the cropland estimates. This was corrected in this reporting cycle.

There weren't any improvements made in this reporting cycle and the similar challenges faced in the BUR1 were also faced in this cycle. Areas for further improvement in this report are the same as those outlined in the BUR1. A table of data needs and future improvements by each reporting subsector is given in table 2-12.



8. IPCC 2006, chapter 6, table 6.4, tropical, moist & wet, includes above and below ground biomass for non- woody biomass

Table 2-12 Summary of data needs and future improvements by each reporting subsector.

GHG source/sink category		Data type[9]	Data source	Notes/assumptions to data	Future Improvement
3.B.1	Forest land	Forest land area and area change and disturbed, organic drained soils, forest growth factors, volume of fuelwood and timber harvest	PNGFA (Collect Earth), published literature source and FAOSTAT	Growth factors are default taken from the IPCC guidelines	- C stock values from NFI (PNG) - Historical area data (before 2000) - distinguish different levels of disturbed forest - gains and loss at more spatial explicit level
3.B.2	Cropland	Cropland area and area change, Forest carbon stock values for biomass and dead organic matter, organic drained soils, *Mineral soil management factors*	PNGFA (Collect Earth), national literature study	Litter stocks are a default taken from the IPCC guidelines	-C stock values from NFI (PNG) (including vegetation of deforested lands, long term carbons tocks of perennial crops) - define management practices for cropland - verify cropland area by subcategory with ground survey
3.B.3	Grassland	Grassland area and area change, Forest carbon stock values for biomass and dead organic matter, Organic drained soils *Mineral soil management factors*	PNGFA (Collect Earth)	No land use changed to grasslands occurred	-C stock for woody and herbaceous biomass - define management practices for Grassland
3.B.4	Wetlands	*Peatland extraction, wetland area and area, area of organic drained soils* *Mineral soil management factors*	Not Estimated	No Land use change to wetlands occurred – LB and DOM not estimated	-C stock values from NFI (PNG) - Identifying high organic soils and peat land area - estimate non-CO2 from drained organic soils - identifying flooded land
3.B.5	Settlements	Settlement area and area change, Forest carbon stock values for biomass and dead organic matter, organic drained soils *Mineral soil management factors*	PNGFA (Collect Earth)		-C stock values from NFI (PNG) - spatial explicit (e.g. LiDAR) data to track forest to settlement - urban biomass waste - Urban tree cover
3.B.6	Other land	Other land area and area change, Forest carbon stock values for biomass and dead organic matter, *Mineral soil management factors*	PNGFA (Collect Earth)	No land use change to other lands occurred- LB and DOM not estimated	- C stock values from NFI (PNG)
3.C.1	Biomass burning-forest land	Land area burned	FAOSTAT	Burning in forest land only	-Use Fire dataset on hotspot areas (GIS data) (UPNG)
3.D.1	Harvested Wood Products	Volume of wood	NA	Tier 1 assumption: instant oxidation	-volumes of wood production, import and export

9. Parameters in italic are not used / available in PNG

2.4.5. Waste

2.4.5.1. **Overview**

The waste sector covers GHG emissions from treatment and disposal of waste, which are estimated for solid waste disposal (4.A.), biological treatment of solid waste (4.B.), incineration and open burning of waste (4.C.), and wastewater treatment and discharge (4.D.) in accordance with treatment processes suggested in the 2006 IPCC Guidelines.

Waste management in PNG remains a poorly managed sector with much improvement needed in the short and long term. The data of waste generation and/or treatment amount are hardly available for most of the case in PNG. Thus, the many estimates are linked to the population data. PNG employs Tier 1 methodologies and default emission factors in the 2006 IPCC Guidelines for most of the GHG emission estimates in the Waste sector. When limited activity data were available, emission estimates were carried out based on assumptions and expert judgement.

PNG generally employs default methodologies and emission factors in GHG emission estimations on the waste sector. Given the paucity of data, emissions estimate from the waste sector in PNG comprised of CH_4 emissions from solid waste disposal sites, CH_4 and N_2O emissions from biological treatment of solid waste, and CH_4 and N_2O emissions from wastewater treatment. Emissions from incineration and open burning of waste are only reported for MSW.

In 2017, emissions from the Waste sector resulted in 1,006 kt CO_2 eq and accounted for 9% of PNG's total greenhouse gas emissions (excluding LULUCF). The emissions of the waste sector have increased in the whole time series (2000-2017) as seen in figure 2-11. The increase is influenced by population growth, development, consumption rate, and rural-to-urban drift. Breakdown of 2017 emissions of the Waste sector by category shows that wastewater treatment and discharge contributed 67 % to total sector emissions in 2017, followed by solid waste disposal (27%), incineration and Open Burning (6%) and biological treatment of solid waste (1%). The contribution of CO_2, CH_4 and N_2O for the total sector emissions are 3.5%, 79.1% and 17.4% respectively.

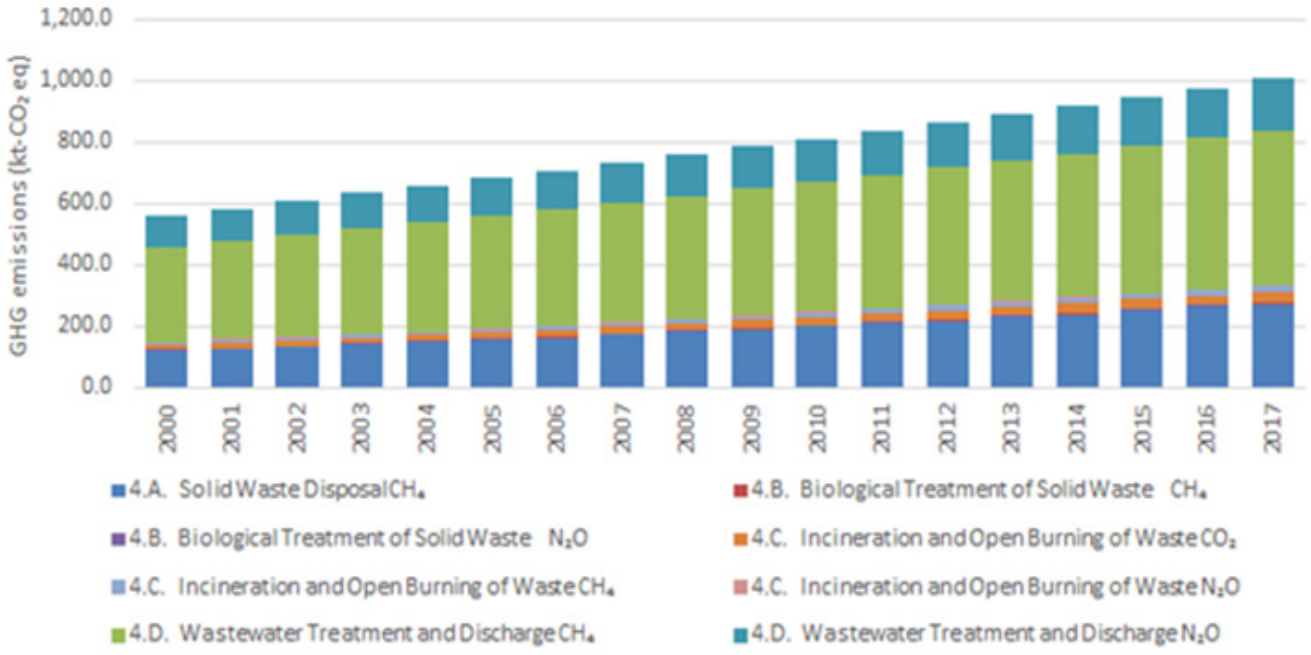


Figure 2-11 Time-series of total GHG emissions from the waste sector by category

2.4.5.2. **Tiers, Methods, source of activity data, emission factors**

PNG generally employs default methodologies and emission factors in GHG emission estimations on the waste sector. Given the paucity of data, emissions estimate from the waste sector in PNG comprised of CH_4 emissions from solid waste disposal sites (4.A.), CH_4 and N_2O emissions from biological treatment of solid waste (4.B.), and CH_4 and N_2O emissions from wastewater treatment (4.D). Emissions from incineration and open burning of waste are only reported for MSW (4.C.).

2.4.5.3. **Improvements made, challenges, areas for further improvement in the future**

The following improvements were made in the waste sector compared to BUR1:

- CH_4 Emissions from open burning of waste estimated for first time
- For CH_4 from wastewater, lagoon treatment (anaerobic shallow lagoon) was added as a wastewater treatment type in addition to septic tank, river lake sea discharge, pit toilet based on a survey study in Port Moresby. The population for each type of wastewater treatment was also improved based on survey study in Port Moresby and 7 cities in PNG.

- For N_2O from wastewater, the amount of protein in industrial wastewater was taken into account in the parameter because industrial wastewater is connected to the domestic wastewater system.

A major constraint faced in conducting this inventory has been the lack of activity data. Challenges encountered in this inventory are:

- Lack of data on land filled waste, composted waste, incinerated/open burned waste, waste composition, parameters for methane estimation for landfills, industrial waste data, population data by domestic waste water treatment method, industrial wastewater data;
- Lack of country specific emission factors;
- Limited information on waste management systems in PNG

These challenges would be addressed with the assistance of the stakeholders. The stakeholders responsible in handling different waste categories would be consulted to find out on availability of data and information on waste management systems in PNG.

3. Mitigation Actions

3.1. Introduction

Since ratifying the Paris agreement on 21 Sep. 2016, PNG has further enhanced various measures to prevent global warming. PNG submitted its Second NDC in Dec. 2020 and further accelerated discussions on mitigation measures. In this chapter, information is provided on the measures that PNG has already implemented, as well as the measures it envisages implementing in the future.

3.2. International Commitments

PNG has been actively engaged in international climate action since it ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994. Since the ratification of the Paris Agreement in 2016, the implementation of mitigation measures has been constantly promoted as part of the United Nations Paris Agreement Act, 2016. In the future, climate change measures are expected to be accelerated on the basis of the Enhanced NDC submitted in 2020.

3.3. Approach to Reducing GHG Emissions by each Sector

The Enhanced NDC provides an approach to reduce GHG emissions in the energy and AFOLU sectors, which are the principal emission sources. Below is a summary of those approaches. The underlying strategies, policies and actions for the implementation of these approaches are outlined in section 3.4.

3.3.1. Energy Sector

In Papua New Guinea, the energy sector is the largest net emitting sector, accounting for an estimated 87.7% of total enmissions (excluding LULUCF) in 2015. Emissions from the energy industry and the transport subsector are especially important, and mitigation measures for both sectors are implemented on the basis of existing policy directives from implementing agencies. PNG is committing to a headline target of carbon neutrality within the energy industries sub sector. This would be achieved through:

(v) Enhance levels of renewables in the energy mix from 30% in 2015 to 78% by 2030 for on-grid connection (non-GHG quantitative target);

(vi) Reducing electricity demand through energy efficiency;

(vii) Fossil fuel off-setting from energy industries sub-sector through nature-based solutions;

(viii) Enhanced data collection

Other potential mitigation measures under the energy sector are from the transport sub sector which involves the reduction of fuel consumption.

3.3.1.1. Enhance levels of the Renewable Energy in Energy mix

As part of PNG's energy transition, the country is targeting a transition in its energy mix in the energy industries for the share of installed capacity of renewables from 30 percent in 2015 to 78 percent in 2030 for on-grid connection managed by PNG Power Limited. The National Electricity Roll-Out Plan and PNG Power Limited's 15-year power development plan were used to establish this target and will also be used to monitor the progress of this target. In addition, access to electricity and cheap renewable energy reduces housework, improves cooking, processes food and non-timber forest products (NTFP), improves safety and security with reliable lighting, and homes at night. Co benefits involves improving the lives of women and youth by participating in domestic commercial and educational activities and reducing air pollution.

3.3.1.2. Reducing Electricity Demand Through Energy Efficiency

In order to achieve a significant reduction in emissions, the efficiency of the equipment must be improved. Minimum Energy Performance Standards and Labelling (MEPSL) is currently under consideration to accelerate efforts to improve energy efficiency by encouraging the introduction of high-efficiency equipment and changing public attitudes. Full implementation of the MEPSL project is expected by 2030.

3.3.1.3. Fossil fuel off-setting from the energy industries sub-sector through nature-based solutions

PNG remains committed to an energy transition but also recognizes that a full transition will take time given PNG's

complex geographies and dispersed population as well as a growing economy. As such, a framework for offsetting of emissions from fossil fuels will be introduced to support economic incentives for transition while also helping to finance domestic nature-based solutions in particular, reduced emissions and enhanced removals from the forest sector.

3.3.1.4. Enhance data collection

PNG will establish a framework for enhanced data collection on energy use and associated emissions to support improved policy and regulation to manage emissions.

3.3.1.5. Reduction of Fuel Consumption in the Transportation Sector

The transportation subsector aims to promote the regulation of clean fuel technologies to establish GHG emission standards and economic incentives for fuel-efficient vehicles. These actions are reflected in the National Transport Strategy, the Medium-Term Transport Plan II 2019-2022, National Energy Policy 2017-2027, and National Climate Compatible Development Management Policy but will need financial and technical support for them to be implemented by 2030. Such actions include the following:

- Reduce vehicle-miles through more compact development patterns;
- Encourage the introduction of fuel-efficient transport equipment;
- Encourage sustainable substitution of fossil fuels with biofuels;
- Monitor vehicle fleet-weighted fuel and CO_2 efficiency;
- Eliminate high emission vehicles;
- Establish low carbon fuel standards;
- Encourage the introduction of hybrid and electric vehicles

3.3.2. AFOLU Sector

Most of the emissions in AFOLU sector occurred as a result of deforestation and forest degradation. Almost all deforestation was due to land-use conversion from forest land to cropland, in particular, subsistence agriculture (68.8 %) and for oil palms plantation development (24.4 %). Logging was the major driver of forest degradation, accounting for over 90 % of the total degraded forest in PNG. Hence, the primary mitigation effort of the sector lies in reducing emission from deforestation and forest degradation due to commercial agriculture, subsistence agriculture and commercial logging. The overarching target in the AFOLU sector is that PNG will shift the upward trend of GHG emission in the AFOLU sector due to the increase of deforestation and forest degradation to a downward trend in the next 10 years (by 2030). This will be achieved through:

(i) GHG-Absolute target;

(ii) GHG-Relative target;

(iii) Non-GHG Quantitative targets;

(iv) Non-GHG Action based targets

3.3.2.1. GHG-Absolute target

This target outlines that by 2030, annual net emission from deforestation and forest degradation due to agriculture expansion and commercial logging is reduced by 10,000 Gg CO_2 eq compared to 2015 level.

3.3.2.2. GHG-Relative target

This target outlines that the LULUCF will be converted from net GHG source (1,716 Gg CO_2 eq) in 2015 to net GHG sink (-8,284 Gg CO_2 eq) by 2030 to mitigate emissions from other sectors.

3.3.2.3. Non-GHG Quantitative targets

This includes the following non-GHG quantitative targets:

- The area of annual deforestation is reduced by 25 % of 2015 level by 2030 (equating to a reduction of 8,300 ha of annual deforestation);
- The area of forest degradation is reduced by 25 % of 2015 levels by 2030 (equating to a reduction of 43,300 ha of annual degradation); and
- The area of planted forest and forest restoration is increased.

3.3.2.4. Non-GHG Action based targets

This includes the following non-GHG action-based targets:

- Enhanced land use planning;
- Promoting climate-friendly agriculture;
  - Oil palm platform;
  - Cocoa platform;
  - Coffee platform;
  - Enhancing community level agriculture productivity;
  - Certification system for climate friendly agriculture products;
  - Enhancing value chain of climate friendly agriculture products;
  - Strengthened monitoring of FCA permits
- Enhancement of timber legality
- Promoting REDD+
- Promoting downstream processing
- Promoting the Painim Graun Planim Diwai initiative and planting 10 million trees initiative.

3.4. Promotion of the Mitigation Actions

This section provides a description of the underlying strategies, policies and mitigation measures.

3.4.1. Strategies, Policies, and Actions Related to Mitigation Actions

PNG has developed a variety of climate change mitigation actions. These key actions are summarized below.

Table 3-1 Summary of the major mitigation actions

Name	Year	Description
Papua New Guinea Vision 2050	2009	The PNG vision 2050 sets targets for PNG to achieve by 2050, including a 90% of GHG emissions reduction to 1990 levels and a providing 100 percent power generation from renewable energy sources.
Papua New Guinea Development Strategic Plan 2010-2030	2010	The PNG DSP embodies the principles of the PNG Constitution and provides the basic guidance necessary to make PNG a middle-income country by 2030. The plan includes the implementation of renewable energy and forest conservation.
Medium Term Development Plan	I: 2010 II: 2015 III: 2018	The PNG MTDP is a five-year plan that drives the development agenda of the Government of Papua New Guinea to secure the future through inclusive sustainable economic growth.
National Strategy for Responsible Sustainable Development for Papua New Guinea	2014	National Strategy for Responsible Sustainable Development for Papua New Guinea is aimed at redefining the development road map by prescribing a growth strategy that is built on the principles of green growth and sustainable development.
National Climate Compatible Development Management Policy	2014	The National Climate Compatible Development Management Policy defines Papua New Guinea's approach to sustainable development, identifies and describes key policy areas for climate change mitigation and adaptation, and outlines the institutions, instruments, roles and responsibilities for implementing climate activities.
Climate Change (Management) Act	2015	This Act provides a framework for the development and implementation of measures in Papua New Guinea to combat climate change in accordance with the Kyoto Protocol and other international agreements and programs.
United Nations Paris Agreement (Implementation) Act	2016	This Act addresses climate change issues in Papua New Guinea and implements the country's obligations under the Paris Agreement. The document is declared a matter of national interest.
National Energy Policy 2017 - 2027	2017	The National Energy Policy 2017-2027 aims to provide sufficient, accessible, reliable and affordable energy in a manner that is competitive, sustainable and environmentally friendly.
National REDD+ Strategy	2017	The National REDD+ Strategy provides the strategic direction for how REDD+ will be integrated into relevant government policies and programmes and the actions of civil society and the private sector over the coming decade (2017 to 2027).
REDD+ Finance and Investment Plan	2020	The REDD+ Finance and Investment Plan (RFIP) which is integral part of the NDC Implementation Plan identified areas within the AFOLU sector to mitigate GHG emissions. The RFIP sets out the potential opportunities that scaling up actions in line with PNG's National REDD Strategy (NRS) could deliver. These include emissions reductions of more than 60 million tonnes of CO_2 eq. over the coming decade, while also delivering significant economic, social and environmental co-benefits.
Papua New Guinea's Sustainable Development Goal 13 Roadmap	2020	The Roadmap consists of a set of 30 actions that need to be achieved by 2030. The 30 actions of the Roadmap are intended to not only address the challenges of climate change but also help set PNG on a pathway to a truly climate smart, healthy and prosperous nation, and to achieve the objectives set out in the country's MTDP III.
Enhanced NDC Implementation Plan (2021-2030)	2021	The Enhanced NDC Implementation Plan (2021-2030) aims to provide a clear and concise framework for implementing PNG's agenda to meet it GHG emission reduction targets in the AFOLU and energy sectors from 2021-2030
NDC Implementation roadmap electricity sector	2021	NDC Implementation roadmap for the electricity sector supports PNG's aspiration for 78% share of renewable energy in the on-grid system by 2030.
NDC Implementation roadmap for Agriculture, Forestry and Other Land Use sector	2021	NDC Implementation roadmap for Agriculture, Forestry and Other Land Use sector is to enhance coordinated action and investment towards the delivery and further enhancing of PNG's targets within the AFOLU sector.
Climate change (Management) (Nationally Determined Contribution) Regulation	2021	Climate change (Management) (Nationally Determined Contribution) Regulation is the legal framework that supports the implementation of PNG's NDC.

3.4.1.1. **Papua New Guinea Vision 2050**

Papua New Guinea Vision 2050 is underpinned by seven Strategic Focus Areas, which are referred to as pillars. One of these is called the Environmental Sustainability and Climate Change Pillar and has been set the following targets.

- Reduce greenhouse emission by 90 percent to 1990 levels;
- Assist the majority of Papua New Guineans to become resilient to natural and human disasters and environmental changes;
- Establish a Sustainable Development Policy in all sectors, especially forestry, agriculture, mining, energy and oceans by 2015;
- Develop mitigation, adaptation and resettlement measures in all impacted provinces by 2015;
- Conserve biodiversity at the current five to seven percent of the world's biodiversity;
- Establish a total of 20 national reserves, wilderness areas and national parks;
- Establish at least one million hectares of marine protected areas;
- Conserve and preserve cultural diversity;
- Provide 100 percent power generation from renewable energy sources;
- Provide 100 percent of weather and natural disaster monitoring systems in all provinces;
- Integrate environmental sustainability and climate change studies in primary, secondary and national high school curricula; and
- Establish an Institute of Environmental Sustainability and Climate Change.

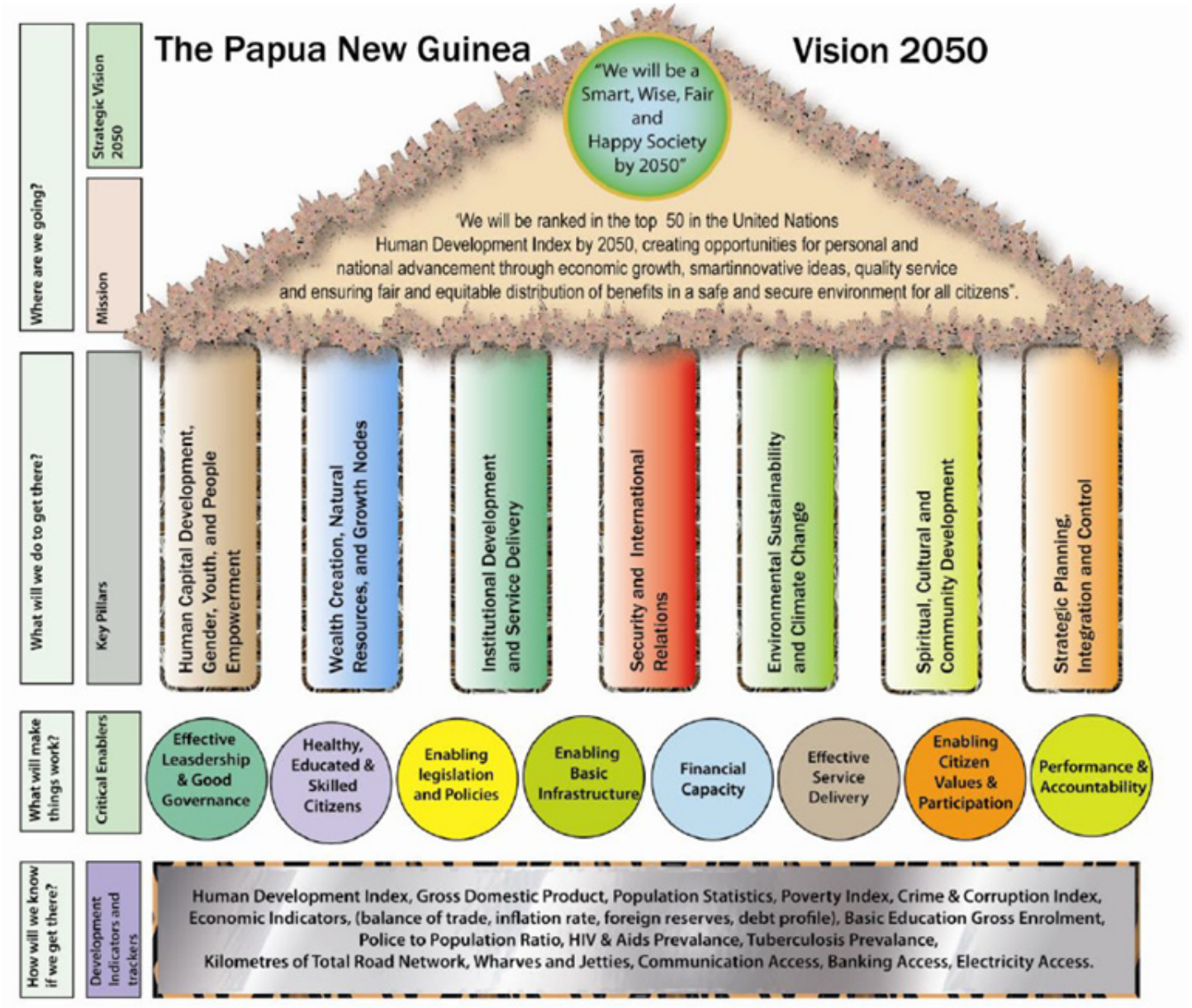


Figure 3-1 The Seven Strategi Focus Areas of Vision 2050

Reference: National Strategic Plan Taskforce "Papua New Guinea Vision 2050"

3.4.1.2. Papua New Guinea Development Strategic Plan 2010-2030

The PNG Strategic Development Plan is a strategic planning document that articulates long-term national goals and formulates strategies that provide guidelines for action plans and resource programs. Strategies under the extractive sectors as well as energy sectors are designed to be pursued with clear consideration for environmental sustainability as well as addressing the issues of climate change in ways that best suit PNG's developmental needs. In the climate change strategy, "Adapt to the domestic impacts of climate change and contribute to global efforts to abate GHG emission" have set as a goal. For instance, access to electricity and the introduction of renewable energy by 2030 are part of the energy sector's target.

3.4.1.3. Medium Term Development Plan III 2018 – 2022

The Medium-Term Development Plan III (MTDP III) captures the main thrust of the Alotau Accord II and sets the Goal of "Securing our future through inclusive, sustainable economic growth" by focusing on key investments to further stimulate the economic growth in the medium term. This plan sets a goal of reducing CO_2 emissions to 12,000 Gg by 2022, and sets "improving systems and inventories to monitor GHG Emissions" and "development of standards and regulations for climate-proofed and resilient infrastructure" as actions to be taken to achieve the reduction target.

3.4.1.4. National Strategy for Responsible Sustainable Development for Papua New Guinea

After the 2012 national election the formation of the government under the Alotau Accord instructed for a review of the DSP 2010-2030 and the subsequent three year Medium Term Development Plan 2011-2015. This was to ensure that all developments are truly strategic and must be aligned with Vision 2050 which lead to the development of the National Strategy for the Responsible Sustainable Development (StaRs). The StaRS offers a new development paradigm. It builds on the gains made by Vision 2050 and the current DSP 2010-2030 and prescribes a new development road map that incorporates these elements that make for a growth strategy that is truly strategic, futuristic and appropriate for the future. The StaRS is the policy shift in long term planning to guide the actions of current and future governments to position PNG towards attaining the following goals: being a leader in the promotion and establishment of the responsible sustainable development paradigm; be a prosperous middle-income country by 2030; and be among the top 50 countries on Human Development Index by 2050.

It introduces three enabling dimensions that are essential for transitioning from the brown driven growth to inclusive green growth. The dimensions are: national green growth plan to create enabling conditions; green growth mainstreaming mechanisms to enable opportunities are explored through existing economic activities; and green growth policy instruments to tap specific opportunities within spatial and resource systems.

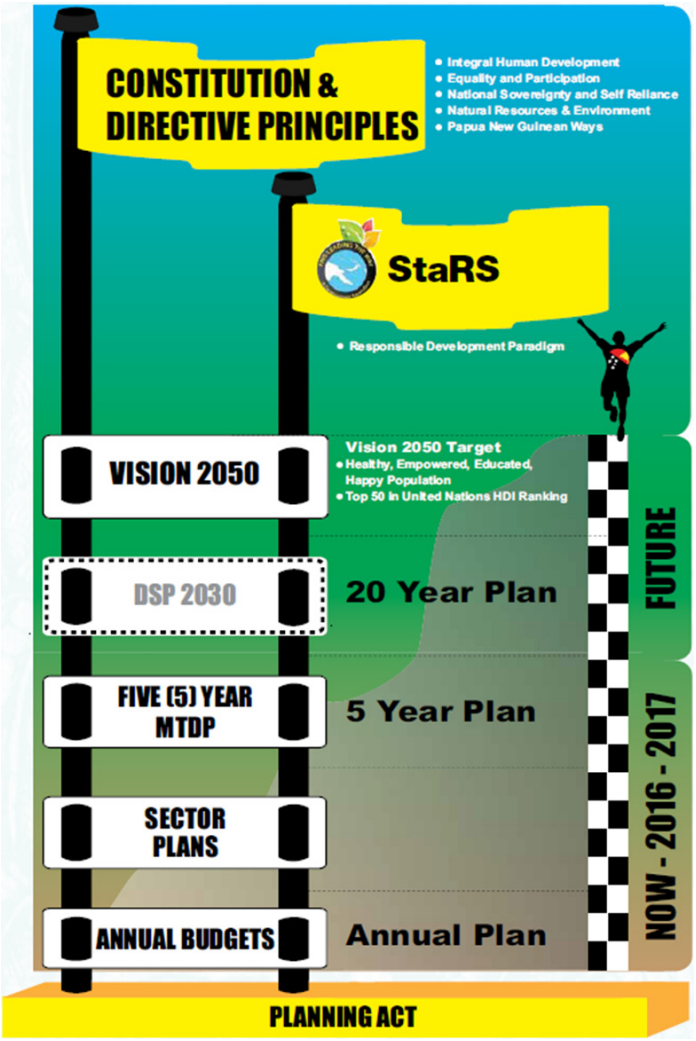


Figure 3-2 Strategic Planning Framework of Government

Reference: National Strategy for Responsible Sustainable Development for Papua New Guinea "Department of National Planning and Monitoring"

3.4.1.5. Climate Compatible Development Management Policy (NCCDMP)

The National Climate Compatible (NDDCMP) is the Government's blue print to achieve a vision in building a climate-resilient and carbon neutral pathway through sustainable economic development for Papua New Guinea. The climate-friendly development strategy in PNG is based on combining economic development and climate change mitigation and adaptation. With respect to the mitigation component, there are three policies;

- Carbon Neutrality by 2050: PNG is climate compatible by 2050
- Land Use and Forestry Sector Emissions Abatement: GHG emissions mitigated in the land use, land use change and forestry (LULUFC) sector
- Green Economic Growth: Development is climate-compatible through efficient, low GHG emissions infrastructure and technology.

3.4.1.6. National Energy Policy 2017 – 2027

The general objective of the energy policy is to ensure affordable, competitive, sustainable and reliable supply of energy to meet national and provincial development needs at least cost, while protecting and conserving the environment. The policy sets out the measures required to achieve these objectives, such as promoting the introduction of renewable energies.PNG has underutilized indigenous energy sources such as hydro, biomass, natural gas, geothermal, solar, and wind. The development of these resources would accelerate Papua New Guinea's potential to increase its electrification rate, energy production and exports (where possible) and sustain economic growth. This policy provides "Background", "Challenges" and "Strategies" for all renewables, and organizes approaches to promote their introduction.

3.4.1.7. National REDD+ Strategy (2017-2027)

The National REDD+ Strategy outlines three action areas and under each area are actions to be undertaken as well as the lead agencies with in the period. The first action area is strengthening Land-Use and Development Planning. Under this action area the two actions to be implemented are: Strengthened and Coordinated National Level Development and Land Use Planning (lead agencies are Department of National Planning and Monitoring (DNPM) and Department of Lands and Physical Planning (DLPP)); and Integrated Subnational Planning (lead agencies are DNPM and Department of Provincial & Local Government Affairs (DPLGA)).

The Second Action Area is Strengthened Environmental Management, Protection and Enforcement. Under this area there are four actions which are: Strengthening climate change legislation, financing and management (lead agency is CCDA); Strengthening Forest management and enforcement practices (lead agency is PNGFA); strengthening conservation and environmental management (lead agency is CEPA); and Strengthening access to information and resource mechanisms (multistakeholder action).

The Third Action Area is Enhanced Economic Productivity and Sustainable Livelihoods under which there are two actions to be implemented which are: Development of a sustainable commercial agriculture sector (lead agencies are DAL and DNPM); and Strengthened food security and increase productivity of family agriculture (lead agencies are DAL and Fresh Produce Development Agency (FPDA)).

3.4.1.8. REDD+ Finance and Investment Plan

REDD+ Finance and Investment Plan will reduce emissions from deforestation and forest degradation, responsible for 90% of PNG's GHG emissions, by supporting the implementation of PNG's National REDD+ Strategy and targeted elements of the REDD+ Finance and Investment Plan as part of the country's NDC. Project outputs cut across sectors and include changes in the way commercial agriculture, in particular oil palm, is developed, improvements in the sustainability of PNG's timber supply, and coordinated land use planning while also supporting the reporting and financial management systems for REDD+ results-based payments. The expected result from implementation of this proposal is 26 Mt CO_2 eq. reduced or avoided.

3.4.1.9. Climate Change (Management) Act

The CCMA established in 2015, and the CCDA has been designated as the governing body of PNG climate change policies. Regarding mitigation, it is obligatory to prepare and submit information including inventories in accordance with the UNFCCC's reporting regulations, and to formulate mitigation plans for entities implementing emission actions in specific fields. As far as adaptation is concerned, the target entity is also required to draw up an adaptation plan and a fine is also foreseen.

3.4.1.10. United Nations Paris Agreement (Implementation) Act

The United Nation Paris Agreement Implementation Act was promulgated in 2016, and the Paris Agreement adopted in 2015 became binding in PNG. In addition, the Paris Agreement is to be implemented through the implementation of the CCMA, and the CCDA has been designated as the implementing body of the Paris Agreement.

3.4.1.11. Papua New Guinea's Sustainable Development Goal 13 Roadmap

The Roadmap consists of a set of 30 actions that need to be achieved by 2030. The Timeline outlines four phases of milestones that will act as the foundation for PNG to achieve the 30 actions of the Roadmap by 2030 and therefore the key targets of SDG13 and PNG's NDCs (as they currently stand). The Stakeholder Action Plan outlines the key stakeholder groups who the PNG Climate Change and Development Authority should collaborate to achieve the 30 actions of the Roadmap. The Management and Implementation table suggests some measurable outcomes that were either already underway or perhaps could be developed to achieve the 30 action of the Roadmap.

Critically, the 30 actions of the Roadmap are intended to not only address the challenges of climate change, but also help set PNG on a pathway to a truly climate smart, healthy and prosperous nation, and to achieve the objectives set out in the country's MTDP III. The 10 sectoral themes relate to climate governance, energy, forestry, agriculture, infrastructure, fisheries, tourism, biodiversity, minerals, and health. These themes are largely related to the impacts of climate change that will be felt in PNG, as well as key sectors of the PNG economy, which are particularly important for both national development and livelihoods of Papua New Guineans.

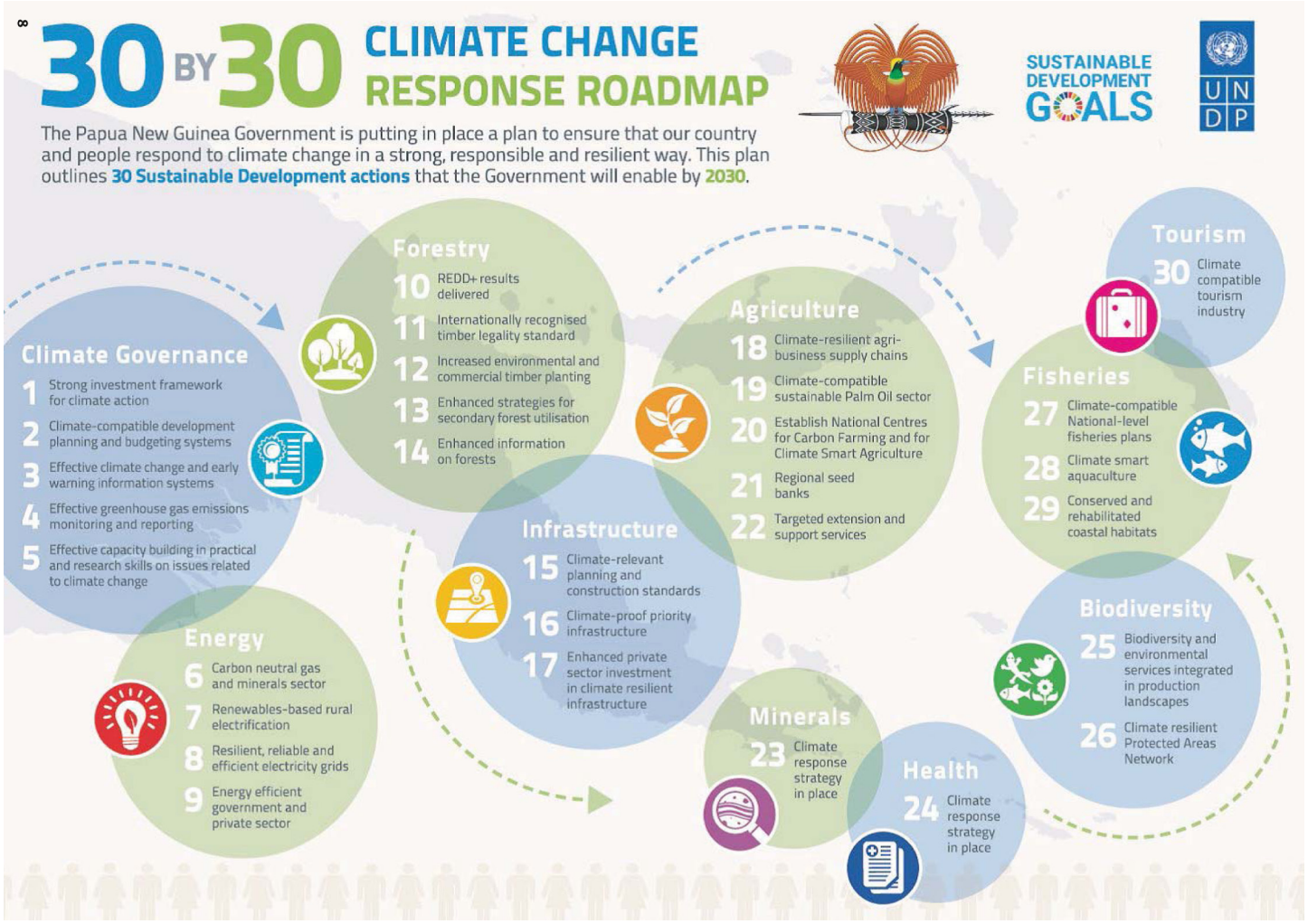


Figure 3-3 30 by 30 Climate Change Response Roadmap

Reference: Papua New Guinea's Sustainable Development Goal 13 Roadmap "Climate Change and Development Authority"

3.4.1.12. Enhanced NDC Implementation Plan (2021-2030)

The Enhanced NDC Implementation Plan seeks to drive and coordinate support from the international development community, investments from both the public and private sectors, and other actions from other relevant key stakeholders, both domestic and foreign, to help PNG achieve its NDC targets. The main objective of the Enhanced NDC Implementation plan is to reach the emissions reduction targets from the energy and AFOLU sectors as well as adaptation targets as defined in PNG's Enhanced NDC 2020. For the AFOLU sector there are 20 direct action pathways and 5 enabling pathways identified to achieve the AFOLU targets in the Enhanced NDC. For the energy sector there are 36 projects and 6 activities to be implemented to achieve the energy sector targets.

3.4.1.13. NDC Implementation roadmap for the electricity sector

The goal of the NDC implementation roadmap for the electricity sector is to support PNG's aspiration for a 78% share of renewable energy in the on-grid system by 2030. The roadmap builds on from the 36 projects outlined in the Enhanced NDC Implementation Plan and illustrates a pathway for implementing these projects and articulates aspects of the enabling environment that may need strengthening to reach the targets set out in the Enhanced NDC.

3.4.1.14. NDC Implementation roadmap for the Agriculture, Forestry and Other Land Use sector

The goal of the NDC Implementation roadmap for the AFOLU sector is to enhance coordinated action and investment towards the delivery and further enhancing of PNG's targets within AFOLU sector. Its objective is to provide a clear AFOLU NDC Implementation roadmap around which action and investment can be mobilized. It provides further information on the 20 direct action pathways and 5 enabling pathways outlined in the Enhanced NDC Implementation Plan, their potential impacts on emissions, and other environment and development goals as well as costs and implementation approach.

3.4.1.15. Climate change (Management) (Nationally Determined Contribution) Regulation

The Climate Change (Management) (Nationally Determined Contribution) Regulation has been prepared to provide a regulatory framework for the implementation of PNG's NDCs. Among other things, the regulation provides for the establishment of a Technical Advisory Committee and Sub Technical Working Committee, formal recognition of targets contained in the NDCs; development implementation plan; Implementation Measures; and Monitoring, Reporting and Verification.

3.4.2. Information on Policies and Measures

Table 3-2 below provides a list of planned and existing mitigation actions that will be implemented to achieve the mitigation targets of the Enhanced NDC submitted in 2020. The lists of actions are extracted from the Enhanced NDC Implementation Plan (2021-2030), NDC Implementation roadmap for the AFOLU sector and NDC Implementation roadmap for the electricity sector.

Table 3-3 provides a list of mitigation actions outside the scope of the Enhanced NDC mainly actions undertaken by the private sector. The list contains CDM projects and projects registered with other international markets.

Table 3-2 List of mitigation actions to achieve the Enhanced NDC targets

Name of mitigation action	Objectives	Nature of action	Sector	Duration	Implementing institution (s)	Nature of progress indicator (s)	Status
Direct Action 1.1 Enhanced monitoring and enforcement of timber legality standard	50% of all concessions fully legal (including FCA timber) by 2025. 100% of concessions fully legal by 2030(including FCA timbe) by	Policy and legislation	Forestry	2021-2030	Lead agency is the PNGFA and supporting agencies are DAL and CEPA.	Percentage of all forestry concession types (over 500m^3) (including FCAs with full legal certification)	Timber legality criteria (standard) has been approved and work is moving for early trialing. PNGFA has in place a number of systems to support data availability
Direct Action 1.2 Regulation of small-scale timber (>500m^3 pa)	Quantification of impacts of small-scale timber in place by 2022. Measures identified to enhance management of small-scale timber harvesting by 2025.	Policy and legislation	Forestry	2021-2030	Lead agency is PNGFA and supporting agencies are district governments and PNG Customs	Enhanced information on nature of small-scale production	Not yet implemented
Direct Action 1.3. Enhance supply of planted timber and reforestation	110,000 ha of land by 2025 and 220,000 ha of land by 2030	Reforestation	Forestry	2021-2030	Lead agency is PNGFA supporting agencies are CEPA and Subnational governments	Hectares (ha) of new planted timber	Initial awareness raising materials
Direct Action 1.4 Establish enhanced environment for forestry governance	Draft forest policy by 2023. Updated forest policy by 2025	Policy	Forestry	2021-2025	PNGFA	Enhanced forestry policy environment	Work conducted on legislative review
Direct Action 1.5. Establish a transition package for old timber concessions	60% reduction on number of old concession types and 90% reduction in old concession types by 2030	Policy	Forestry	2021-2030	Lead agency is PNGFA supporting agencies are CEPA DAL, DLPP, OPIC, Cocoa board, FPDA, CIC and Subnational governments	Level of reduction in concessions under old license types	Not yet implemented
Direct Action 2.1 Strengthened application of environmental safeguards	Documents for 50% of projects updated and publicly available by 2025, documents for 100% of projects by 2030. By 2025 3 and by 2030 6 subnational jurisdictions operating with designated authority on environmental monitoring and enforcement	Policy	Environment and conservation sector	2021-2030	Lead agency is CEPA and supporting agencies are PNGFA, CCDA, Provincial Government, Other sector agencies, NGOs, Private sector and Donors	Environmental assessments, permits and management plans for land use projects are updated and publicly available. Subnational governments engaged in environmental monitoring and enforcement	Not yet implemented

Name of mitigation action	Objectives	Nature of action	Sector	Duration	Implementing institution (s)	Nature of progress indicator (s)	Status
Direct Action 2.2 Enhanced protected area development and management	-By 2025 An additional 3mha of PA's are added to network against 2020 levels of which at least 30% is identified as at high risk of land use conversion. -By 2030 An additional 6mha of PA's are added to network against 2020 levels of which at least 30% is identified as at high risk of land use conversion. -By 2025 Reduction in levels of forest loss within PA by 30% against 2020 levels -By 2030 Reduction in levels of forest loss within PA by 80% against 2020 levels	Policy	Environment and conservation sector	2021-2030	Lead agency is CEPA and supporting agencies are PNGFA, CCDA, Provincial Government, Other sector agencies, NGOs, Private sector and Donors	-Enhanced terrestrial PA coverage -PA effectiveness enhanced -PAs sustainability financed	Significant support to PAs already in place through development partner programs with GEF6 PA finance also currently working to establish and capitalize a funding mechanism
	-By 2025 60% PAs included within subnational budgets And -$10m mobilised per annum to support PA management -By 2030 100% PAs included within subnational budgets And -$20m mobilized per annum to support PA management						
Direct Action 3.1. Establish national sustainable land use planning framework	NSLUP approved by National Executive Council (NEC) by 2022. 2 regulations supporting implementation developed by 2023. Draft national land use plan (LUP) developed by 2025. Updated NSLUP and regulations approved by 2030. Full national LUP in place by 2030	Policy and Legislation	Land use	2021-2030	Lead agency is DLPP and supporting agencies are DPLLGA, DAL and DNPM	Guiding policy and regulatory framework for sustainable land use planning in place.	NSLUP at final phase of development. Provincial physical planning offices established in a number of provinces. Provincial Physical Planning boards (11 already established)

Name of mitigation action	Objectives	Nature of action	Sector	Duration	Implementing institution (s)	Nature of progress indicator (s)	Status
Direct Action 3.2 Establish national sustainable land use planning information system	-Central LU Information system in place by 2025 -System integrated with systems at provincial level in four provinces by 2025 -System with interim links with other sector systems by 2025 -System fully operational with fully linked with other sector systems by 2030 System operational within all provinces	Policy	Land use	2021-2030	Lead agency is DLPP and supporting agencies are DNPM,DPLLGA	Establishment of a fully operational land use information system	Existing systems in place but in need of updating and strengthening of integration
Direct Action 3.3 Develop spatially explicit subnational development plans	Spatially explicit land use plans in place for 5 provinces by 2025 Spatially explicit land use plans in pace for all provinces 2030	Policy	Land use	2021-2030	Lead agency is DLPP and supporting agencies are DNPM, DPLLGA	Spatially explicit plans in place at provincial level	Work done on site specific LUPs
Direct Action 4.1 Strengthen agricultural planning and policy framework and its application	Climate smart national agricultural development policy by 2023. Passage of agriculture sector legislation by 2025	Policy and Legislation	Agriculture	2021-2025	Lead agency is DAL and supporting agencies are NRI and Agri-Commodity boards	Enhanced policy and legislative framework	Draft agriculture bill developed. Work on commodity-based climate-smart agriculture policies under development
Direct Action 4.2 Strengthen access to and quality of extension systems	Framework for extension financing agreed and in place by 2025. Full financing in place for extension by 2030. 30% increase in number of extension offices by 2025. 296 agriculture extension officers operating in all LLG in the country by 2030	Policy	Agriculture	2021-2020	Lead agency is DAL and supporting agencies are NARI Provincial government line agencies and Development Partners	Establishment of effective extension development and financing system Number of Local Level governments (LLGs) with trained agricultural extension officers in place.	Trials one on provision of privatized extension systems for oil palm. Support to improved family and commercial crop extension systems through donor programs
Direct Action 4.3 Strengthen framework for	Palm oil action plan agreed by 2022. Palm oil policy by	Policy	Agriculture	2021-2030	Lead agency is DAL and supporting agencies are CCDA and DNPM	Policy framework in place and changed in	Initial scoping studies for Palm Oil Platform and

Name of mitigation action	Objectives	Nature of action	Sector	Duration	Implementing institution (s)	Nature of progress indicator (s)	Status
sustainable palm oil development	2023. 90% of palm oil exports sustainably certified in 2025 and in 2030					percentage of sustainability certified exports	operations conducted initial reviews on high conservation value/high carbon stock classifications in PNG as well as possible market access and options for future development
Direct Action 4.4 Strengthen Framework for sustainable cocoa development	Cocoa action plan agreed by 2022. Cocoa policy by 2023. 30% of cocoa exports sustainably certified by 2025. 60% of cocoa exports sustainably certified by 2030	Policy	Agriculture	2021-2030	Lead agency is DAL and supporting agencies are CCDA and DNPM	Policy framework in place and changed in percentage of sustainability certified exports	Operational working groups for cocoa development and development partner support to improve quality of production and market access
Direct Action 4.5 Strengthen Framework for sustainable coffee development	Coffee action plan agreed by 2022. Cocoa policy by 2023. 30% of coffee exports sustainably certified by 2025. 60% of coffee exports sustainably certified by 2030	Policy	Agriculture	2021-2030	Lead agency is DAL and supporting agencies are CCDA and DNPM	Policy framework in place and changed in percentage of sustainability certified exports	Draft climate compatible coffee strategy developed
Development of Renewable Energy Policy	To provide an enabling framework for renewable energy development	Policy	Energy	2022-2023	Lead agency is NEA and supporting agencies are PPL and CCDA	Policy framework in place and development of new renewable energy sources	Not yet implemented
Resource mapping for potential renewable energy source	Map and potential renewable energy sources to achieving the vision 2050 target which is to generate electricity from 100% renewables	Policy	Energy	2022-2025	Lead agency is NEA and supporting agencies are PPL and CCDA	New renewable energy sources are developed	Not yet implemented
National Energy Efficiency roadmap	Energy Efficiency roadmap designed and implemented	Policy	Energy	2018-2021	Lead agency is NEA and supporting agencies CCDA and UNDP under FREAGER project	Reduction in energy demand	Draft National Energy Efficiency roadmap developed
Development of action plan for fossil fuel emission offsetting framework	To identify detailed activities that will be implemented to establish a framework for fossil fuel emission offsetting	Policy	Energy	2022-2024	Lead agency is CCDA and supporting agencies are NEA and PNGFA	Fossil fuel offsetting projects identified	Not yet implemented

Name of mitigation action	Objectives	Nature of action	Sector	Duration	Implementing institution (s)	Nature of progress indicator (s)	Status
Development of energy data collection strategy	To address gaps, challenges and capacity building needs to improve energy data collection	Policy	Energy	2022	Lead agency is CCDA and supporting agencies are NEA	Improvement on energy data and inclusion of GHG targets in next NDC	Draft is being developed
Green transport E-Mobility Policy for PNG	The E-Mobility policy will enable the development and implementation of electric vehicles in PNG	Policy	Transport/ Energy	2022-	Lead agency is DoT and supporting agencies are NEA, CCDA and DHERTS	Importation of number of electric vehicles	Technical support has be secured from Climate Technology Center and Network (CTCN) and initial scoping work
Divune-Popondetta Hydro project	To install 3.1MW of hydro power plant in Popondetta to replace fossil fuel consumption	Infrastructure development	Energy	2021	PPL	Percentage share of renewables	The hydro power plant has been commissioned
Samarai solar project	To install 0.075MW of solar plant in Samarai to replace fossil fuel consumption	Infrastructure development	Energy	2022	PPL	Percentage share of renewables	The solar plant is currently being constructed
Naoro Brown hydro project	To install 80MW of hydro plant in Central Province to replace fossil fuel consumption	Infrastructure development	Energy	2023	PPL	Percentage share of renewables	The hydro plant is currently being constructed
Edevu hydro project	To install 51MW of hydro plant in Central Province to replace fossil fuel consumption`	Infrastructure development	Energy	2023	PPL	Percentage share of renewables	The hydro plant is currently being constructed
Ramazon hydro project	To install 3MW of hydro plant in the Anthonomus Region of Bougainville to replace fossil fuel consumption`	Infrastructure development	Energy	2022	PPL	Percentage share of renewables	The hydro plant is currently being constructed
Baime hydro project	To install 11.6MW of hydro power plant in Morobe province to replace fossil fuel consumption`	Infrastructure development	Energy	2024	PNG Forestry Products (IPP)	Percentage share of renewables	The hydro plant is currently being constructed
Rouna hydro additional project (STOD)	To install additional 8MW on existing Rouna hydro power plant	Infrastructure development	Energy	2021	PPL	Percentage share of renewables	Additional 8MW has been installed
Lower lake Hargy hydro project	To install l 2MW hydro power plant in West New Britain province to replace fossil fuel consumption`	Infrastructure development	Energy	2022	PPL	Percentage share of renewables	The hydro plant is currently being constructed

Name of mitigation action	Objectives	Nature of action	Sector	Duration	Implementing institution (s)	Nature of progress indicator (s)	Status
Ru Creek 2 hydro project	To install 2.5MW hydro power plant in West New Britain Province to replace fossil fuel consumption	Infrastructure development	Energy	2026	PPL	Percentage share of renewables	The hydro plant is currently being constructed
Markham Valley solar with battery project	To install 17MW solar power plant in West New Britain Province to replace fossil fuel consumption	Infrastructure development	Energy	2022	PNG Biomass	Percentage share of renewables	The solar plant is currently being constructed
Warangoi hydro power plant rehabilitation	To rehabilitate and add additional 10MW in order to reduce fossil fuel consumption in East New Britain Province	Infrastructure development	Energy	2023	PPL	Percentage share of renewables	The rehabilitation of the hydro power plant is currently taking place
Wabag hydro power project	To install 12MW hydro power plant in Enga province to reduce fossil fuel consumption	Infrastructure development	Energy	2023	Enga provincial government/PPL/Energy Investment Limited	Percentage share of renewables	The hydro plant is currently being constructed
Ramu 1 hydro (Refurbishment) project	To add an additional 17MW in order to reduction fossil fuel consumption.	Infrastructure development	Energy	By 2023	PPL	Percentage share of renewables	The refurbishment is currently taking place
Ramu 2 hydro power project	To install 180MW hydro power plant in order to reduce fossil fuel consumption	Infrastructure development	Energy	By 2028	Shenzon hydro	Percentage share of renewables	Currently at the initial stages of feasibility studies
Kerema Solar PV & ESS project	To install 1.5MW solar power plant in Gulf Province	Infrastructure development	Energy	2022-2024 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Alotau Solar PV & ESS project	To install 1.5MW solar power plant in Milne Bay	Infrastructure development	Energy	2022-2024 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Daru Solar PV & ESS project	To install 1.5MW solar power plant in Western Province	Infrastructure development	Energy	2024-2026 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Manus Solar PV & ESS project	To install 1.5MW solar power plant in Manus Province	Infrastructure development	Energy	2022-2024 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support

Name of mitigation action	Objectives	Nature of action	Sector	Duration	Implementing institution (s)	Nature of progress indicator (s)	Status
Alotau Solar PV & ESS project	To install 1MW solar power plant in Milne Bay Province	Infrastructure development	Energy	2023-2026 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Saussia Solar PV & ESS project	To install 10MW solar power plant	Infrastructure development	Energy	2022-2024 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Aitape Solar PV & ESS project	To install 0.4MW solar power plant in West Sepik Province	Infrastructure development	Energy	2022-2023 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Fincshafen Solar PV & ESS project	To install 0.45MW solar power plant in Morobe Province	Infrastructure development	Energy	2024-2026 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Kavieng Solar PV & ESS project	To install 1.5MW solar power plant New Ireland Province	Infrastructure development	Energy	2023-2025 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Maprik Solar PV & ESS project	To install 0.2MW solar power plant in East Sepik Province	Infrastructure development	Energy	2022-2024 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Murua Hydro project	To install 3MW hydro power plant in Gulf Province	Infrastructure development	Energy	2025-2028 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Gumini hydro project	To install 1.5MW hydro power plant in Milne Bay	Infrastructure development	Energy	2023-2026 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Damar/Mabam hydro project	To install 3MW hydro power plant in East Sepik province	Infrastructure development	Energy	2025-2028 (proposed frame)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Daundo hydro project	To install 1.5MW hydro power plant in West Sepik province	Infrastructure development	Energy	2025-2028 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Lawes hydro project	To install 2MW hydro power plant in Manus province	Infrastructure development	Energy	2025-2028 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support

Name of mitigation action	Objectives	Nature of action	Sector	Duration	Implementing institution (s)	Nature of progress indicator (s)	Status
Kereu 1 hydro project	To install 0.6MW hydro power plant in AROB	Infrastructure development	Energy	2022-2025 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Butaweng hydro power project	To install 0.2MW hydro power plant in Morobe province	Infrastructure development	Energy	2024-2026 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Kimadan hydro power project	To install 1.5MW hydro power plant in New Ireland province	Infrastructure development	Energy	2025-2027 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Sohun hydro power project	To install 0.3MW hydro power plant in New Ireland province	Infrastructure development	Energy	2023-2025 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Mavelo hydro power project	To install 10MW hydro power plant in East New Britain province	Infrastructure development	Energy	2025-2029 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support
Kavieng biomass plant	To install 2MW biomass power plant in New Ireland province	Infrastructure development	Energy	2026-2030 (proposed timeframe)	Lead agency is PPL and supporting agencies are NEA/CCDA	Percentage share of renewables	Not yet implemented. Need international funding support

Table 3-3 Other existing and planned mitigation projects outside the scope of the Enhanced NDC

Summary of the mitigation action
Name of Mitigation action
RE generated from Geothermal Power Project
Objectives
To promote renewable energy and rural electrification by constructing geothermal power plants that utilize the abundant geothermal energy resources that exist in PNG.
Description
The Project Activity is the construction of a Geothermal Power Plant (LGPP) on Lihir Island. This project is to take place at the Lihir Gold Mine, which is owned by Lihir Gold Limited. Geothermal discharge wells and shallow steam-relief wells have been drilled at the Lihir Gold Mine site to decrease geothermal hazards due to steam pressure build up, and to depressurise residual steam or gas pockets in the vicinity of the mine. Therefore the geothermal resources used by the power plant are a co-product of the mining operations that would have otherwise been emitted into the atmosphere and wasted. By utilising the existing geothermal resources of Lihir Island to generate electricity, this project will displace most of the existing diesel generation on the island driven by the combustion of carbon-intensive heavy fuel oil (HFO).
Nature of Action
Infrastructure development, Technology
sector
Energy industry
GHG covered
CO_2, CH_4
duration
2006 - 2016 (crediting period)
status
Completed
implementing institution
Lihir Gold Ltd. (Project Participant)
quantitative targets
The total emission reductions from the project activity are estimated to be 278,904 tCO2 eq./year over the period of 10 years of crediting periods.
Methodologies and Assumptions
ACM0002 ver. 4 -Consolidated methodology for grid-connected electricity generation from renewable sources

Progress of the mitigation action
Name of the progress indicators
Amount of GHG reduced
Unit
tCO_2 eq./yr
Base year, Start year
2006
Baseline emissions
216,264 tCO_2 eq./yr (2007.10 - 2008.08)
Project emissions
15,889 tCO_2 eq./yr (2007.10 - 2008.08)
indicator target value
278,904 tCO_2 eq./yr
Reduction impacts in the last reporting year
200,376 tCO_2 eq./yr (2007.10 - 2008.08)
Most relevant data sources for indicator value
DCM monitoring report https://cdm.unfccc.int/Projects/DB/DNV-CUK1143246000.13/view

Summary of the mitigation action
Name of Mitigation action
RE generated from Methane capture Kumbango POME methane capture project
Objectives
This CDM project aims to reduce methane emissions generated by the open anaerobic lagoon wastewater treatment system in Kumbango Palm Oil Mill. This is achieved by introducing in-ground anaerobic covered lagoon digesters which will recover biogas as renewable energy for use onsite at the mill, refinery and fractionation plants displacing the fossil fuel usage at the plant and also supply the generated power to the grid reducing the fossil fuel load at grid. Through the installation of dedicated engines to utilize biogas for electricity production, the project will also add an additional renewable generation source to the PNG Power Kimbe grid. In doing so, the project helps to increase the amount of environmentally safe renewable electricity which is generated in Papua New Guinea.
Description
The project will be developed in two phases: Phase I: The installation of one unit covered digestor with two units of biogas engine (2 x 953kW) Phase II: The installation of another one units of biogas engine once the project activity is connected to the grid. Thus, the total of three units (3 x 953kW) of biogas engine will be exporting the generated electricity to the grid after meeting internal company deamnd. The aspects related to QA/QC of the monitoring plan are addressed as the following: 1. On-site measurement/sampling 2. Equipment maintenance and calibration 3. Audit and Corrective Actions 4. Training and Communication 5. Record-keeping and Documentation All measurements will use calibrated measurement equipment that will be maintained regularly and checked for its functioning.
Nature of Action
Infrastructure development, Technology
sector
Energy industry, Waste handling and disposal
GHG covered
CH_4
duration
2012 - 2019 (crediting period)
status
Completed
implementing institution
New Britain Palm Oil Limited (NBPOL) Carbon Bridge Pte Ltd
quantitative targets
The total emission reductions from the project activity are estimated to be 55,769 tCO2 eq. per year over the period of 7 years of crediting periods.
Methodologies and Assumptions
AMS-III.H. ver. 16 - Methane recovery in wastewater treatment AMS-I.F. - Renewable electricity generation for captive use and mini-grid AMS-I.D. ver. 16 - Grid connected renewable electricity generation

Progress of the mitigation action
Name of the progress indicators
Amount of GHG reduced
Unit
tCO_2 eq./yr
Base year
2012
Baseline emissions
2012: 19,914 tCO2 eq/yr 2013: 83,093 tCO2 eq/yr
Project emissions
2012: 13,381 tCO2 eq/yr 2013: 33,857 tCO2 eq/yr
indicator target value
62,790 tCO2 eq.yr
Reduction impacts in the last reporting year
49,236 tCO2 eq./yr (2013)
Most relevant data sources for indicator value
CDM Monitoring report (https://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1310633056.02/view)

Summary of the mitigation action
Name of Mitigation action
RE generated from Methane capture Mosa POME methane capture project
Objectives
This CDM project aims to reduce methane emissions generated by the open anaerobic lagoon wastewater treatment system in Mosa Palm Oil Mill. This is achieved by introducing in-ground anaerobic lagoon digesters which will recover biogas as renewable energy for use in the mill and displacing the fossil fuel usage at the plant and also supply the generated power to the grid reducing the fossil fuel load at grid. Through the installation of dedicated engines to utilize biogas for electricity production, the project will also add an additional renewable generation source to the PNG Power Kimbe grid. In doing so, the project helps to increase the amount of environmentally safe renewable electricity which is generated in Papua New Guinea.
Description
The project will be developed in two phases: Phase I: The installation of one unit covered digestor with two units of biogas engine (2 x 953kW) Phase II: The installation of another one units of biogas engine once the project activity is connected to the grid. Thus, the total of three units (3 x 953kW) of biogas engine will be exporting the generated electricity to the grid after meeting internal company deamnd. The aspects related to QA/QC of the monitoring plan are addressed as the following: 1. On-site measurement/sampling 2. Equipment maintenance and calibration 3. Audit and Corrective Actions 4. Training and Communication 5. Record-keeping and Documentation All measurements will use calibrated measurement equipment that will be maintained regularly and checked for its functioning.
Nature of Action
Infrastructure development, Technology
sector
Energy industry, Waste handling and disposal
GHG covered
CH_4
duration
2012 - 2019 (crediting period)
status
Completed
implementing institution
New Britain Palm Oil Limited (NBPOL)
quantitative targets
The total emission reductions from the project activity are estimated to be 63,005 tCO2 eq. per year over the period of 7 years of crediting periods.
Methodologies and Assumptions
AMS-III.H. ver. 16 - Methane recovery in wastewater treatment AMS-I.D. ver. 16 - Grid connected renewable electricity generation

Progress of the mitigation action
Name of the progress indicators
Amount of GHG reduced
Unit
tCO_2 eq./yr
Base year
2012
Baseline emissions
2012: 11,065 tCO2 eq/yr 2013: 76,108 tCO2 eq/yr
Project emissions
2012: 7,177 tCO2 eq/yr 2013: 30,619 tCO2 eq/yr
indicator target value
63,005 tCO2 eq.yr
Reduction impacts in the last reporting year
45,489 tCO2 eq./yr (2013)
Most relevant data sources for indicator value
CDM Monitoring report (https://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1310693618.63/view)

Summary of the mitigation action

Name of Mitigation action

RE generated from Methane capture Numudo POME methane capture project

Objectives

This CDM project aims to reduce methane emissions generated by the open anaerobic lagoon wastewater treatment system in Numundo Palm Oil Mill. This is achieved by introducing an in-ground anaerobic digester ponds which will recover biogas as renewable energy for use in the mill displacing the fossil fuel usage at plant and also supply to the grid reducing the fossil fuel load in grid.

Through the installation of a dedicated engine to utilize biogas for electricity production, the project will also add an additional renewable generation source in West New Britain. In doing so, the project helps to increase the amount of environmentally safe renewable electricity which is generated in Papua New Guinea.

Description

The project will be developed in two phases:

Phase I: The installation of one unit covered digestor with two units of biogas engine (2 x 953kW)

Phase II: The installation of another two units of biogas engine once the project activity is connected to the grid.

Thus, the total of four units (4 x 953kW) of biogas engine will be exporting the generated electricity to the grid after meeting internal company deamnd.

The aspects related to QA/QC of the monitoring plan are addressed as the following:

1. On-site measurement/sampling
2. Equipment maintenance and calibration
3. Audit and Corrective Actions
4. Training and Communication
5. Record-keeping and Documentation

All measurements will use calibrated measurement equipment that will be maintained regularly and checked for its functioning.

Nature of Action

Infrastructure development, Technology

sector

Energy industry, Waste handling and disposal

GHG covered

CH_4

duration

2015 - 2021 (crediting period)

status

Under planning

implementing institution

New Britain Palm Oil Limited (NBPOL)

quantitative targets

The total emission reductions from the project activity are estimated to be 54,362 tCO2 eq. per year over the period of 7 years of crediting periods.

Methodologies and Assumptions

AMS-III.H. ver. 15 - Methane recovery in wastewater treatment

AMS-I.D. ver. 16 - Grid connected renewable electricity generation

AMS-I.A. ver. 14 - Electricity generation by the user

Progress of the mitigation action

Name of the progress indicators

Amount of GHG reduced

Unit

$tCO_2eq./yr$

Base year

2015

Baseline emissions

2015: 71,573tCO2 eq/yr

2016: 86,489tCO2 eq/yr

2017: 84,440tCO2 eq/yr

2018: 79,966tCO2 eq/yr

2019: 72,304tCO2 eq/yr

2020: 66,905tCO2 eq/yr

2021: 65,616tCO2 eq/yr

Project emissions

This project have not yet been implemented yet.

indicator target value

54,362tCO2 eq./yr

Reduction impacts in the last reporting year

This project have not yet been implemented yet.

Most relevant data sources for indicator value

CDM Monitoring report

(https://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1312421071.87/view)

Summary of the mitigation action
Name of Mitigation action
RE generated from Methane capture Kapiura POME methane capture project
Objectives
This CDM project aims to reduce methane emissions generated by the open anaerobic lagoon wastewater treatment system in Kapiura Palm Oil Mill. This is achieved by introducing an inground anaerobic digester pond which will recover biogas as renewable energy for use in the mill displacing the fossil fuel usage at plant and also supply to the grid reducing the fossil fuel load in grid. Through the installation of a dedicated engine to utilize biogas for electricity production, the project will also add an additional renewable generation source in West New Britain. In doing so, the project helps to increase the amount of environmentally safe renewable electricity which is generated in Papua New Guinea
Description
The project will be developed in two phases: Phase I: The installation of one unit covered digestor with two units of biogas engine (2 x 953kW) Phase II: The installation of another one unit of biogas engine once the project activity is connected to the grid. Thus, the total of four units (3 x 953kW) of biogas engine will be exporting the generated electricity to the grid after meeting internal company deamnd. The aspects related to QA/QC of the monitoring plan are addressed as the following: 1. On-site measurement/sampling 2. Equipment maintenance and calibration 3. Audit and Corrective Actions 4. Training and Communication 5. Record-keeping and Documentation All measurements will use calibrated measurement equipment that will be maintained regularly and checked for its functioning.
Nature of Action
Infrastructure development, Technology
sector
Energy industry, Waste handling and disposal
GHG covered
CH_4
duration
2013 - 2019
status
Under planning
implementing institution
New Britain Palm Oil Limited (NBPOL)
quantitative targets
The total emission reductions from the project activity are estimated to be 63,801 tCO2 eq. per year over the period of 7 years of crediting periods.
Methodologies and Assumptions
AMS-III.H. ver. 16 - Methane recovery in wastewater treatment AMS-I.D. ver. 17 - Grid connected renewable electricity generation AMS-I.A. ver. 14 - Electricity generation by the user

Progress of the mitigation action
Name of the progress indicators
Amount of GHG reduced
Unit
tCO_2 eq./yr
Base year
2013
Baseline emissions
2013: 72,103 tCO2 eq/yr 2014: 87,343 tCO2 eq/yr 2015: 90,168 tCO2 eq/yr 2016: 91,784 tCO2 eq/yr 2017: 96,798 tCO2 eq/yr 2018: 96,099 tCO2 eq/yr 2019: 93,176 tCO2 eq/yr
Project emissions
This project have not yet been implemented yet.
indicator target value
63,801 tCO2 eq.yr
Reduction impacts in the last reporting year
This project have not yet been implemented yet.
Most relevant data sources for indicator value
CDM Monitoring report (https://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1329281642.19/view)

Summary of the mitigation action

Name of Mitigation action

RE generated from Methane capture Hagita POME methane capture project

Objectives

This CDM project aims to reduce methane emissions generated by the open anaerobic lagoon wastewater treatment system in Hagita Palm Oil Mill. This is achieved by introducing an inground anaerobic digester pond which will recover biogas as renewable energy for use in the mill displacing the fossil fuel usage at plant and also supply to the grid reducing the fossil fuel load in grid.

Through the installation of dedicated engines to utilize biogas for electricity production, the project will add an additional renewable generation source in Milne Bay Province. In doing so, the project helps to increase the amount of environmentally safe renewable electricity which is generated in Papua New Guinea.

Description

The project will be developed in two phases:

Phase I: PNG Power electricity grid not yet connected to site. The biogas will be combusted in biogas gensets and electricity supplied for use in the project activity equipment and the Hagita mill and associated compounds when the biomass boiler is not in operation. Biogas will also be channelled and combusted in the existing biomass boiler when needed.

Phase II: – site connected to the PNG Power electricity grid. The biogas will be combusted in biogas gensets and electricity supplied to the grid and for use in the project activity equipment, as well as the Hagita mill and associated compounds when the biomass boiler is not in operation. Biogas will also be channelled and combusted in the existing biomass boiler when needed.

The aspects related to QA/QC of the monitoring plan are addressed as the following:

1. On-site measurement/sampling
2. Equipment maintenance and calibration
3. Audit and Corrective Actions
4. Training and Communication
5. Record-keeping and Documentation

All measurements will use calibrated measurement equipment that will be maintained regularly and checked for its functioning.

Nature of Action

Infrastructure development, Technology

sector

Energy industry, Waste handling and disposal

GHG covered

CH_4

duration

2014 - 2024

status

Under planning

implementing institution

New Britain Palm Oil Limited (NBPOL)

quantitative targets

The total emission reductions from the project activity are estimated to be 44,998 tCO2 eq. per year over the period of 10 years of crediting periods.

Methodologies and Assumptions

AMS-III.H. ver. 16 - Methane recovery in wastewater treatment

AMS-I.D. ver. 17 - Grid connected renewable electricity generation

AMS-I.A. ver. 14 - Electricity generation by the user

Progress of the mitigation action

Name of the progress indicators

Amount of GHG reduced

Unit

tCO_2 eq./yr

Base year

2014

Baseline emissions

2014*: 23,188 tCO2 eq/yr

2015: 52,208 tCO2 eq/yr

2016: 56,821 tCO2 eq/yr

2017: 56,821 tCO2 eq/yr

2018: 56,821 tCO2 eq/yr

2019: 56,821 tCO2 eq/yr

2020: 56,821 tCO2 eq/yr

2021: 56,821 tCO2 eq/yr

2022: 56,821 tCO2 eq/yr

2023: 56,821 tCO2 eq/yr

2024*: 28,411 tCO2 eq/yr

*taking into account start and end date of project

Project emissions

This project have not yet been implemented yet.

indicator target value

44,998 tCO2 eq.yr

Reduction impacts in the last reporting year

This project have not yet been implemented yet.

Most relevant data sources for indicator value

CDM Monitoring report

(https://cdm.unfccc.int/Projects/DB/RWTUV1348641543.49/view)

Summary of the mitigation action

Name of Mitigation action

RE generated from Methane capture Sangara POME methane capture project

Objectives

This CDM project aims to reduce methane emissions generated by the open anaerobic lagoon wastewater treatment system in Sangara Oil Mill. This is achieved by introducing an inground anaerobic digester pond which will recover biogas as renewable energy for use in the mill displacing the fossil fuel usage at plant and also supply to the grid reducing the fossil fuel load in grid.

Through the installation of dedicated engines to utilize biogas for electricity production, the project will add an additional renewable generation source in Oro Province. In doing so, the project helps to increase the amount of environmentally safe renewable electricity which is generated in Papua New Guinea.

Description

The project will be developed in two phases:

Phase I: PNG Power electricity grid not yet connected to site. The biogas will be combusted in biogas gensets and electricity supplied for use in the project activity equipment and the Sangara mill and associated compounds when the biomass boiler is not in operation. Biogas will also be channelled and combusted in the existing biomass boiler when needed.

Phase II: site connected to the PNG Power electricity grid. The biogas will be combusted in biogas gensets and electricity supplied to the grid and for use in the project activity equipment, as well as the Sangara mill and associated compounds when the biomass boiler is not in operation. Biogas will also be channelled and combusted in the existing biomass boiler when needed.

The aspects related to QA/QC of the monitoring plan are addressed as the following:

1. On-site measurement/sampling
2. Equipment maintenance and calibration
3. Audit and Corrective Actions
4. Training and Communication
5. Record-keeping and Documentation

All measurements will use calibrated measurement equipment that will be maintained regularly and checked for its functioning.

Nature of Action

Infrastructure development, Technology

sector

Energy industry, Waste handling and disposal

GHG covered

CH_4

duration

2014 - 2024 (crediting period)

status

Under planning

implementing institution

New Britain Palm Oil Limited (NBPOL)

quantitative targets

The total emission reductions from the project activity are estimated to be 58,515 tCO2 eq. per year over the period of 10 years of crediting periods.

Methodologies and Assumptions

AMS-III.H. ver. 16 - Methane recovery in wastewater treatment

AMS-I.D. ver. 17 - Grid connected renewable electricity generation

AMS-I.A. ver. 14 - Electricity generation by the user

Progress of the mitigation action

Name of the progress indicators

Amount of GHG reduced

Unit

tCO_2 eq./yr

Base year

2014

Baseline emissions

2014*: 14,774 tCO2 eq/yr
2015: 64,631 tCO2 eq/yr
2016: 72,595 tCO2 eq/yr
2017: 72,392 tCO2 eq/yr
2018: 71,057 tCO2 eq/yr
2019: 69,467 tCO2 eq/yr
2020: 69,246 tCO2 eq/yr
2021: 67,265 tCO2 eq/yr
2022: 67,265 tCO2 eq/yr
2023: 67,265 tCO2 eq/yr
2024*: 50,448 tCO2 eq/yr
*taking into account start and end date of project

Project emissions

This project have not yet been implemented yet.

indicator target value

58,515 tCO2 eq/yr

Reduction impacts in the last reporting year

This project have not yet been implemented yet.

Most relevant data sources for indicator value

CDM Monitoring report
(https://cdm.unfccc.int/Projects/DB/RWTUV1347967607.62/view)

Summary of the mitigation action

Name of Mitigation action

RE generated from Methane capture Warastone POME methane capture project

Objectives

This CDM project aims to reduce methane emissions by introducing an in-ground anaerobic digester ponds which will recover biogas as renewable energy for use in the mill, mill residential compound and Numundo abattoir, that otherwise would get emitted to atmosphere from the open anaerobic lagoon wastewater treatment system which could generally would have got installed at Warastone Palm Oil Mill.

Through the installation of a dedicated engines to utilize biogas for electricity production, the project will also add an additional renewable generation source in West New Britain. In doing so, the project helps to increase the amount of environmentally safe renewable electricity which is generated in Papua New Guinea.

Description

In this project, two sets of 953 kWe (2 x 953kW) biogas generators will be installed with a total installed capacity is estimated at 1,906 kW (1.906MW).

The aspects related to QA/QC of the monitoring plan are addressed as the following:

1. On-site measurement/sampling
2. Equipment maintenance and calibration
3. Audit and Corrective Actions
4. Training and Communication
5. Record-keeping and Documentation

All measurements will use calibrated measurement equipment that will be maintained regularly and checked for its functioning.

Nature of Action

Infrastructure development, Technology

sector

Energy industry, Waste handling and disposal

GHG covered

CH_4

duration

2013 - 2019

status

Construction of this project have not yet started

implementing institution

New Britain Palm Oil Limited (NBPOL) (West New Britain)

quantitative targets

The total emission reductions from the project activity are estimated to be 46,720 tCO2 eq. per year over the period of 7 years of crediting periods.

Methodologies and Assumptions

AMS-III.H. ver. 15 - Methane recovery in wastewater treatment

Progress of the mitigation action

Name of the progress indicators

Amount of GHG reduced

Unit

tCO_2 eq./yr

Base year

2013

Baseline emissions

2013 - 66,524 tCO2 eq
2014 - 66,524 tCO2 eq
2015 - 66,524 tCO2 eq
2016 - 66,524 tCO2 eq
2017 - 66,524 tCO2 eq
2018 - 66,524 tCO2 eq
2019 - 66,524 tCO2 eq

Project emissions

This project has not yet started

indicator target value

46,720 tCO2 eq.yr

Reduction impacts in the last reporting year

This project has not yet started

Most relevant data sources for indicator value

CDM Monitoring report
(https://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1312857037.54/view)

Summary of the mitigation action
Name of Mitigation action
RE generated from Biomass Project
Objectives
To provide reliable baseload power to new demand and movement from diesel self-generation on to grid supply for households and industries, businesses, and government customers on the Ramu grid
Description
The project consist of the installation of a new grid-connected power plant with a total installed average dispatchable capacity of 30MW, composed of generation units with maximum generation capacity of 36MW before auxiliary and wood chipping power usage. The project involves the development of around 15,000 ha of dedicated fuel wood plantations. This project is registered under the Gold Standards carbon credits The project will be monitored using the monitoring plan and monitoring reports will be published annually by the implementing agency. Data monitoring will include (i) Metering the electricity generation from the power system (ii) Recording the biomass material consumption (differentiated by type and source) (iii) Recording the amount of non-coking coal co-fired in the boiler (iv) Recording biomass growth verification period (v) Recording the amount of water used in the energy process (vi) Recording the amount of residues reused in an enriched compost (fly ash) (vii) Recording the off-site electricity consumption
Nature of Action
Economic development
sector
Energy industry
GHG covered
CO_2
duration
2022-2047
status
Construction phase of the Biomass plant unit
implementing institution
PNG Biomass Markham Valley Energy project
quantitative targets
Average emissions reduced from the project is estimated to be 153,375 tCO2 per year for a period of 5 years crediting period and will be renewed twice until 15 years are completed.
Methodologies and Assumptions
ACM0018: Electricity generation from biomass in power-only plants version 4.0
Progress of the mitigation action
Name of the progress indicators
Amount of CO2 reduced
Unit
tonnes/year
Base year
2022
Indicator baseline value
2022 - 133,519 tCO2 2023 - 147,862 tCO2 2024-157,244 tCO2 2025-163,221 CO2 2026- 165,030 CO2
Indicator value in the last reporting year
Still under construction
indicator target value
153,375 tCO2/year
Reduction impacts in the last reporting year
Still under construction
Most relevant data sources for indicator value
PNG Biomass Sustainability report

Summary of the mitigation action
Name of Mitigation action
Aforestation and Reforestation
Objectives
The main objective of the plantation is to produce fuel for the next 25 years to be used in a biomass plant
Description
The project consist of the establishment of 15,000 ha of eucalyptus plantations on unimproved open grassland This project is registered under the Gold Standards carbon credits QA/QC procedures will be implemented to ensure that net GHG removals are measured and monitored precisely, credibly, verifiable, and transparently. These procedures are described in the Standard Operating Procedures (SOP) that PNG Biomass has already developed for the different activities of the project such as the establishment, maintenance and measurement of the forest plantations.
Nature of Action
Land conversion
sector
LULUCF
GHG covered
CO_2
duration
2018 - 2048
status
A total area 12,400 ha of plantation have been established
implementing institution
PNG Biomass Markham Valley Energy project
quantitative targets
Average annual emissions reduced from the project is estimated to be 21,224 tCO2 per year over the 30 years crediting period
Methodologies and Assumptions
(i) Gold Standard Afforestation/Reforestation (A/R) GHG Emissions Reduction & Sequestration
Progress of the mitigation action
Name of the progress indicators
Amount of CO2 reduced
Unit
tonnes/year
Base year
2018
Indicator baseline value
-583,849
Indicator value in the last reporting year
Haven't commenced yet with accounting of reduced emissions
indicator target value
21,224 tCO2/year
Reduction impacts in the last reporting year
Haven't commenced yet with accounting of reduced emissions
Most relevant data sources for indicator value
PNG Biomass Sustainability report

3.5. Information on the Description of Domestic MRV

The BUR1 outlined the REDD+ MRV system that is being used for monitoring the progress of REDD+ activities captured in PNG's National REDD+ Strategy. The current domestic MRV arrangement builds on the previous MRV system and was formulated during the preparation of the Enhanced NDC that was submitted to the UNFCCC in 2020. The domestic MRV arrangement is part of the governance structure that governs and monitors the progress of the activities and projects that will be implemented to achieve the mitigation and adaptation targets in the Enhanced NDC. These activities and projects are outlined in the Enhanced NDC Implementation Plan (2021-2030), NDC Implementation Road map for the Electricity sector and NDC Implementation Road map for the AFOLU sector.

The Climate Change (Management) (Nationally Determined Contribution) Regulation 2022 have been prepared to provide a regulatory framework for the implementation of PNG's NDCs. Among other thing, the regulation provides for the establishment of Technical Advisory Committee and Sub-Technical Working Committees; formal recognition of targets contained in the NDCs; development of implementation plan; implementation measures; and monitoring, reporting and verification. The current domestic MRV arrangement can be seen in the figure 3-4 below.

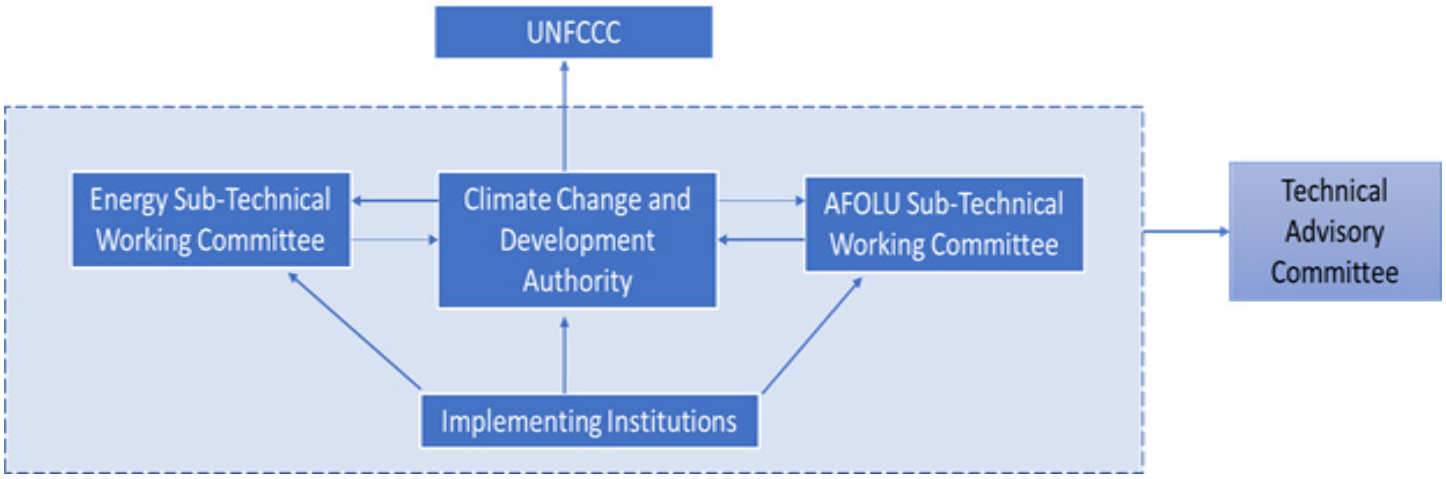


Figure 3-4 Domestic MRV arrangement

3.5.1. Implementing Institutions

Implementing institutions communicate the progress of NDC implementation activities or projects, development partners engagements including information on funds allocated and disbursed. to the Sub-Technical Working Committees and CCDA. In addition to this, they also communicate the funding gaps, technical and capacity needs as well as policy-related hurdles. List of implementing institutions for each NDC implementation activity or project is captured in table 3-2.

3.5.2. CCDA

CCDA is the central coordinating agency for all NDC implementation activities and projects that will achieve the NDC targets. CCDA works closely with the implementing institutions and Sub Technical Working Committees to collate information on project implementation including the support received and needed. CCDA then prepares the UNFCCC communications which captures the information provided by the implementing institutions.

3.5.3. Sub-Technical Working Committees

PNG established two Sub Technical Working Committees (STWC) for the Energy and AFOLU sectors based on the mitigation targets in the Enhanced NDC. The STWCs consist of technical experts from the public and private sectors as well as Non-Governmental Organizations in the Energy and AFOLU sectors. The STWCs are responsible for verifying the UNFCCC communications prepared by CCDA prior to the submission to the UNFCCC. The Climate Change (Management) (Nationally Determined Contribution) Regulation 2022 give provision to establish additional sectoral STWCs depending on future NDC targets.

3.5.4. Technical Advisory Committee

The Technical Advisory Committee consist of heads of relevant government agencies as well as senior management level in the private sector and non-government organisations. Among other functions of the TAC as contained in the Climate Change (Management) (Nationally Determined Contribution) Regulation 2022, the functions with relations to MRV are:

(i) To monitor the implementation of the targets under the NDC in accordance with the Implementation Plan; and

(ii) To coordinate data collection; and

(iii) To coordinate the activities of the sub-committees.

4. Support Needed and Received

This chapter captures the support needed and the support that has been received by PNG to implement climate change activities in the country.

4.1. Support Needed

The financing, capacity and technology needs in relation to climate change (mitigation, adaptation, reports, inventories, international negotiation) increase the vulnerability of the country. Obstacles and gaps must be constantly overcome to enable the implementation of climate change policies.

In a developing country like Papua New Guinea, climate change policies and strategies come up to compete with other national priorities, such as health, education and road in fractures development.

Through the Sub Technical Working Group Meetings and stakeholder consultations and views information gathering has been made through this chapter with regard to the needs, gaps and barriers in three main areas;

1) GHG Inventory Process – *From Data Collection, Measurement, Reporting & Verification*
2) Mitigation Activities in Papua New Guinea identified through sector lead - *Implementing Agencies*
3) Adaptation Activities in Papua New Guinea identified through sector lead - *Implementing Agencies*

The mitigation and adaptation targets in PNG's Enhanced NDC are fully conditional to external support from the international community. During the preparation of the Enhanced NDC, the country has identified the type of support that it will require to achieve the Enhanced NDC targets. This support includes, financial needs, technology needs, technical and capacity building needs and are outlined in the Enhanced NDC Implementation Plan (2021-2030), NDC Implementation Road Map for the Electricity Sector and NDC Implementation Road Map for the AFOLU Sector.

4.1.1. Financial needs

According to the Enhanced NDC Implementation Plan (2021-2030), the financial resources required to implement the actions achieve the Enhanced NDC targets over the 10 years period is estimated to be in excess of 1 billion USD. The estimated cost to achieve the energy and AFOLU mitigation targets is 750 million USD. While the estimated cost to achieve the adaptation targets is 250 million USD. These figures are based on preliminary estimates thus a more in-depth analysis needs to be carried out to determine the real cost of implementing the activities in the Enhanced NDC Implementation Plan (2021-2030).

4.1.2. Technology needs

The technology needs for the energy sector as identified in the Enhanced NDC Implementation Plan (2021-2030) and the NDC Implementation Road Map for the Electricity Sector includes the development of solar systems and mini hydro system that will displace the fuel-based generators that supply the on-grid system managed by PNG Power Limited. There are 10 proposed solar projects and 10 proposed hydro projects. In addition to this, there is also a proposed biomass electricity project. PNG also plans to introduce electric vehicles in the near future which may require the development of charging stations.

Technology needs under the LULUCF sector includes the establishment of monitoring systems assets under the forestry, agriculture, Land and environment sectors. This will be used to monitor the progress of the actions identified in the Enhanced NDC Implementation Plan (2021-2030) and the NDC Implementation Road Map for the AFOLU Sector. Such systems would also be helpful to inform future plans and policies.

The technology needs under adaptation identified in the Enhanced NDC Implementation Plan (2021-2030) are for the transport and infrastructure development. Technology needs for transport includes climate resilient transport infrastructures for all modes of transport inclusive of airports, wharves roads and bridges. In addition to this, there is need for an early warning system asset.

There is a need to conduct a thorough technology needs assessment in PNG to identify more country specific technology needs since those identified above are based on preliminary assessments.

4.1.3. Technical and Capacity Building Needs

Technical and capacity building needs in PNG are needed in the different climate change action areas which includes adaptation, mitigation, GHG inventory and cross cutting. Table 4-1 below outlines the type of technical and capacity building needs under each of this action area.

Table 4-1 Technical and capacity building needs for each climate change action area

Climate Change Action Area	Technical and Capacity Building Needs
Cross cutting	- Development of sectoral policies to address climate change issues - Monitoring and Evaluation (M&E) knowledge and skills - Technology Needs Assessment - Financial needs analysis
Adaptation	- Vulnerability Needs Assessment (VNA) knowledge and skills - Climate Induced Hazard modelling knowledge and skills
Mitigation	- Mitigation impact assessment - Sustainable development assessment - Transformative change assessment - Understanding of different tools used for mitigation assessment, sustainable development assessment and transformative change assessment
GHG Inventory	- Enhanced understanding of 2006 IPCC guidelines - Understanding of 2019 refinement to the 2006 IPCC guidelines - Data achieving and management skills - Understanding of different tools used for GHG inventory - Uncertainty analysis knowledge and skills - QA/QC knowledge and skills

4.2. Support Received for Climate Change Activities

Papua New Guinea has submitted it BUR1 and has been able to receive financial and technical support to assist in its implementation of climate change activities in the country. Within this section, it contains a summary of climate change initiatives for which has been classified according to the type of support received:

- Financial Resources;
- Capacity building and technical assistance;
- Technology transfer

The base year in which financial resources have been set in the period between 2017-2022. Other funding resources such as the Official Development Assistance (ODA) due to its relevance in the international cooperation. It has also assisted in PNG's efforts in its climate change agenda which is envisioned to continue in the future. Table 4-2 below provides a list of support PNG has received from 2017-2022. It should be noted that this is not an exhaustive list as proper framework needs to be in place to monitor the support that has been received in the country.

Table 4-2 List of support received from 2017 to current

Project	Source of support	Status	How support was received	Area of support	Type of support	Financial instrument	Implementing agency (s)	Duration	Amount
Solar farm & integrated water supply for rural communities	GIZ& European Union (EU)	Ended	Multilateral	Adaptation and Mitigation	Technology transfer and technical assistance	Grant	National Energy Authority (NEA), Central Provincial Government, PNG Power and Water PNG	2016-2018	EURO 1 million
Building Resilience to Climate Change in Papua New Guinea	Asian Development Bank	ongoing	Multilateral	Adaptation	Technology transfer, technical assistance and capacity building	Grant	PNG Ports, NFA, National Agriculture Research Institute, Department of Agriculture and Livestock and CCDA	2016-2023	USD 32.23 Million
Forest Carbon Partnership Facility Readiness Preparation Grant-Top up fund (Project 2)	World Bank FCPF	Ended	Multilateral	Mitigation	Technical Assistance and Capacity Building	Grant	UNDP, CCDA, PNGFA, CEPA, DAL, DLPP, DNPM	2018-2020	USD 5.2 Million
REDD+ Program – Technical Assistance & Capacity Building	Italy Government (Italy-PNG MOU) & CfRN	Ended	Bilateral	Mitigation	Technical Assistance and Capacity Building	Grant	CCDA	2017-2019	EUR 400,000
Facilitating Renewable Energy & Energy Efficiency Applications for Greenhouse Gas Emission Reduction (FREAGER)	GEF	Ongoing	Multilateral	Mitigation	Technology transfer, technical assistance, and capacity building	Grant	CCDA, PPL, Eastern Highlands Provincial Government, East Sepik Provincial government Fund Accredited Agency UNDP	2017 - 2021	USD 3,140,640
Strengthening capacity in the agriculture and land-use sectors for the enhanced transparency framework	GEF	Ended	Multilateral	MRV	Technical Assistance and Capacity Building	Grant	CCDA, PNGFA & DAL Fund accredited agency FAO	2018-2021	USD 1 Million
Pacific Appliance Labelling and Standards	Australian Government	Ended	Multilateral	Mitigation	Technical Assistance and Capacity Building	Grant	CCDA & Accredited agency-SPC	2017-2018	
Preparation of the First Biennial Update Report and Third National Communication under the UN Framework Convention on Climate Change (UNFCCC)	GEF	Ended	Multilateral	MRV	Technical Assistance and Capacity Building	Grant	CCDA, NSO, NWS, CEPA, PNGFA, DNPM, DAL, DPE, DoT, DLPP Fund Accredited Agency UNEP	2014 - 2020	USD 832,000

Project	Source of support	Status	How support was received	Area of support	Type of support	Financial instrument	Implementing agency (s)	Duration	Amount
Project for enhancing capacity to develop a sustainable GHG inventory system for PNG	JICA	Ended	Bilateral	MRV	Technical Assistance and Capacity Building	Grant	CCDA, PNGFA, DAL, CEPA, Water PNG, NCDC, PPL, NEA	2017-2020	K8,700,000
Capacity Development for Operationalization of PNG National Forest Resource Information Management System (FRIMS) for Addressing Climate Change	JICA	Ended	Bilateral	Cross-cutting	Technical Assistance and Capacity Building	Grant	PNGFA Accredited agency & JICA	2014-2019	K 20.3 million
USAID Climate Ready	United States Agency for International Development (USAID)	Ended	Bilateral	Adaptation	Technical Assistance and Capacity Building		CCDA and USAID	2017 - 2021	
Advancing Papua New Guinea's National Adaptation Plan	GCF	Ongoing	Multilateral	Adaptation	Technical Assistance and Capacity Building	Grant	UNDP & CCDA	2020-2022	USD 1,890,000
Enhancing Adaptive Capacity of communities to climate change-related floods in the North Coast and Islands Region of PNG	Adaptation fund	Ended	Multilateral	Adaptation	Technical Assistance and Capacity Building	Grant	CCDA, UNDP, Provincial Governments, NGOs	2012-2017	USD 6.3 million
Climate-Smart Agriculture opportunities for enhanced food production in PNG (C-SMART) Project	Australian Government	Ongoing	Bilateral	Adaptation	Technical Assistance and Capacity Building	Grant	CCDA, DAL, NARI & NWS	2019-2023	AUD 2.6 million
Climate Readiness (USAID-CR) Project	United States Agency for International Development (USAID)	Ongoing	Bilateral	Adaptation	Technical Assistance and Capacity Building	Grant	CCDA, Government partners	2016-2022	USD 23.9 million
Biodiversity conservation through PNG Policy on protected areas	JICA	Ongoing	Bilateral	Cross-cutting	Technical Assistance and Capacity Building	Grant	CCDA, CEPA, PNGFA, DAL, DLPP, DNPM, UNDP	2015-2020	K 15.3 million
GCF Readiness and Preparatory Support Programme	GCF	Ended	Multilateral	Cross-cutting	Technical Assistance and Capacity Building	Grant	CCDA	2019-2020	USD 983,030

Project	Source of support	Status	How support was received	Area of support	Type of support	Financial instrument	Implementing agency (s)	Duration	Amount
Establishing Systems for Sustainable Integrated Land-Use	GEF Other Partners	Ongoing	Multilateral	Cross-cutting	Technical Assistance and Capacity Building	Grant	UNDP, CEPA, DAL, PNGFA, DLPP, DNPM	2021-2026	USD 10.7 Million USD 49 million
Planning across New Britain Island in PNG									
Strengthening Integrated Sustainable Landscape Management in Enga Province Papua New Guinea	EU	Ongoing	Multilateral	Cross-cutting	Technical Assistance and Capacity Building	Grant	UNDP, CEPA, DAL, PNGFA, DLPP, DNPM	2021-2025	USD 5.4 million
Capacity building to strengthen sustainable implementation of renewable energy technologies for rural energy access (Pacific regional program)	Korean International Cooperation Agency (KOICA)	Ongoing	Multilateral	Mitigation	Capacity building	Grant	GGGI/Pacific Islands Development Forum	2018-2021	USD 1,500,000 (Total for the regional program)
Readiness support to strengthen Papua New Guinea's engagement with the Green Climate Fund	Green Climate Fund and Korean International Cooperation Agency	Ended		Cross-cutting	Capacity building	Grant	GGGI	2017-2020	USD 827,427
Papua New Guinea Capacity building on Climate Change Project Identification and Development	Korean International Cooperation Agency (KOICA)			Cross-cutting	Capacity building	Grant	GGGI	2018-2019	USD 112,830
Readiness for registry and nesting system to facilitate climate-related investments in agriculture, forest, and other land-use sector in PNG	GCF	Ongoing	Multilateral	MRV	Technical Assistance and Capacity Building	Grant	CCDA/PNGFA FAO	2021-2023	

Project	Source of support	Status	How support was received	Area of support	Type of support	Financial instrument	Implementing agency (s)	Duration	Amount
Climate Action Enhancement Package (CAEP)	NDC Partnership	Ended	Multilateral	Cross-cutting	Technical Assistance and Capacity Building	Grant	CCDA NDC Partnership support unit/GIZ (BMZ)/GGGI/IRENA/UNEP/FAO	2018-2021	
Climate Resilient Green Growth Project	Australia DFAT	Ongoing	Bilateral	Climate Action	Technical assistance	Grant	GGGI, CCDA, Enga, Milne Bay, New Irelands	2019 – 2022	USD 4.4 M
Training and Capacity Building for Climate Action	Australia DFAT	Ongoing	Bilateral	Climate Action	Capacity building	Grant	GGGI	20221	USD 600,000
Inclusive Green Finance Policy for PNG's banking sector	NZ MFAT	Ongoing	Bilateral	Climate Action	Technical Assistance	Grant	GGGI, CEFI	2021-2023	USD 140,615
Strengthening NDA Capacity on Project Evaluation and Development of Climate Finance Strategy to Enhance Papua New Guinea's Access to Climate Finance	GCF	Ongoing	Multilateral	Climate Action	Technical Assistance and Capacity building	Grant	GGGI	2022-2023	USD 290,774

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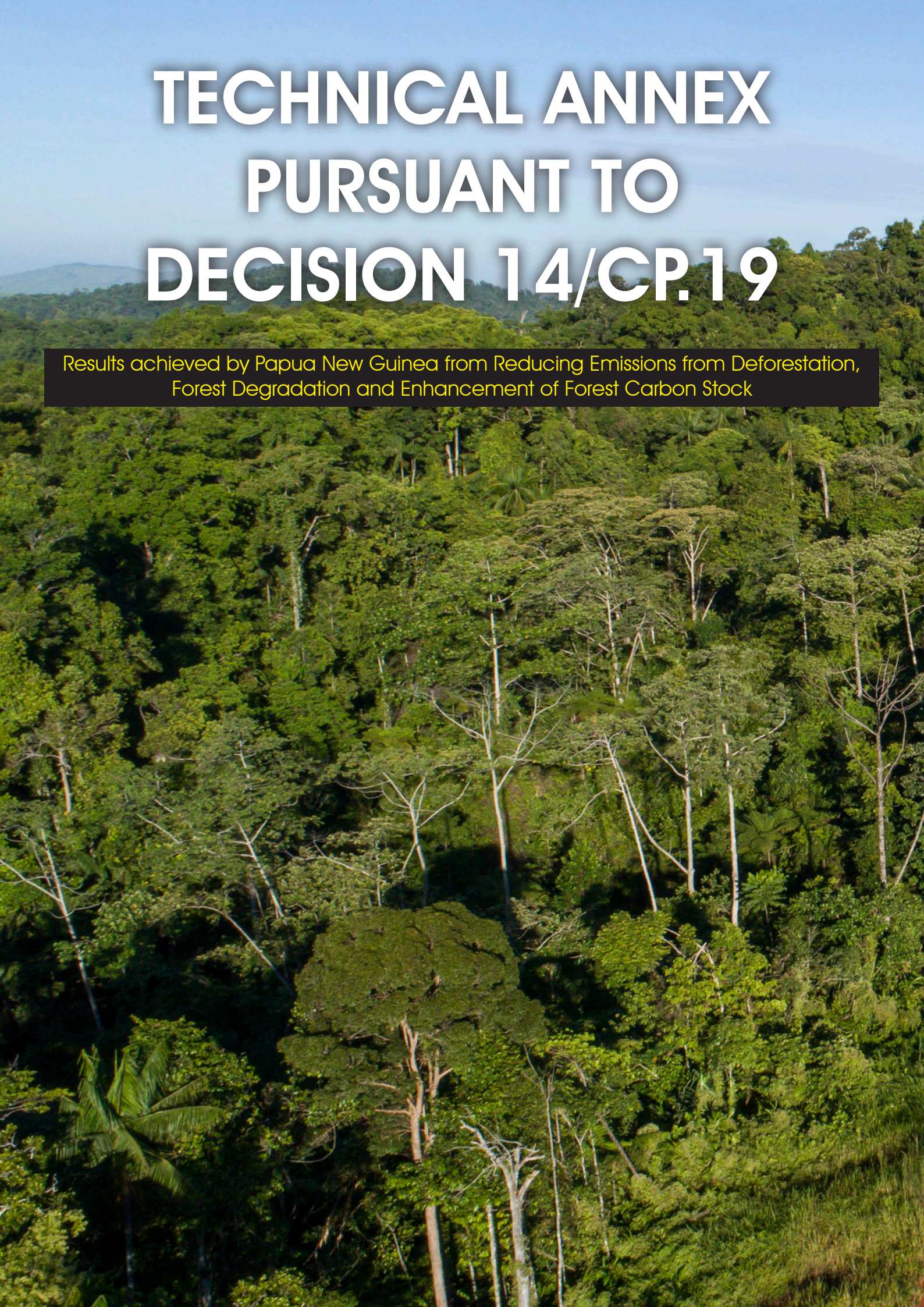
TECHNICAL ANNEX PURSUANT TO DECISION 14/CP.19

Results achieved by Papua New Guinea from Reducing Emissions from Deforestation, Forest Degradation and Enhancement of Forest Carbon Stock



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Executive summary

PNG submitted its national Forest Reference Level (FRL) to the UNFCCC in January 2017 which underwent Technical Assessment (TA) resulting in a modified FRL and a Technical Assessment Report. The modified FRL contains substantial additional information according to the guidance from the Assessment Team, and was resubmitted later in 2017. The TA of the FRL submitted by Papua New Guinea was undertaken in accordance with the guidelines and procedures for the TA of submissions from Parties on proposed FRELs and/or FRLs as contained in the annex to decision 13/CP.19. Based on the technically assessed FRL, PNG first calculated its REDD+ results achieved in 2014 and 2015 and reported the outcome in the technical annex to the country's First Biennial Update Report (BUR1) to UNFCCC in April 2019.

In the Technical Annex of this BUR2, PNG is reporting the REDD+ results for the period 2016-2018 against the Technically Assessed FRL (2017). The total results achieved by PNG in reducing emissions from deforestation and forest degradation against the technically assessed FRL in that period (2016, 2017 and 2018) were equal to 61,341,155 tCO_2eq/year. PNG notes that the submission of this Technical Annex with REDD+ results is voluntary and exclusively for the purpose of obtaining and receiving results-based payments for its REDD+ actions, pursuant to decisions 13/CP.19, paragraph 2, and 14/CP.19, paragraphs 7 and 8. PNG would also like to participate in the Green Climate Fund (GFC) Results Based Payment (RBP) pilot programme for potential payment under its Phase 2 for results obtained in the years 2016, 2017, 2018, and later. PNG therefore calculated the REDD+ results assessed against a historical average FRL with an allowable upwards adjustment for the purpose of participating in the GCF RBP pilot programme. This was done in accordance with the GCF Scorecard which place restrictions on the construction approach for FREL/FRLs eligible for RBP beyond the UNFCCC modalities, allowing FREL/FRLs to only use historical average of emissions with a limited possible adjustment for high forest cover, low deforestation (HFLD) countries. Consistent with the GCF Scorecard and as an HFLD country, PNG reported a total REDD+ results of 47, 314,877 tCO_2eq/year for the years 2016, 2017 and 2018 assessed against the recalculated historical average FRL of 5-year (2009-2013) Historical Average plus 0.02% of total carbon stock in 2013.

These GHG emission reductions in the years 2016, 2017 and 2018 can be alluded to following policies and actions by GoPNG; (i) Awareness and educational activities on climate change and REDD+ have been extensively conducted throughout the country since OCCD was established; (ii) PNG moving away from Forest Clearance Authority (FCA) to the Forest Management Agreement (FMA) which has provisions for sustainable forest management, which is in line with the country's overall forestry priority and PNG's international commitment on REDD+; (iii) Implementation of the Medium Term Development Plan (2011-2015), Papua New Guinea Development Strategic Plan (2010- 2030) and the PNG Vision 2050 which discourage deforestation but promote reforestation/afforestation; (iv) Forestry and Climate Change Framework for Actions (2009-2015) which identifies afforestation, reduced deforestation and reforestation as means to mitigate climate change; and (v) Implementation of the Climate Compatible Development Plan for PNG by PNGFA in collaboration with CCDA. However elucidating what actions and policies contributed how much emission reduction would require separate study.

PNG has an operational and robust national REDD+ MRV System for monitoring and evaluating the REDD+ results achieved through the implementation of REDD+ activities (Deforestation and Forest degradation) to ensure that the results reported or claimed for the GCF RBP are maintained over the rest of the results period (2016-17-18) under the pilot programme. PNG is developing a REDD+ Registry with funding from its GCF REDD+ Readiness Project that will further enhance monitoring and evaluation of the REDD+ results reported.

1. Introduction

Papua New Guinea (PNG) completed and submitted its Forest Reference Level (FRL) to the UNFCCC in 2017, which shows the historical annual emissions from deforestation and forest degradation of 31 million tCO_2eq per annum, and it predicts an ongoing increase in the emissions levels. UNFCCC technical assessment process has been completed and the modified FRL was submitted and published on UNFCCC website. PNG's FRL covers the activities that "reduce emissions from deforestation", "reduce emissions from forest degradation" and "enhancement of forest carbon stocks", which are among the elements included in decision 1/CP.16, paragraph 70. This Technical Annex reports those results obtained by PNG in reducing emissions from deforestation, forest degradation, and enhancement of forest carbon stock for the period 2016, 2017, and 2018 against the Technically Assessed FRL with reference period of 2001 - 2013.

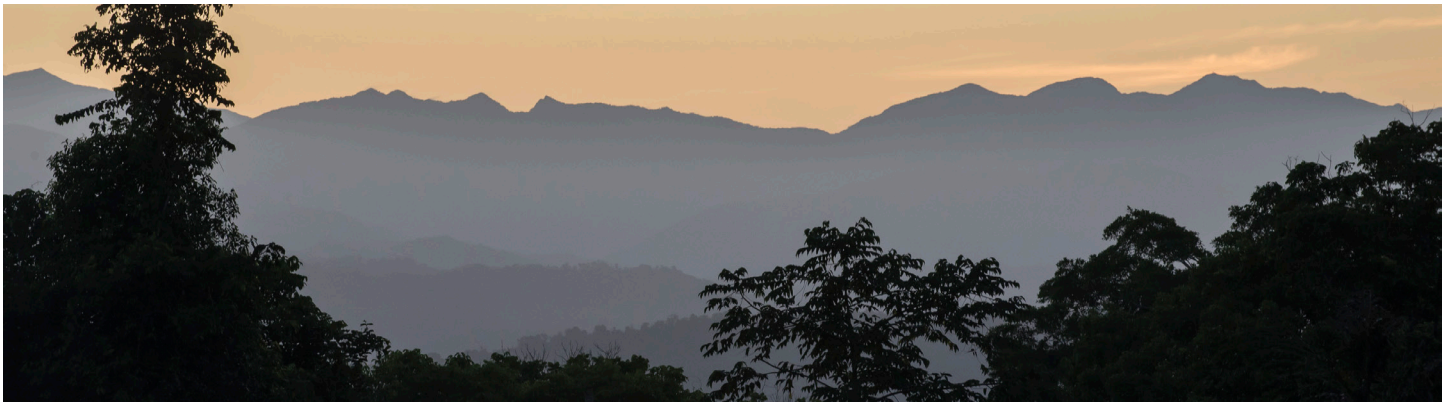
PNG would like to use the opportunity to submit this Technical Annex to its Second Biennial Update Report (BUR2) in the context of result-based payments for REDD+ under the UNFCCC. PNG notes that the submission of this Technical Annex with REDD+ results is voluntary and exclusively for the purpose of obtaining and receiving results-based payments for its REDD+ actions, pursuant to decisions 13/CP.19, paragraph 2, and 14/CP.19, paragraphs 7 and 8. This technical annex was prepared by the Government of PNG (GoPNG) with the technical support of the AFOLU Sub Technical Working Committee (STWC), and the REDD+ TWC, which comprise of members from Government, private sector, Academia, NGOs/CSOs, and development partners. The national experts within these committees also contributed in the development of FRL and its technical assessment.

This submission by GoPNG represents a second step in PNG's voluntary commitment to provide information on REDD+ results under the UNFCCC, building upon the experience of submitting PNG's First Technical Annex, which contained the results of reducing emissions from deforestation and forest degradation, and enhancement of forest carbon stock in the entire national territory of PNG from 2014 - 2015, measured against the Technically Assessed FRL which was completed and submitted by PNG to the UNFCCC in 2017.

1.1 Objectives for submitting the REDD+ results

The PNG's REDD+ results reported in this Technical Annex for the period 2016 - 2018 were assessed against the Technically Assessed FRL (2017). The technically assessed FRL uses regression model and a reference year of 2001-2013. This reporting was done for the purpose of completion of PNG's initial FRL period which is from 2014-2018; REDD+ results for 2014 and 2015 were reported in PNG's BUR1 to UNFCCC. Additionally, PNG also reports the REDD+ results against the GCF Reference Level in this technical annex which applies historical average + HFLD adjustment, a reference period of 2009-2013 and a results period of 2016-2018. This was done for potential payment under the GCF RBP Phase 2.

Prior to submitting BUR2, PNG has made significant progress towards developing capacities to establish its national REDD+ architecture to be eligible to receive results-based payments through the UNFCCC. PNG has also significantly improved the National Forest Monitoring System. PNG developed its National REDD+ Strategy in 2017 which outlines the key action areas across the forest, agriculture, land and environment sectors. PNG's Forest Reference Level (FRL) was submitted to the UNFCCC in 2017, which shows the historical annual emissions from deforestation and forest degradation increased from 20 to 38 million tCO_2eq per annum between 2001 and 2013, and it projects an ongoing increase in the emissions levels. PNG then submitted its First Biennial Update Report (BUR1) to the UNFCCC in 2019. BUR1 contains the REDD+ results during 2014-15 period as a Technical Annex. At the time of the BUR2 submission, PNG has successfully developed all four-design elements of the Warsaw Framework (National REDD+ Strategy, National Forest Monitoring System, Safeguard Information System, and FREL/FRL).



2. Summary Information from the Technically Assessed Forest Reference Level

PNG completed and submitted its Forest Reference Level (FRL) to the UNFCCC in 2017. UNFCCC technical assessment process has been completed and the modified FRL was submitted and published on UNFCCC website[10]. The national FRL by Papua New Guinea for the historical reference period 2001–2013 is the values of the carbon dioxide (CO_2) emissions for 2014–2018 projected using an equation based on a linear regression model. The FRL includes the emissions associated with deforestation, defined as the conversion of forest land to non-forest land; forest degradation, defined as the conversion from primary forest to disturbed forest; and forest carbon stock enhancement, defined as the conversion of non-forest land to forest land.

In accordance with decision 13/CP.19 and in the context of results-based payments, PNG proposed that its FRL covers the activities relating to "reducing emissions from deforestation", "reducing emissions from forest degradation" and "enhancement of forest carbon stocks", which are among the elements included in decision 1/CP.16, paragraph 70. The national FRL for the results period 2014 – 2018 has values corresponding to 43,369,737 (2014), 45,049,344 (2015), 46,728,951 (2016), 48,408,557 (2017) and 50,088,164 (2018) tonnes of carbon dioxide equivalent per year. The technical assessment (TA) of PNG's FRL took place (as a centralised activity) from 13 to 17 March 2017 in Bonn, Germany, and was coordinated by the UNFCCC secretariat[11]. It was noted by the assessment team that the data and information used by PNG in constructing its FRL were mostly transparent and complete and in overall accordance with the guidelines contained in the annex to decision 12/CP.17. Some modifications were made to the initial FRL submission as a result of the technical assessment resulting in a modified FRL submission.

The technical assessment (TA) process gave PNG the opportunity to provide clarifications and information that were considered by the Assessment Team (AT) in the preparation of the report[12]. As a result of the facilitative exchange with the AT during the TA session, PNG submitted a modified version of its FRL on 10 July 2017, which took into consideration the technical inputs by the AT. The modifications improved the clarity and transparency of the submitted FRL and altered the approach used to construct the proposed FRL. The TA report (TAR[13]) was prepared based on the modified FRL submission and was published on the UNFCCC website on 02 March 2018. The TAR contains the assessed FRL and a few areas identified by the assessment team for further technical improvement, according to the scope of the technical assessment in the annex to decision 13/CP.19. The modified submission that contains the assessed FRL and the original submission are available on the UNFCCC website as well as the REDD+ Web platform[14].

Table 1 PNG's FRL building blocks

Building blocks	Description
Forest definition	○ Tree crown cover ≥ 10%, an area of ≥ 1ha with trees able to attain a minimum height of 3 meters (m)
Data (AD & EF)	Activity Data (AD) ○ Annual time series data for 2000 to 2015 available ○ Accuracy Assessment – Done Emission Factors (EF) ○ Emission factors calculated for each of the identified strata based on 2006 IPCC Guidelines and country specific data ○ Future improvement planned using the data from National Forest Inventory currently under implementation
Scope	○ REDD+ Activities: Deforestation, Forest Degradation and Enhancement of Forest Carbon Stock ○ Pools: Below and above ground biomass ○ Gases (CO_2) first submission– other gases later
Scale	○ Agreement on National scale reached
Methodology	○ Reference period: 13 years (2000 – 2013) ○ Adjustment: Linear projection

10. https://redd.unfccc.int/submissions.html?country=png
11. Decision 13/CP.19, annex, paragraph 7.
12. Decision 13/CP.19, annex, paragraphs 1(b), 13 and 14.
13. https://unfccc.int/documents/65143
14. See https://redd.unfccc.int/submissions.html?country=png.

The following bullet points provide brief explanations on the key areas covered within the modified FRL submission according to the requirements outlined within decision 13/CP.19, as well as further and specific references within the modified FRL submission where details may be obtained.

- The REDD+ Activities included in the FRL are outlined on page 9 of the modified FRL submission and include deforestation, forest degradation and carbon stock enhancement. It provides specific explanations on the reasons for the selection of these activities as well as those not included.
- The national forest definition for the country is provided on page 6 of the modified FRL submission and provides the basis for determining whether deforestation, degradation, afforestation or reforestation was occurring.
- The Territorial Forest Area covered and Scale of the FRL is the national level with specific explanations on the reasons for this selection provided on page 11 of the modified FRL submission.
- Pools and Gases included in the FRL are explained in detail on page 10 of the modified FRL submission with details also provided on carbon pools not covered, and the reasons for their exclusion.
- The period (in years) of the assessed FRL are provided on page 11 of the modified FRL submission and outlines the detailed explanations on why these periods were selected.

3. Results of REDD+ Activities

3.1 The REDD+ results relative to the FRL in terms of CO_2 equivalent

Decision 14/ CP.19, paragraph 3, "agrees that the data and information used by Parties in the estimation of anthropogenic forest-related emissions by sources and removals by sinks, forest carbon stocks, and forest-area changes, as appropriate to the activities referred to in decision 1/CP.16, paragraph 70, undertaken by Parties, should be transparent, and consistent over time and with the established forest reference emission levels and/or forest reference levels in accordance with decision 1/CP.16, paragraph 71(b) and (c) and section II of decision 12/CP.17".

CO2 emissions from deforestation and forest degradation in Papua New Guinea in the period from 2001 to 2013, used in the construction of the FRL, were estimated using the formula:

Annual emission (tCO_2e) = 1,679,607 x Year -3,339,358,085[15]

For this Technical Annex, the REDD+ results for the years 2016, 2017, and 2018 were calculated using the same approach, simply by subtracting the Total Emissions and Removals values for that period from the FRL 2014 -2018 results. However, PNG realised that the linear extrapolation of post-deforestation removals would result in an over-estimation of emission reduction, i.e. an over-estimation of results, therefore it proposed a small correction as explained in section 3.2. So for year t, the reduced emissions from deforestation and forest degradation[16] were as follows:

REDD+Results (t)
=FRL (2014 to 2018)-Total Emissions and Removals at year t
-Post deforestation c correction at year t;(tCO_2/yr)

Hence, the emission reduction in 2016 corresponds to:

46, 728,951 tCO_2 - 31, 700,092 tCO_2 – 1, 251,557 tCO_2 = 13, 777,302 tCO_2eq/year, etc.

The total results achieved by PNG in reducing emissions by REDD+ activities from 2016 to 2018, was the sum of the results achieved for each year of the period shown in Table 2.

- **REDD+ Results Period (2016-2018)**

Table 2 REDD+ results in 2016, 2017 and 2018

Year	FRL emission	Actual emission	Post deforestation correction[17]	REDD+ results
	(t CO_2 eq/year)			
2016	46,728,951	31,700,092	1, 251,557	**13,777,302**
2017	48,408,557	22,462,875	1, 551,524	**24,394,158**
2018	50,088,164	25,039,130	1,879,340	**23,169,695**

Total REDD+ result achieved by PNG in the years 2016 - 2018 against the Technically Assessed FRL (2017) = 13,777,302 tCO_2 + 24,394,158 tCO_2 + 23, 169, 695 tCO_2 = **61,341,155** [18]**tCO_2eq/year** [(see Figure 1) (Refer to Table 3 for complete time series information)]

15. See page 35 of PNG's modified FRL at https://redd.unfccc.int/submissions.html?country=png.
16. It is important to note that PNG reports zero (0) removals from carbon stock enhancement in the historical reference period (2001 – 2013) and 2016-2018.
17. See section 3.2 Correction of post-deforestation removals for the description.
18. The one's place may be differently shown due to the rounding process. This also applies to Table 3.

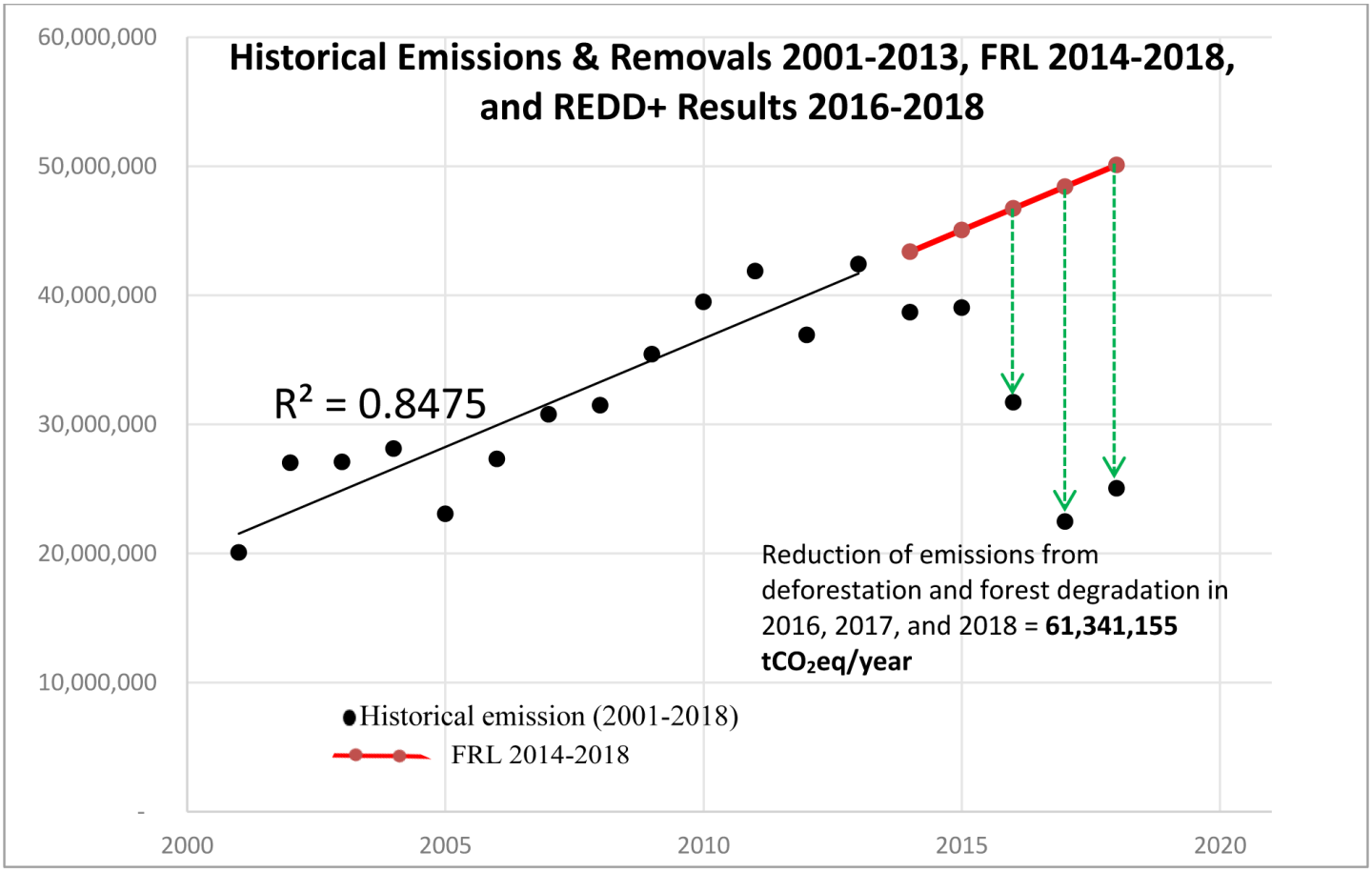


Figure 1 REDD+ Results achieved by PNG from in 2016, 2017, and 2018 assessed against PNG's technically assessed FRL

The GHG emission reductions in 2016, 2017, and 2018 can be alluded to the policies and actions listed below. However elucidating what actions and policies contributed how much emission reduction would require separate study.

- Government declaration of a moratorium on the issuing of Special Agriculture and Business Leases (SABLs) in 2011 and subsequent suspension of SABL in 2014. SABLS were intended to promote large-scale agriculture over customary land with the consent of the traditional landholders. However, many commercial logging operators were obtaining SABLs without undertaking any agricultural development and without seeking the consent of traditional landholders. This led to protests from local communities and widespread criticism from the global community. Since the conclusion of an investigation into SABLs in 2014, over half of the issued SABLs were revoked as the proponents did not follow the proper land acquisition process.
- PNG's National REDD+ Strategy (NRS) 2017 which outlines the broad framework to reduce carbon emissions from the forest and land-use sector and conserve PNG's unique levels of biodiversity and enable tangible benefits to reach communities.
- The Forest Plan 1996 that seeks to implement the Forestry Policy 1991 through periodic and detailed planning that establishes limits on total allowable cuts for timber harvesting each year. The Forest Policy 1991 addresses need for the sustainable management of forest resources and adopts an integrated approach to implementing this goal through administrative, research and project approaches.
- The National Climate Compatible Development Management Policy (NCCDMP) 2014 that outlines the development of strategies in which a national system for information gathering, monitoring and evaluation, management and reporting, GHG inventory and monitoring, reporting and verification.
- The Protected Areas Policy (PAP) 2014 provides the framework to protect and conserve areas that exist within naturally forested areas.
- Forestry and Climate Change Framework for Actions (2009-2015) which identifies afforestation, reduced deforestation and reforestation as means to mitigate climate change.
- Implementation of the Medium Term Development Plan (2011-2015), Papua New Guinea Development Strategic Plan (2010- 2030) and the PNG Vision 2050 which discourage deforestation but promote reforestation/afforestation;
- Awareness and educational activities on climate change and REDD+ have been extensively conducted throughout the country since the establishment of Climate Change and Development Authority (CCDA) in 2010.

Table 3 Annual Emissions from Deforestation and Forest Degradation from 2001 to 2013; Forest Reference Emission Level Used to Estimate; The Emission Reduction Results in the Periods of 2016-2018 and REDD+ Results Achieved on these Periods

Year	Deforestation (tCO_2/yr)	Forest Degradations (tCO_2/yr)	Carbon Stock Enhancement (tCO_2/yr)	Total emissions and removals 2001 – 2013 (tCO_2/yr)	Regression 2001-2013/FRL 2014 - 2018 (tCO_2/yr)	REDD+ Results 2016-2018 – against linear FRL (tCO_2/yr)	Post-deforestation correction	Corrected REDD+ Results 2016-2018 (tCO_2/yr)
	Emission	**Emission**	**Removals**	**Emissions & Removals**	**Emissions & Removals**	**Emissions & Removals**	**Removals**	**Emission & Removals**
2001	4,623,017	15,441,146	0	20,064,162	21,534,851			
2002	1,911,491	25,101,056	0	27,012,547	23,214,457			
2003	3,249,282	23,834,478	0	27,083,761	24,894,064			
2004	2,131,153	25,977,828	0	28,108,981	26,573,671			
2005	3,636,414	19,424,818	0	23,061,232	28,253,277			
2006	1,338,504	25,969,659	0	27,308,164	29,932,884			
2007	2,936,725	27,823,956	0	30,760,681	31,612,491			
2008	3,014,378	28,459,714	0	31,474,091	33,292,097			
2009	4,047,172	31,373,792	0	35,420,964	34,971,704			
2010	4,021,547	35,461,013	0	39,482,561	36,651,311			
2011	6,618,171	35,244,691	0	41,862,863	38,330,917			
2012	8,798,126	28,122,531	0	36,920,657	40,010,524			
2013	11,006,534	31,395,182	0	42,401,717	41,690,131			
2014	9,109,166	29,567,990	0	38,677,156	43,369,737			
2015	9,593,969	29,430,034	0	39,024,003	45,049,344			
2016	7,594,475	24,105,617	0	31,700,092	46,728,951	15,028,859	1,251,557	13,777,302
2017	4,988,858	17,474,017	0	22,462,875	48,408,557	25,945,682	1,551,524	24,394,158
2018	5,302,528	19,736,602	0	25,039,130	50,088,164	25,049,035	1,879,340	23, 169, 695
Total	76,035,651	412,627,889	0	488,663,539	644,607,135	66,023,576	4,682,421	**61,341,155**

The REDD+ results and the calculation used as shown in this Technical Annex applies the same methodology[19], the same data set and the same data source and forest definition[20] used for PNG's FRL and the GHG inventory.

3.2 Correction of post-deforestation removals

Following a suggestion from the UNFCCC Technical Assessment of the Forest Reference Level submission, PNG has included post-deforestation removals as to not over-estimate emissions from deforestation. PNG's FRL is a linear extrapolation of emissions from degradation, deforestation and post-deforestation removals. The FRL can be disaggregated as the sum of linear projections of the emitting activities and post-deforestation removals as shown in Figure 2.

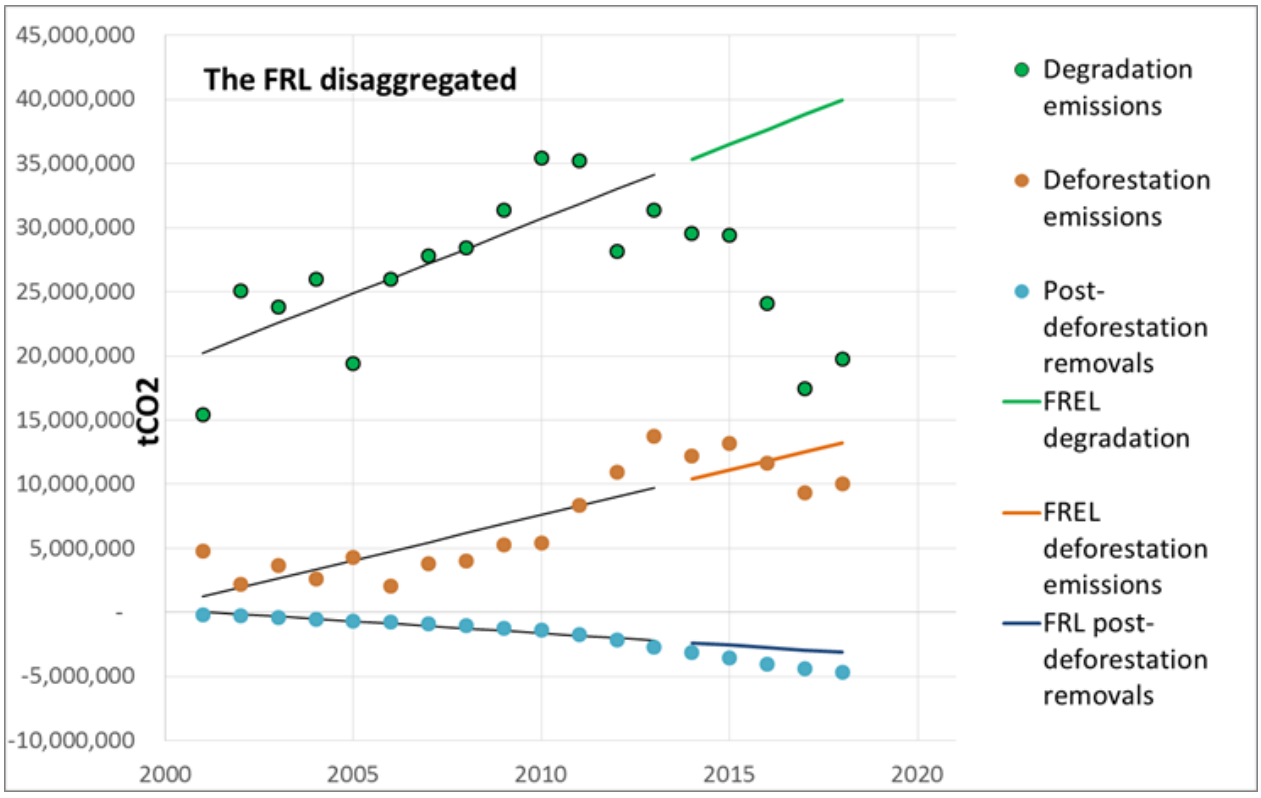


Figure 2 The FRL disaggregated by net degradation emissions, gross deforestation emissions and post-deforestation removals (the last two together making net emissions from deforestation)

19. See chapter 6 of PNG FRL (http://unfccc.int/8414) for detail information on calculation of emissions and removals.
20. See chapter 2 of PNG FRL (http://unfccc.int/8414) for information on PNG's National Forest Definition.

The disaggregated FRL shows us that the emission reductions (the results assessed against the FRL) come mainly from reduced degradation. Deforestation in 2014 and 2015 increased compared to the FRL and had a negative impact on results. For the years 2016-2018 deforestation was reduced and responsible for a share of the REDD+ results, albeit, a small share compared to reduced emissions from forest degradation.

Removals on deforested land are accounted for the year of the deforestation event and 19 subsequent years, applying a linear growth function as suggested by IPCC. This means however, that since accounting for post-deforestation growth starts in the first year of the reference level (2000-2001), post-deforestation removals increase each year since each year new deforested land is added while growth continues on previously deforested land. As such, in a situation where annual deforestation remains constant over the reference period, the associated removals show a linear increase. In PNG's situation however, deforestation is not constant but instead shows a linear increase over the reference period. In terms of the associated removals this means that every year, a larger amount of removals are added to the annually increasing cumulative removals on deforested land. As such, the associated removals do not increase linearly, but exponentially which resulted in an exponentially shaped curve (Figure 3).

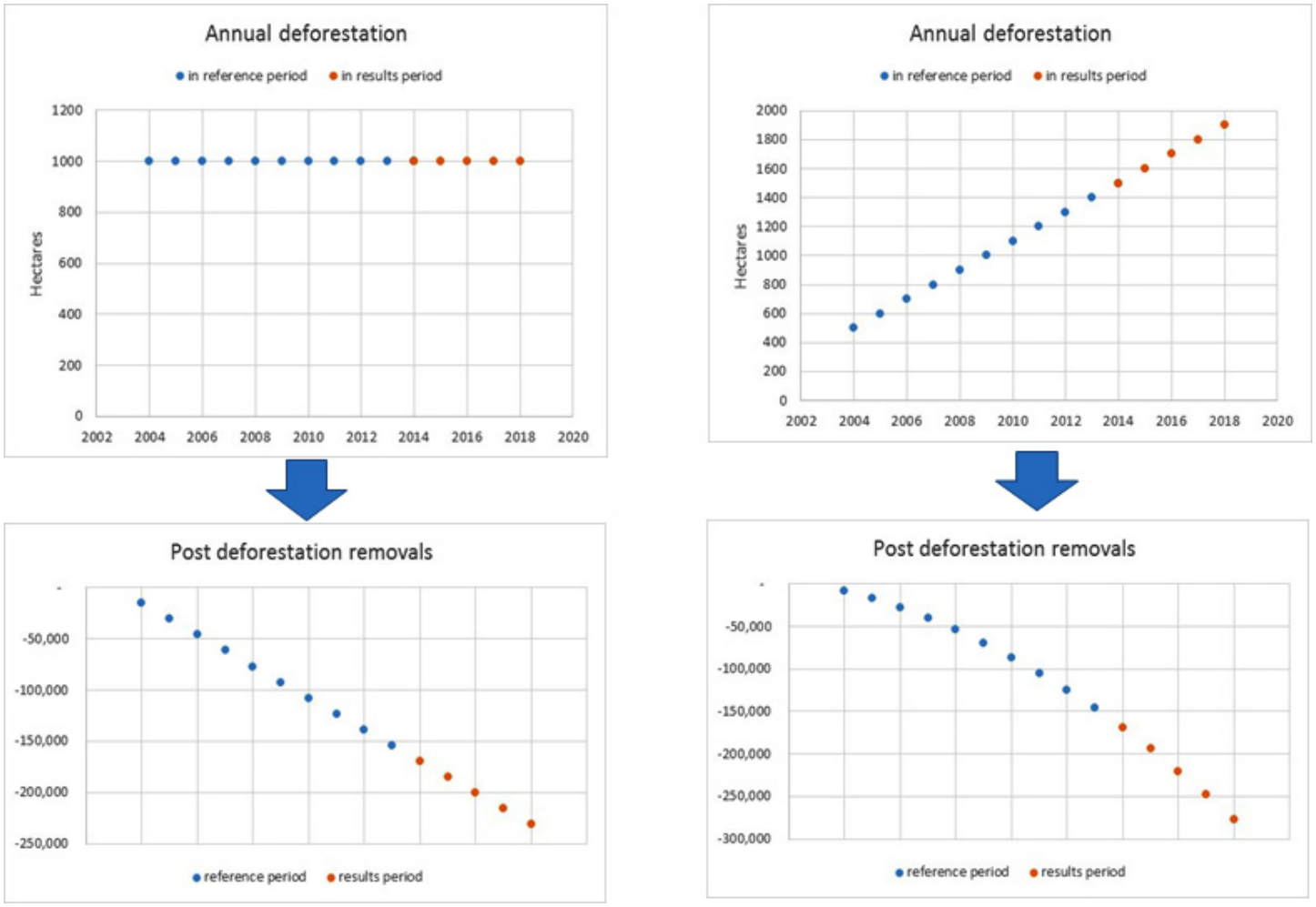


Figure 3 Stable and linearly increasing deforestation and the associated post-deforestation removals

The above explanation means that when applying a linear function to removals associated with linearly increasing deforestation, post-deforestation does not increase linearly but exponentially. If we apply a linear extrapolation to the removals during the reference period, the expected removals during the results period would be under-estimated as illustrated in Figure 4. Therefore, PNG believes the post-deforestation removals during the results period (2016-2018) to be under-estimated with the linear extrapolation FRL. This would result in an over-estimation of emission reductions which would not be accurate and therefore PNG proposes a correction of post-deforestation removals by re-calculating the FRL values in a manner consistent with the linearly increasing deforestation.

The correct calculation of expected deforestation is[21]:

Post-deforestation removals (2001) = (Def area2001) x RF

Post-deforestation removals (2002) = (Def area2001 + Def area2002) x RF

.....

Post-deforestation removals (2016) = (Def area$_{2001}$ + Def area$_{2002}$ + Def area$_{2003}$ + Def area$_{2004}$ + Def area$_{2005}$ + Def area$_{2006}$ + Def area$_{2007}$ + Def area$_{2008}$ + Def area$_{2009}$ + Def area$_{2010}$ + Def area$_{2011}$ + Def area$_{2012}$ + Def area$_{2013}$ + Def area$_{2014}$+ Def area$_{2015}$+ Def area$_{2016}$) x RF

21. The correct calculation is based on Riemann sum formula

This is the same as:

Post-deforestation removals (2016) = Post-deforestation removals (2015) + Def area2016 x RF

Which is: -3,540,545 tCO_2 + (32,816 ha x -13.98 tCO_2/ha) = **-3, 999,312.68 tCO_2eq/yr**

Post-deforestation removals (2017) = Post-deforestation removals (2016) + Def area2017 x RF

Which is: -3, 999,373 tCO_2 + (34,808 ha x -13.98 tCO_2/ha) = **-4, 485,988.84 tCO_2 eq/yr**

Post-deforestation removals (2018) = Post-deforestation removals (2017) + Def area2018 x RF

Which is: -4, 486,049 tCO_2 + (36,800 ha x -13.98 tCO_2/ha) = **-5, 000,513 tCO_2 eq /yr**

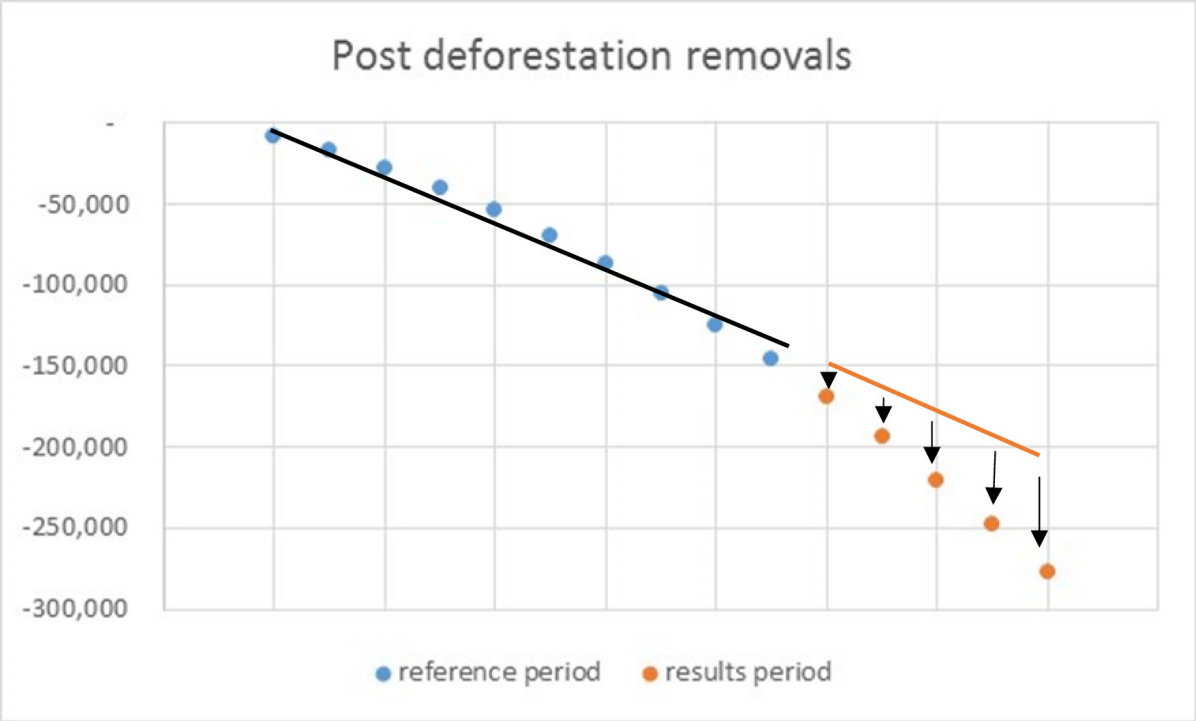


Figure 4 Illustration how a linear extrapolation of post-deforestation removals associated with linear increasing deforestation under-estimates future removals expected under "business as usual".

The correction of post-deforestation removals is then as follows (all values are in tCO_2):

Table 4 PNG's post-deforestation removals correction

	2016	2017	2018
1. Linear extrapolation post-deforestation removals in FRL	-2,747,816	-2,934,525	-3,121,235
2. Correct extrapolation of post-deforestation removals expected with linear deforestation	-3, 999,373	-4, 486,049	-5, 000,575
Proposed correction (i.e. row 1 – row 2 in this table)	-2,747,816 – (-3, 999,373) = **1,251,557**	-2,934,525 – (-4, 486,049) = **1,551,524**	-3,121,235 – (-5, 000,575) = **1,879,340**

In summary, PNG proposes the above-calculated correction to post-deforestation removals in 2016, 2017 and 2018 to avoid over-estimating REDD+ results. This correction does not affect the measured values (2001-2013 and 2014-2015; 2016-2018) and therefore there is full consistency between the GHG inventory – which reports only the measured/historical data, no projection/FRL involved – and the FRL (based on measured values from 2001-2013). The only thing the correction does is let the FRL approximate better the Business-As-Usual GHG emissions (especially) in 2016, 2017, and 2018 which are used in the calculation of REDD+ results against the 2016 -2018 measured values. In other words, the FRL correction seeks to get a better fit with the extrapolation based on the historical data therefore the correction would increase consistency, as shown in Figure 5. This approach would be used to improve PNG's future FRLs and REDD+ results.

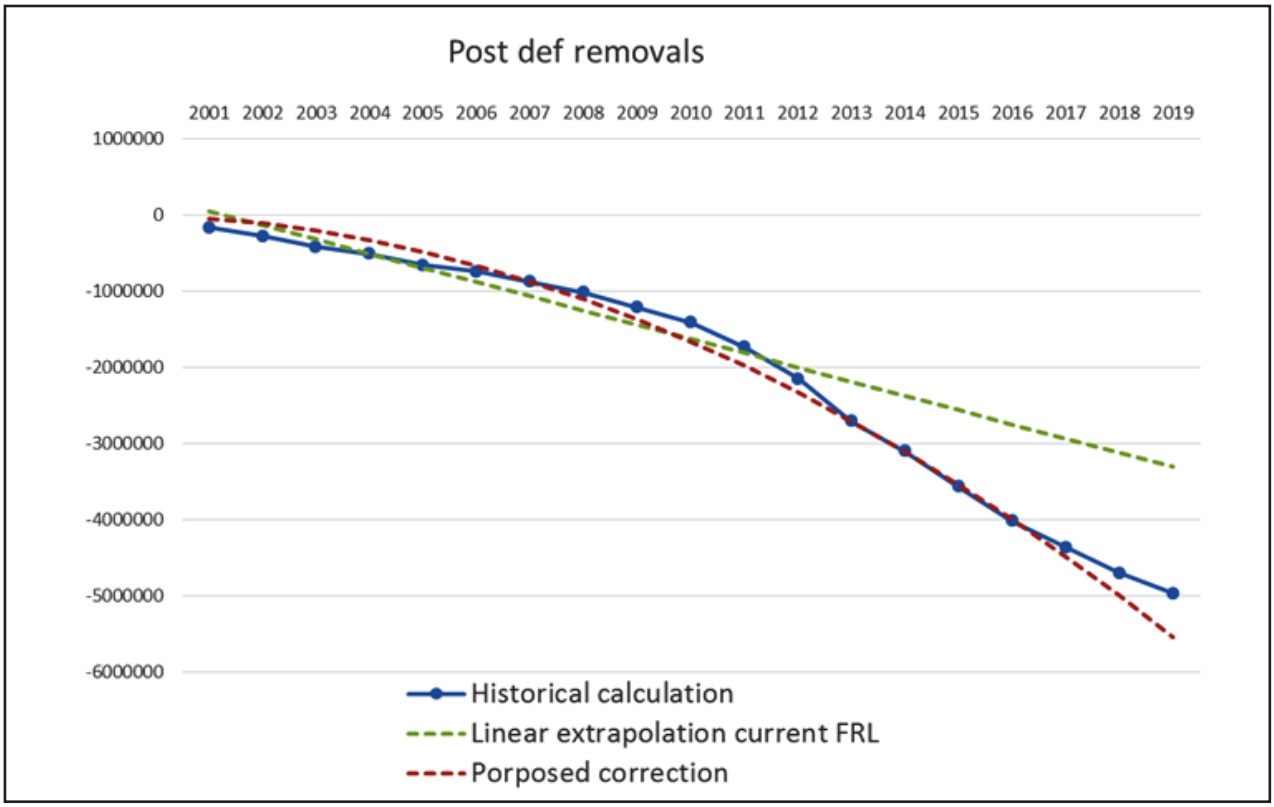


Figure 5 Historical calculation (2001-2013), current FRL and proposed corrected FRL

3.3 Consistency with National GHG Inventory and REDD+ Results

Dec 12/CP.17 decides that FRELs and/or FRLs shall be established maintaining consistency with each country's national GHG inventories. Accordingly, PNG GHG inventory, FRL and the REDD+ results uses the same dataset and same methodology but with some differences in included activities, carbon pools and greenhouse gasses.

The most significant differences between the GHG Inventory LULUCF sector (hereafter LULUCF) and FRL/REDD+ results is the choice of inclusion/exclusion of the biomass regrowth of degraded forest that was degraded prior to the reference period. LULUCF and FRL/REDD+ results are prepared using the same data of annual land use change assessment between 2000 and 2018 using Collect Earth tool (see Chapter 5 in this Technical Annex for detailed methodology). PNG included deforestation, forest degradation and carbon stock enhancement as REDD+ activities in the FRL. Biomass regrowth of the forest, which was degraded prior to 2000 was not included in carbon stock enhancement because it was not possible to identify repeated degradation in the forest already degraded and estimate the intensity of degradation. On the other hand, this was included in the LULUCF by using the growth factors for >20 yr in IPCC Guidelines (2006). For the forest degraded after 2000, stock difference of average biomass of primary forest and logged over forest in respective forest type was applied to estimate the carbon loss due to degradation and gains from subsequent recovery for both LULUCF in BUR and FRL/REDD+ results. Removal due to regrowth of degraded forest that was degraded prior to 2000 was 41,426,000 tCO_2eq/year in 2018. This was included for LULUCF in BUR but not in FRL/REDD+ and it causes the significant differences of the net emissions reported. In addition, FRL/REDD+ results did not include gases other than CO_2 because the reliable data was lacking and also they were likely insignificant for the activities included in the FRL while CH_4 and N_2O on the total land area were also included in LULUCF sector in BUR. Litter and soil organic carbon were not included in FRL and REDD+ results due to lack of reliable data while they were included in LULUCF sector in BUR using 2006 IPCC Guidelines default values for the estimation for reasons of completeness. Fuel wood gathering is not included in forest degradation in FRL/REDD+ results due to lack of reliable data but it was included in LULUCF in BUR. These additional methodological differences slightly mitigate the large difference caused by inclusion/exclusion of biomass regrowth of degraded forest that was degraded prior to 2000. The overall difference of net emissions between LULUCF sector in BUR and FRL/REDD+ results was 10,427,130 tCO_2eq/year in 2018 (BUR LULUCF; 14,612,000 tCO_2eq/year, REDD+ results 25, 039, 130 tCO_2eq/year. The differences on methodology between LULUCF in BUR and FRL/REDD+ results are listed in Table 5. Conform the quality principle of completeness for the LULUCF sector in BUR, all anthropogenic emissions and removals from managed land (full geographic coverage), all gases (including CH_4 and N_2O) and pools (including soils and litter) have to be included if country specific or default data are available using a tier 1 methodology according to Decision 15 CP.17 Annex I (II.B 4(d)). This is not a requirement for FREL/FRLs. Countries can include only emissions and removals of included activities, gasses and pools during the reference period.

Dec 12/CP.17 agrees that countries may take a step-wise approach to the development of FREL/FRLs, improving them over time by incorporating better data, improved methodologies and additional pools. Countries are also encouraged to update their FREL/FRLs periodically to take into account new knowledge, trends or any modification of scope and methodologies, as much as possible. PNG has been significantly improving its capacity on land use change assessment and availability of reliable spatial information and statistical data. PNG will continue improving its capacity and the differences between BUR and FRL/REDD+ results are expected to diminish in the submission of BTRs and future FRL/REDD+ results.

Table 5 List of the differences on methodology between LULUCF sector in BUR1 and FRL/REDD+ results

	LULUCF in BUR	FRL/REDD+ results
Gas	CO_2, CH_4 and N_2O are included.	CO_2 is included.
Carbon pool	Above & blow ground biomass, litter and soil are included	Above & belowground biomass are included.
Activity	Removal due to forest regrowth of the degraded forest that was degraded prior to 2000 is included.	Removal due to forest regrowth of the degraded forest that was degraded prior to 2000 is not included.
	Biomass loss due to fuel wood removal is included	Fuel wood removal is not included in forest degradation

4. REDD+ results for GCF RBP

Based on the PNG's technically assessed FRL (2017), PNG first calculated its REDD+ results achieved in 2014 and 2015 and reported the outcome in the technical annex to the country's First Biennial Update Report (BUR1) to UNFCCC in April 2019. Results for the years 2016, 2017 and 2018 are reported in Chapter 3 of this technical annex. In line with UNFCCC decisions, these results were measured against the technically assessed FRL, which is a linear regression of historical emissions from deforestation and forest degradation. PNG would like to participate in the GCF RBP pilot programme for potential payment under its Phase 2 for results obtained in the years 2016, 2017, 2018, and later. PNG therefore prepared REDD+ results assessed against a historical average FRL with an allowable upwards adjustment for the purpose of participating in the GCF RBP pilot programme. This was done in accordance with the GCF Scorecard, which place restrictions on the construction approach for FREL/FRLs eligible for RBP beyond the UNFCCC modalities, allowing FRELs to only use historical average of emissions with a limited possible adjustment for high forest cover, low deforestation countries (HFLD).

4.1 PNG FRL and REDD+ results for GCF RBP

4.1.1 GCF scorecard elements relevant for recalculating PNG's FRL

The GCF RBP Scorecard (GCF/B.18.23) element (ii) under section 2a suggests a fail if the FREL is not based on average annual historical emissions and the country is not a high Forest Cover, Low Deforestation (HFLD) country.
For countries that have consistently maintained high forest cover and low deforestation rates an adjustment that:

- does not exceed 0.1% of the carbon stock over the eligibility period in the relevant national or subnational area, and
- does not exceed 10% of the FREL/FRL

may be applied to the average annual historical emissions to reflect quantified, documented changes in circumstances during the reference period that likely underestimate future rates of deforestation or forest degradation during the eligibility period.

PNG has REDD+ Results in 2016, 2017 and 2018 (61,341,155 tCO_2eq/year) against the Technically Assessed FRL. In this annex, PNG recalculates which part of these results would be eligible for the GCF RBP pilot programme by assessing them against historical average emissions and an upwards adjustment of 0.1% of the carbon stock over the eligibility period in the national area. For this recalculation, PNG uses the same data as the UNFCCC technically assessed FRL only replacing the linear regression with a 5-year historical average and above-mentioned adjustment.

The following sections address the relevant scorecard elements and provide a recalculation of the share of REDD+ results that could be eligible for RBPs following the scorecard restrictions.

4.1.2 PNG is a high forest cover, low deforestation (HFLD) country

Forest area of PNG declined from 36.25 million ha (78.6% of the country's land area) in 2000 to 35.91 million ha (77.8% of the country's land area) in 2018. Annual deforestation rate during the reference period (2001-2013) ranges between 0.2% to 0.11%. Annual deforestation rate in 2016, 2017 and 2018 are 0.09%, 0.07% and 0.07% respectively[22]. Fonseca et al. 2007 define HFLD as >50% forest cover and <0.22% annual forest loss. With its high forest cover and low deforestation rate, PNG can therefore be considered an HFLD country.

4.1.3 PNG's recalculated Forest Reference Level for GCF RBP pilot programme

PNG did the recalculation of its FRL and REDD+ results in accordance with the GCF scorecard for the GCF RBP pilot programme. The recalculation only concerns the construction approach (i.e. only how the data is "projected" using a historical average instead of linear projection) but uses the exact same historical data points, the exact same underlying methods as the technically assessed FRL, the same scale, the same scope and the same forest thresholds.

22. PNG Forest Authority, Collect Earth land use assessment 2001-2019 Results

For the purpose of recalculating the FRL for the GCF RBP pilot programme, PNG calculated average historical emissions for the period 2009-2013. In view of the rapidly changing national circumstances and rapidly increasing emissions, a recent period is believed to be a better approximation of expected emissions under business-as-usual.

Considering PNG's HFLD status and increasing emissions over the reference period, PNG proposes an upwards adjustment to its recalculated FRL for RBPs. The scorecard provides two restrictions for upwards adjustments, namely; the FRL should not exceed 10% of historical average emissions OR 0.1% of the total carbon stock over the accounting period (i.e. 0.02% of the total carbon stock).

The average historical emissions for 2009-2013 were 39,217,752 tCO2 eq/year, therefore 10% of the FRL suggests an allowable upwards adjustment of 3,921,775 tCO_2eq/year.

The total forest carbon stock in PNG corresponding to the year 2013 was 14,772,860,913 tCO_2eq/year, therefore 0.1% of the total forest carbon stock divided by the eligibility period (5 years) suggests an allowable upwards adjustment of 2,954,572 tCO_2eq/year.

After examining the results produced by the two different methods, PNG decided to use the most restrictive limit or adjustment method which is 0.1% of the total carbon stock over the accounting period (i.e. 0.02%)

As such, the recalculated FRL (CO_2 emissions from deforestation and forest degradation in Papua New Guinea in the period from 2009 to 2013) for GCF RBP pilot programme applied the following formula:

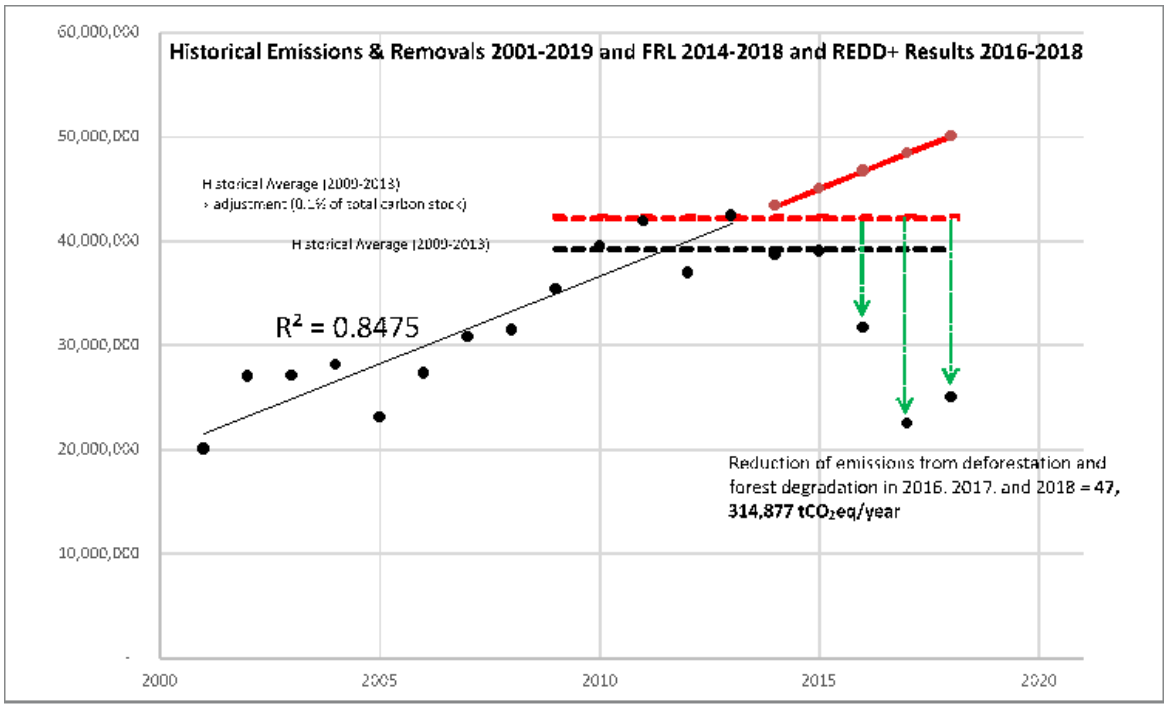


Figure 6 PNG's Recalculated Forest Reference Level for GCF RBP

Annual emission (tCO_2e) = average emissions from deforestation and forest degradation 2009-2013 + (0.001 x total forest carbon stock)/5

The recalculated FRL [(Historical Average (2009-2013) + Adjustment (0.02% of total carbon stock)] in Figure 6 for the period 2009-2013 has a value of 42,172,324 tCO_2 eq/year compared to the Historical Average (2009-2013) which is 39,217,752 tCO_2 eq/year.

Table 6 Recalculated Historical Average 2009-2013 FRL values for PNG

Year	Deforestation (tCO_2/yr)	Forest Degradations (tCO_2/yr)	Carbon Stock Enhancement (tCO_2/yr)	Total emissions and removals 2009 – 2013 (tCO_2/yr)	Historical Average 2009-2013 (tCO_2/yr)	Historical Average + 0.1% of total Carbon Stock/5 (tCO_2/yr)
	Emission	**Emission**	**Removals**	**Emissions & Removals**	**Emissions & Removals**	**Emissions & Removals**
2009	4,047,172	31,373,792	0	35,420,964	39,217,752	42,172,324
2010	4,021,547	35,461,013	0	39,482,561	39,217,752	42,172,324
2011	6,618,171	35,244,691	0	41,862,863	39,217,752	42,172,324
2012	8,798,126	28,122,531	0	36,920,657	39,217,752	42,172,324
2013	11,006,534	31,395,182	0	42,401,717	39,217,752	42,172,324

4.2 PNG REDD+ results 2016-2018 against the adjusted historical average FRL 2009-2013

4.2.1 REDD+ Results Calculation

The REDD+ results for the years 2016 to 2018 were assessed against the recalculated historical average FRL of 5-year (2009-2013) Historical Average plus 0.02% of total carbon stock in 2013. The following formula was applied to calculate the REDD+ results:

REDD+ results (t) = FRL (Historical Average + 0.02% of total C Stock) 2014 to 2018 – Total Emissions and Removals at year t; (tCO_2/yr.)

Thus, REDD+ results achieved by Papua New Guinea in 2016, 2017 and 2018 against the historical average FRL is calculated as follows:

(i) 2016: 42,172,324 tCO_2 – 31,700,092 tCO_2= 10,472,232 tCO_2 eq/year
(ii) 2017: 42,172,324 tCO_2 – 22,462,875 tCO_2 = 19,709,449 tCO_2 eq/year
(ii) 2018: 42,172,324 tCO_2 – 25,039,130 tCO_2 = 17,133,195 tCO_2 eq/year

Total REDD+ results achieved by PNG in 2016, 2017, and 2018 against the Historical Average FRL= 10,472,232 tCO2 + 19,709,449 tCO_2 + 17,133,195 tCO_2 = 47, 314,877 tCO_2 eq/year.

Table 7 PNG REDD+ results 2016-2018

Year	Total emissions and removals 2009 – 2018 (tCO_2/yr)	FRL /(Historical Average + 0.02% of total C Stock) (tCO_2/yr)	REDD+ Results 2016-2018 (tCO_2 eq/year)
2009	35,420,964	42,172,324	
2010	39,482,561	42,172,324	
2011	41,862,863	42,172,324	
2012	36,920,657	42,172,324	
2013	42,401,717	42,172,324	
2014	38,677,156	42,172,324	
2015	39,024,003	42,172,324	
2016	31,700,092	42,172,324	10,472,232
2017	22,462,875	42,172,324	19,709,449
2018	25,039,130	42,172,324	17,133,195
Total			**47, 314,877**

4.2.2 Existing system for monitoring REDD+ results

PNG has an operational and robust national REDD+ MRV System[23] for monitoring and evaluating the REDD+ results achieved through the implementation of REDD+ activities (Deforestation and Forest degradation) to ensure that the results reported or claimed for the GCF RBP are maintained over the rest of the results period (2016-17-18) under the pilot programme. PNG is currently developing a REDD+ Registry with funding from its GCF REDD+ Readiness Project that will further enhance monitoring and evaluation of the REDD+ results reported. The REDD+ Registry System is closely related to BUR, Technical Annex (REDD+ Results Reporting) and FRL. The large part of information of those reports are produced from NFMS and the other systems in PNG and Data Management System (DMS) of REDD+ Registry System will be developed as enhancement of PNG's existing NFMS.

23. Detail information on PNG's REDD+ MRV is at Chapter 7 of this Technical Annex.

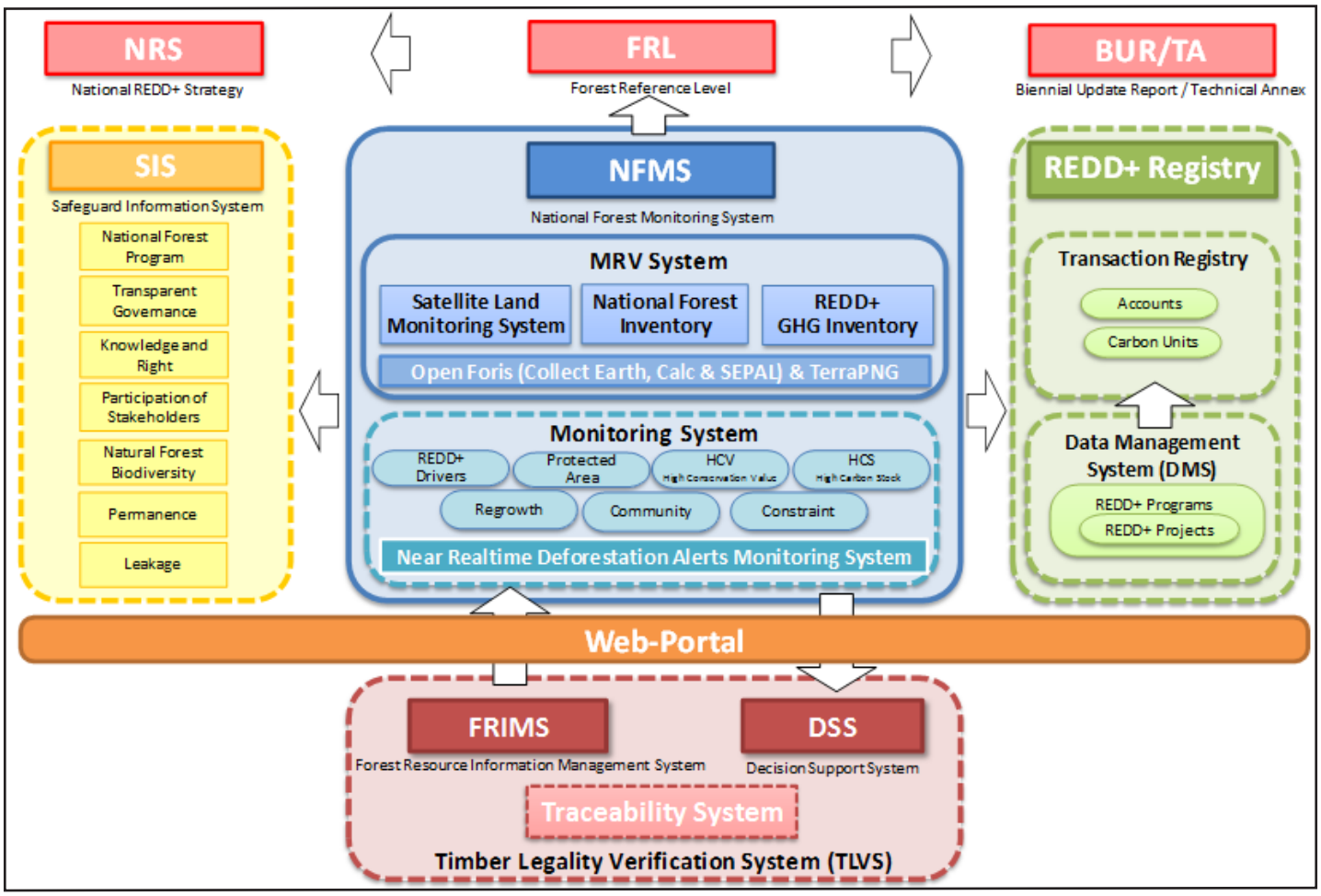


Figure 7 Planned workflow of REDD+ Registry System and NFMS and the other related systems in PNG

The cause of the emission reduction observed in 2016, 2017 and 2018 was due to the implementation of REDD+ related policies and measures[24] by the Government of Papua New Guinea since 2009. When PNG's REDD+ registry is fully developed, a component of it will be dedicated to identifying and documenting the exact actions and policies that contributed to the emission reduction/REDD+ results reported.

24. These policies and measures are listed on Page 9 of this Technical Annex.

5. A description of how the elements contained in decision 4/CP.15, paragraph 1 (c) and (d), have been taken into account

5.1 Use of the most recent IPCC guidance and guidelines

The construction of PNG's FRL and its corresponding Technical Annex and GHG inventory of LULUCF sector were based on IPCC methodology. PNG used the 2006 IPCC Guidelines and Good Practice Guidelines LULUCF as a basis for estimating anthropogenic forest-related greenhouse gas emissions and removals resulting from changes in carbon stocks in forest land converted to other land-use categories (Deforestation), forest land remaining forest land (Forest degradation) and non-forest land to forest land (Carbon stock enhancement)[25]. Forest land was stratified by forest type and type of disturbance. Historical annual emissions were estimated using emission factors[26] appropriate to various forest strata, derived from scientific literature and the 2006 IPCC Guidelines, and activity data obtained through the Collect Earth assessment[27]. FRL values for the period 2014–2018 were projected using an equation based on a linear regression model.

5.2 Establish, according to national circumstances and capabilities, robust and transparent national forest monitoring systems

PNG established the national forest monitoring system using a combination of remote sensing and ground-based forest carbon inventory approaches[28] to determine the extent of its current forest cover, the land use, land use-change, and associated carbon stock and the changes using a two-phase approach:

i. **Phase 1:** Remote Sensing data analysis (activity data) based on a systematic sampling method using Open Foris Collect Earth

ii. **Phase 2:** Ground based forest carbon inventory (emission factors) based on plot clusters on a random restricted sampling design

5.2.1 Remote Sensing data analysis (activity data)

PNG used the established national forest monitoring system to produce activity data for Forest Reference Level as well as REDD+ Results Reporting using the same methodology to be consistent over the time. PNG also has been working to improve the national forest monitoring system to be more transparent. The following sections provide the information of the remote sensing data analysis as a part of the established national forest monitoring system.

Overview of assessment

Activity data used for the construction of PNG national Forest Reference Level (FRL) and REDD+ Results Reporting were obtained from an annual historical time series analysis of land use, land-use change and forestry (LULUCF) carried out by Papua New Guinea Forest Authority (PNGFA) using the same assessment methodology by Collect Earth for both the period of 2000 - 2013 for FRL and 2016 - 2018 for REDD+ Results Reporting.

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

25. see BUR section 2.4.4. for details on LULUCF
26. for details on EF refer to PNG modified FRL submission section 6.3
27. for details on Collect Earth methodology see section 5.2.1
28. Decision 4/CP.15cision 4/CP.15

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 grid sampling at national level was used to generate the national annual historical activity data for the entire area of the country.
Sampling design and unit

A systematic 0.04-degree (about 4.44 x 4.44 km) and 0.02-degree (about 2.22 x 2.22 km) grid consisting of a total of 25,279 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. The national level systematic sampling design allows estimating 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.

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 weight coverage of 4%.

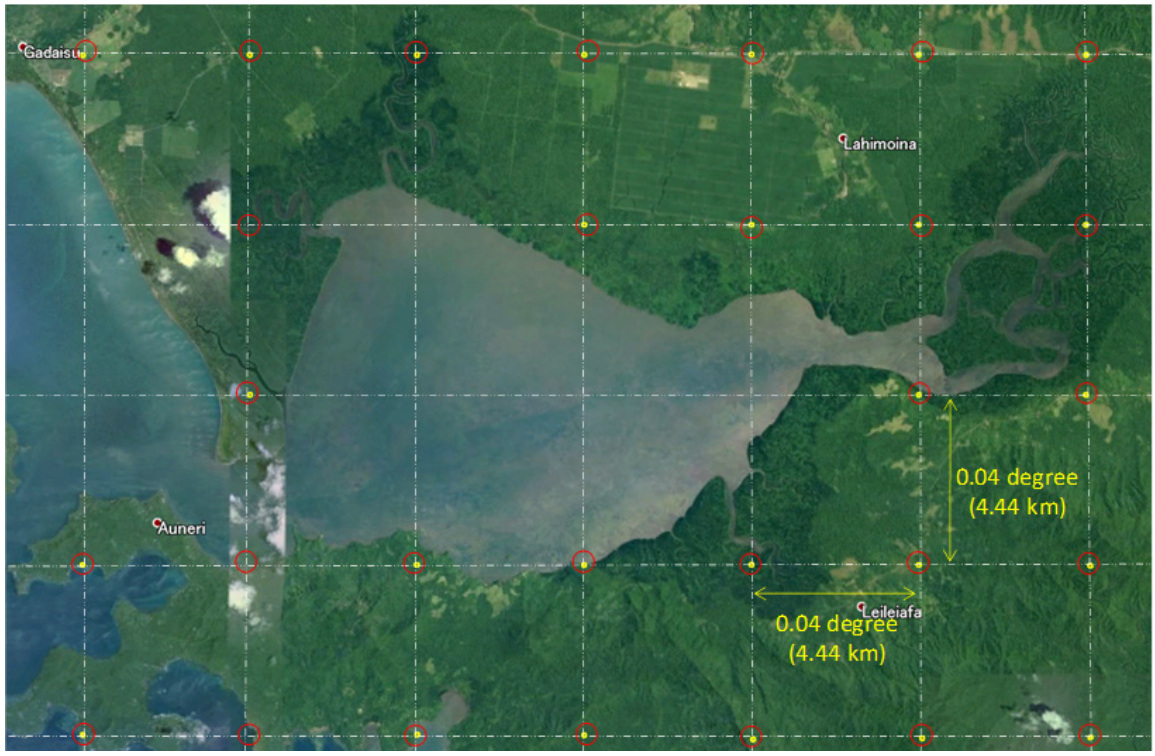


Figure 8 Image of the distribution of the assessment plots

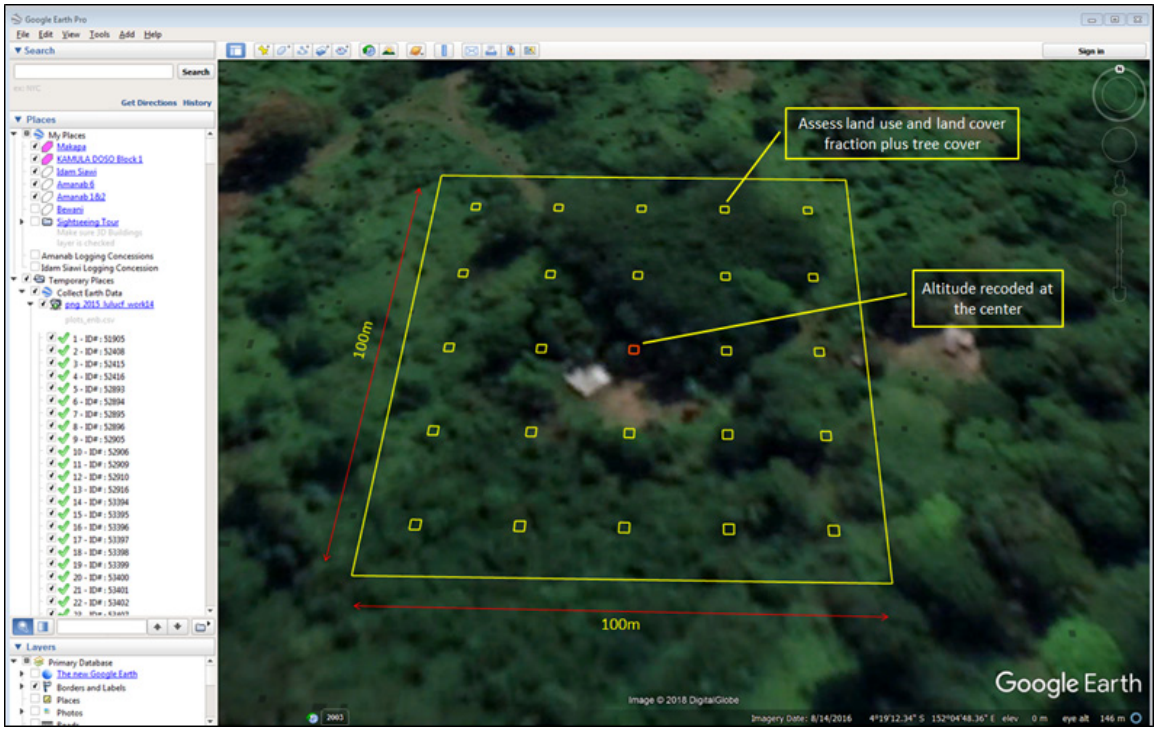


Figure 9 Image of the distribution of the assessment plots

Reference data to use

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. This 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 2018 (e.g. Annual TOA Reflectance Composite, Annual NDVI Composite, Annual Greenest-Pixel TOA Reflectance Composite, etc. from Landsat 5, 7 and 8).

Table 8 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)	2000-2018 (to date)	Land use and disturbance
Bing Maps	World-View, QuickBird, Ikonos, SPOT, etc.	High (0.5-2.5m)	2000-2005, 2007-2018 (to date)	Land use and disturbance
Planet Maps	Dove, Skyesat, RapidEye	Middle (3-5 m)	2018- 2019 (to date)	Reference data Accuracy assessment
Google Earth Engine	Landsat 7 (Annual Greenest Pixel)	Low (30m resolution)	1999-2013	Historical land use change
	Landsat 8 (Annual Greenest Pixel)		2014 -2018 (to date)	Check Current Situation
	Sentinel 2A/2B	Middle (10m)	2016- 2018 (to date)	Supplemental data Recent information

Assessment procedure

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 10 shows form (a) for recording information on the IPCC Land Use and Land Use Change and country specific sub-categories; form (b) the land cover elements to be measured; form (c) information on high resolution imagery; form (d) other sources of information used to support assessment; form (e) canopy cover measurement if land use is forest land; form (f) assessment of human impact type and year in a forest land category; form (g) information on logging concession if sampling plot falls within a boundary of a logging concession.

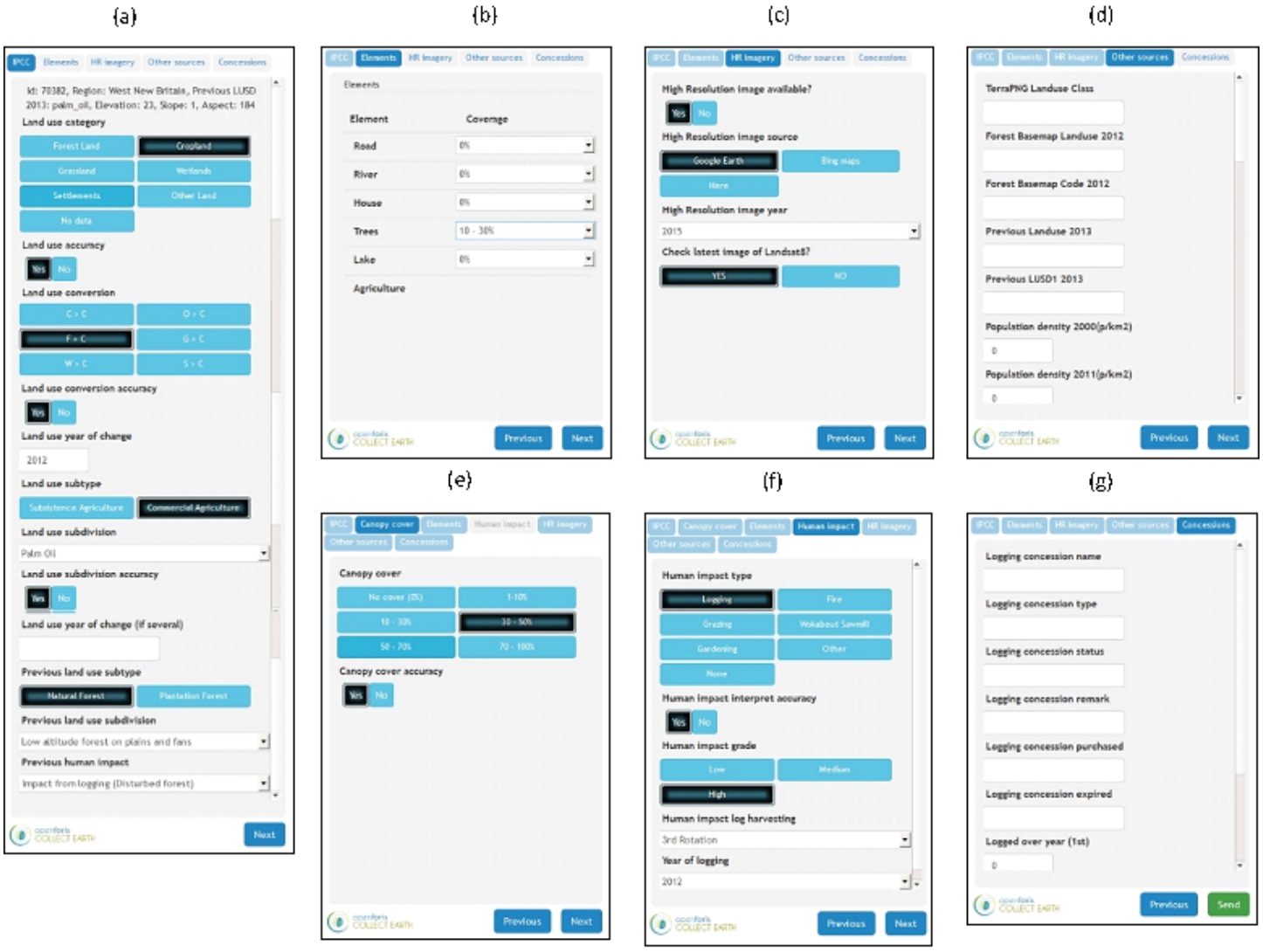


Figure 10 Illustration of the seven (7) PNG Collect Earth data collection forms

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 9 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 table 10 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. The operator uses Google Earth Engine with the different time series on Landsat 7 and Landsat 8 to determine the actual year of change from one land use conversion to another.

Hierarchical rules to apply

A single land use class is easier 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 ≥10% coverage by 'settlement' is considered 'settlement' because the hierarchical rule determines that settlement takes precedence over forest, even if the plot has >10% forest cover and so forth. The hierarchical rules that apply are shown in the table 10 below.

Table 10 Land use Hierarchical Rules

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

Table 11 IPCC Land Use Categories, PNG Sub-type Category and Sub-division Category

IPCC Land use Category	Sub-type Category	Sub-division category
Forestland	Natural Forest	Low altitude forest on plains and fans, Low altitude forest on uplands, Lower montane forest, Montane forest, Dry seasonal forest, Littoral forest, Seral forest, Swamp forest, Savanna, Woodland, Scrub, Mangrove (12)
	Plantation Forest	Eucalyptus, Araucaria, Pinus, Acacia, Terminalia, Teak, Other Forest Plantation (8)
Cropland	Subsistence Agriculture	Shifting, Permanent, not sure (3)
	Commercial Agriculture	Tea, Sugar, Coffee, Oil palm, Cocoa, Coconut, Cocoa/Coconut, Rubber Other (8)
Grassland		Herbland, Rangeland, Other (3)
Wetland		River, Lake, Dam, Nipa Swamp[29], Other Swamp (6)
Settlement		Village, Hamlet, Large settlement, Infrastructure (4)
Other land		Bare soil, Sand, Rock (3)
*No data		Cloud, Sea, other reasons

**This is an additional option apart from the six IPCC land use categories.*

29. If the canopy cover of trees exceeds 10%, they are considered swamp forest. Nipa swamps don't have trees but are dominated by Nipa palms which are classified under wetland

Forest land has been classified into land use subdivision based on the vegetation type and plantations. Vegetation types have been classified based on the structural formation and described in Papua New Guinea Resource Information System (PNGRIS) Publication No.4. There are 12 vegetation types in PNG forests. Full description of PNG vegetation types is available in Hammermaster & Saunders (1995). Lowland altitude forests below 1000m (on plains, fans and on uplands) contain a high presence of merchantable timber species and easily accessible landform than other forest types.

Table 12 Forest Vegetation Class used in the Collect Earth Assessment

Forest types	Short description
Natural Forest	
Low Altitude Forest on Plains and Fans	below 1000 m
Low Altitude Forest on Uplands	below 1000 m
Lower Montane Forest	above 1000 m
Montane Forest	above 3000 m
Dry Seasonal Forest	restricted to southwest PNG in a low-rainfall area (1800-2500 mm)
Littoral Forest	dry or inundated beach
Seral Forest	river line, upper stream, river plains and volcano blast area
Swamp Forest	swamp area
Woodland	low and open tree layer
Savanna	< 6m and open tree layer in low rainfall area with a marked dry season
Scrub	community of dense shrubs up to 6 m
Mangrove	along coastline and in the deltas of large rivers
Montane coniferous forest	high altitude forests dominated by coniferous species (Podocarpaceae)
Plantation Forest	
Forest Plantations	Includes all species of Eucalyptus Plantation, Araucaria Plantation (*Araucaria cumminghamii* (Hoop Pine) and *Araucaria hunstanii* (Klinkii Pine)), Pinus Plantation, Acacia Plantation, Terminalia Plantation, Rubber Plantation and others not included above.

Disturbance 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 13 Forest Disturbance and key features used in the Collect Earth assessment

	Disturbed forest	Key features	Remarks
Man-made	Logged forest	Logging roads, etc	Easy to see
	Gardening	Isolated patches of temporary clearings at the edge of cropland areas	Challenging to see in Landsat
	Fire	Burnt forest	Challenging to see in Landsat
	Portable sawmill	Based on local knowledge	As above
	Mining	Mining concession and facilities	
	Petroleum	Development plan	
	Infrastructure	Roads and facilities	
	Others	Mining clearings & those not identified	As above
Natural	Flooding	River/sea coast	
	Landslide	Mountain slope	
	Eruption	Volcanic mountain	
	Frost	Highlands etc	
	Other		
No disturbance			
Unknown	Others	Mining clearings & those not identified	As above

Stratification by disturbance

Natural forest types are divided into primary forest and disturbed forest as per the following definitions:

- Primary forests are densely populated old or matured native tree species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.
- Disturbed forests are naturally regenerated forest where there are clearly visible indications of human activities (FRA, 2015). The disturbances are further subdivided into the following;
    - Commercial logging – refers to a large-scale logging operation with a permit or license within an acquired boundary of a forest area for a longer term of a contract or lease.
    - Gardening – refers to an activity isolated and unevenly distributed patches of forest clearings usually in a rural or remote setting. This includes isolated patches of temporary forest clearings often at the edge of cropland areas i.e. shifting cultivation.
    - Fire – refers to burning (human impact) within a forest area for instance slash and burn for gardening or hunting.
    - Portable sawmill – refers to a small-scale operation within a forest area.
    - Other – refers to other activities (mining, wood extraction, grazing etc.) which impacts a forest area.

The forest and land use change area were constructed to reflect only anthropogenic activities. This is true for both deforestation and forest degradation. This distinction between managed and unmanaged land was made according to the presence of logging roads, permanent roads & bridges, forest cover losses within proximity to villages and accessibility in terms of the topography. Where the forest cover loss was observed in inaccessible areas or far from villages/settlements and roads, these losses were not recorded or reported. Such observations were suspected to be due to natural disturbances (e.g; volcanic activities, landslides, cyclones).

Quality Assurance/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 analyse 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 showing a total of 200 ha and above tree cover loss within 1600 ha (4x4 km) around the plot in 2000-2018 but neither deforestation nor forest degradation was recorded by Collect Earth assessment. In most cases the difference between Collect Earth data and Hansen data occurred due to the lack of details of land cover interpretation of the Hansen data. For instance, harvesting and replanting of oil palm plantation is reported as tree cover loss and gain in the Hansen data but it is considered Cropland remaining Cropland in Collect Earth assessment 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 Hansen data shows 20ha or less tree cover loss within 1600 ha around the plot but deforestation or forest degradation was recorded in Collect Earth assessment. These QA/QC process ensure the reliability of the Collect Earth assessment data.

For the purpose of REDD+ Results reporting, Collect Earth assessment data for the accounting period 2016 - 2018 went through the same QA/QC process which was used for developing FRL. The assessment results were compared against the Global Forest Change data (Hansen data) to ensure the reliability of the Collect Earth assessment data.

The version of the Hansen data which PNG used for the FRL and the QA/QC (reference period: 2000-2013, and the FRL period: 2014-2018) was version 1.2, which has data until 2014 but not 2015. By the time of the QA/QC for BUR/REDD+ Results Reporting, Hansen data was updated to version 1.5, which has the data until 2016 and the data of 2014 was revised (increased).

Therefore, the revised Hansen data was re-processed then linked with customized Collect Earth plots and grids. The same QA/QC process was applied for the data 2014 and 2015 then 802 plots in total were reviewed with verification check list. The screenshot of customized Collect Earth with updated Hansen data is shown in Figure 11.

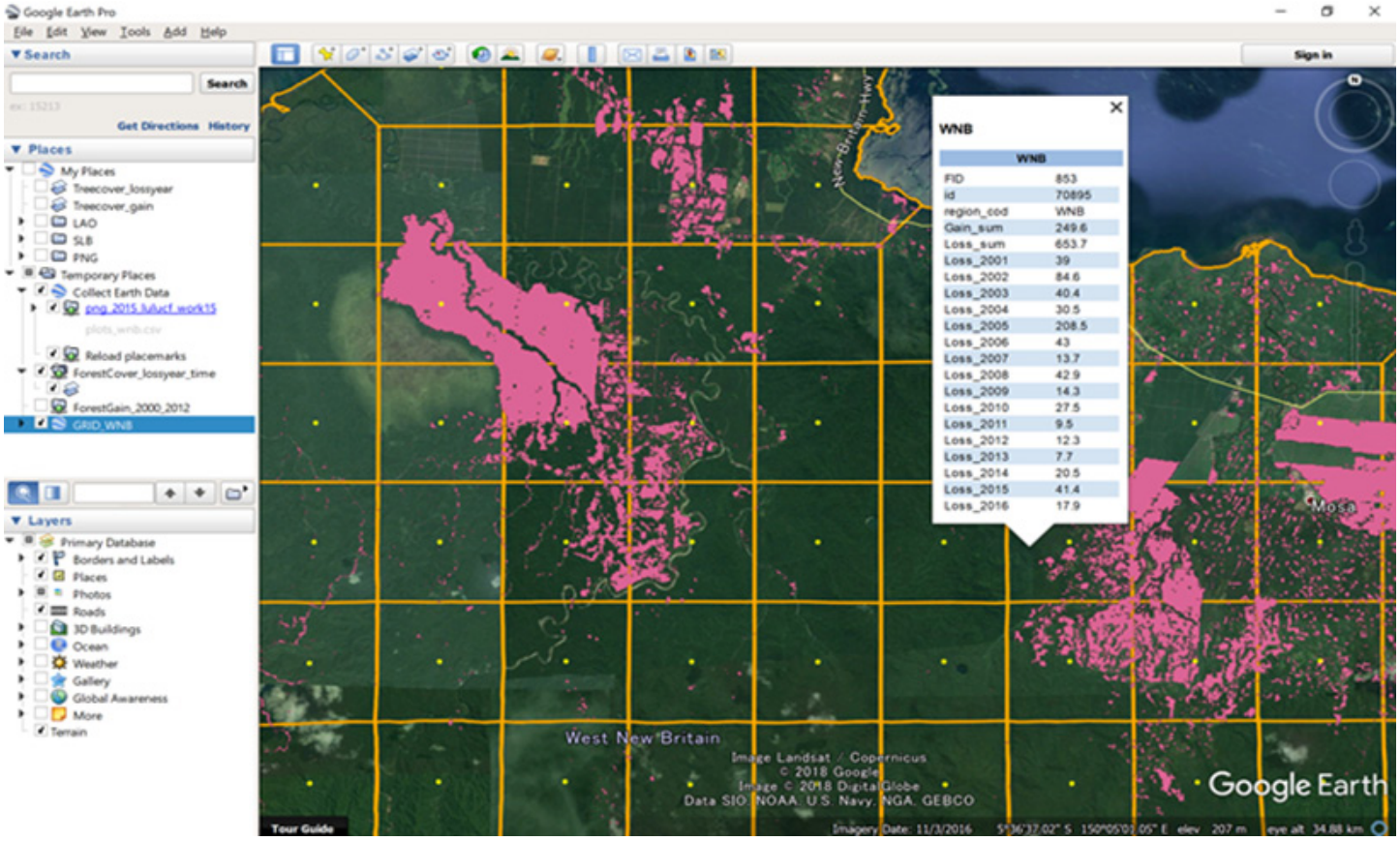


Figure 11 Linking revised Hansen Data with Collect Earth plots and grids (pink polygons are the Hansen data)

As a summary of the descriptions in Remote Sensing data analysis (activity data), the illustration of work flow of Collect Earth assessment is shown in Figure 12.

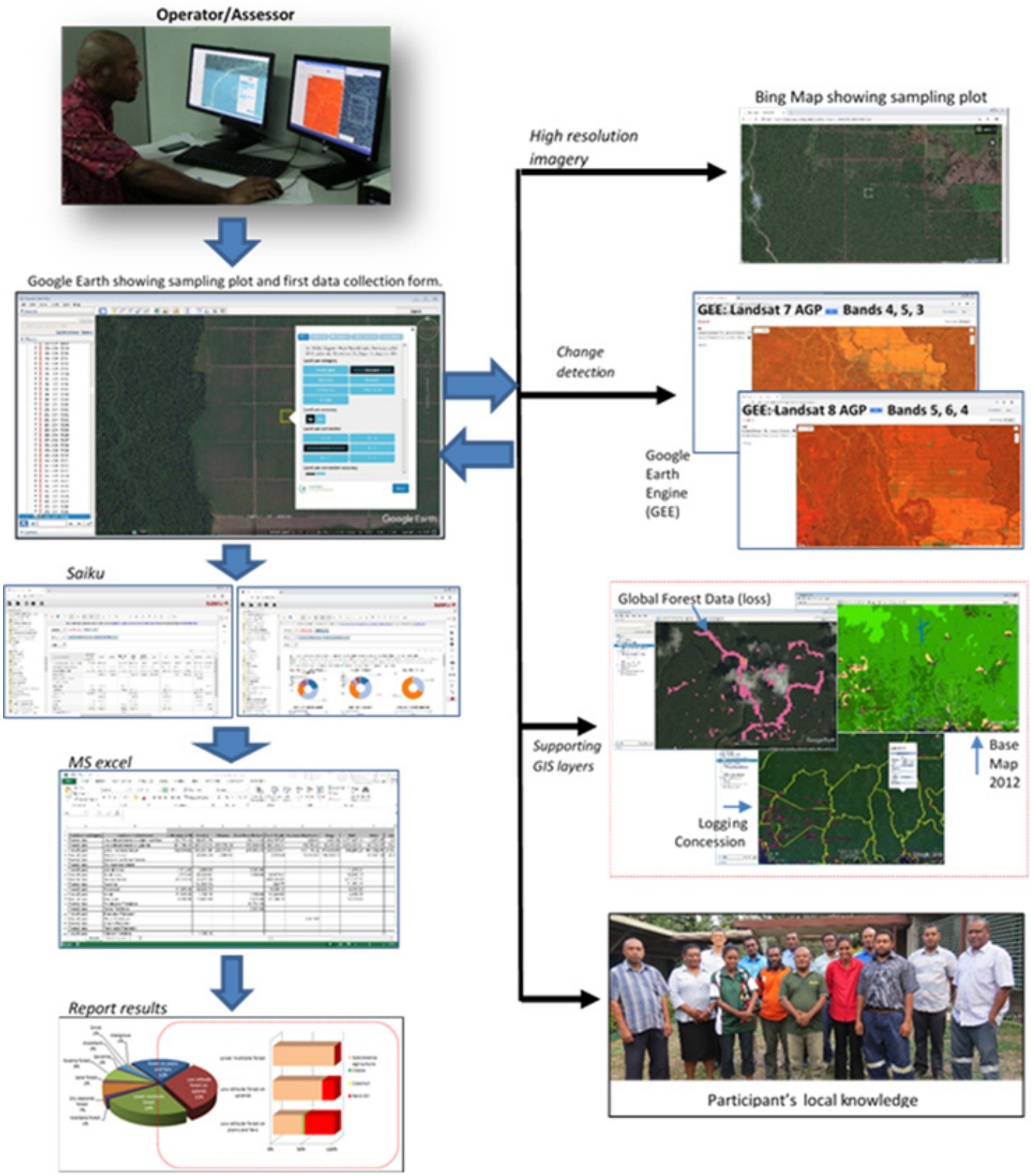


Figure 12: Illustration of workflow of Collect Earth assessment

5.2.2 Ground based forest carbon inventory (emission factors)

PNG has been commencing ground-based forest carbon inventory since 2016 as the main component of its Multi-Purpose National Forest Inventory (NFI) to develop country specific emission factors with an aim to accurately estimate GHG emissions and removals in the LULUCF sector. The NFI methodology is built on the methods and capacity developed within the PNG Forest Authority (PNGFA) over a number of years but with a wider scope in addressing forest management and biodiversity conservation in the country. (See section 6.3 for the information on the NFI).

Although it is anticipated that PNG is planning to use the results of the NFI for future FRLs, GHG inventories and REDD+ results reporting to improve the accuracy and reliability of the data and value, the survey and the analysis are still underway at the time of submitting 1st BUR and its Technical Annex. Therefore, the sub-sections below explain the current data used for FRL and REDD+ Results Report, based on the IPCC guidelines with some existing works in PNG (basically the same explanation in the emission factors section in the modified PNG national forest reference level submitted in 2017).

Forest stratification

There are 12 vegetation types in PNG's natural forest, which is described in PNGRIS Publication No.4 (Hammermaster & Saunders 1995). For the Collect Earth assessment, "mountain coniferous forest" was added because of the high conservation value of the specific forest type. Each forest type excluding Woodland, Savanna, Scrub and Mangrove were further stratified to three disturbance categories namely primary, logged over and forest disturbed by other than logging (e.g., fire, gardening). No commercial logging is conducted in Woodland, Savanna, Scrub and Mangrove. Consequently, these forest types were classified to only two disturbance categories namely; primary and forests disturbed by other than logging. In addition to natural forest, there are plantation forests with two disturbance categories (primary and disturbed other than logging). In total forest in PNG were stratified to 37 strata (table 12).

Above ground biomass

Above ground biomass of a unit forest area of each forest type and different type of disturbances needs to be estimated to calculate emissions from deforestation and forest degradation. Collecting such information is one of the major objectives of PNG's first National Forest Inventory, which is currently under implementation. However, it will take another 2-3 years before the full information derived from the National Forest Inventory become available. The review of existing information was conducted to identify the most appropriate aboveground biomass per unit area of each forest strata. The forest biomass information derived from small plot (e.g. 1 ha) in a specific forest was excluded from consideration because of the high local heterogeneity of PNG forest (Abe 2007, Vincent et al. 2015) and tropical rainforest elsewhere (Nascimento & Laurance 2002).

Fox et al. (2010) reported the average of above ground biomass of primary lowland tropical rainforest in PNG as 222.8 t/ha based on ten 1 ha permanent sample plots (PSP) managed by PNG Forest Research Institute. This is lower than any of ten lowland tropical rainforest studies (230 – 597 t/ha) in PNG summarised by Bryan et al. (2010a) and also lower than averages for tropical equatorial forest (Gibbs & Brown 2007: 328 t/ha; IPCC 2006: 350 t/ha; Lewis et al. 2009: 404 t/ha). Often well-developed large forest are preferred and selected for ecological studies, and consequently, aboveground biomass of study plots may biased toward more productive forest. On the other hand, PSP plots are often located in proximity to roads or villages due to management reasons. They may have been subject to some degree of previous disturbance and it might cause lower carbon stock. However above ground biomass estimated for 50 ha plot at Wanang lowland tropical rainforest in Madang Province is 210.7 t/ha (Vincent et al. 2015) and estimated for 3,000 ha lowland tropical rain forest of Makapa concession in Western province is 222.7 t/ha (Bryan et al. 2010b), generate estimates in agreement with Fox et al. (2010). Consequently, it is considered most appropriate to apply the average above ground biomass provided by Fox et al. (2010) to estimate carbon stock of the primary forest of five lowland tropical rainforest type (low altitude forest on plains and fans, low altitude forest on uplands, littoral forest, seral forest and swamp forest) in PNG.

For above ground biomass of logged over lowland tropical rainforest in PNG, Fox et al. (2010) reported 146.0 t/ha as the average of 115 1-ha PSP plots across the country. This is also supported by Bryan et al. (2010b) reporting 152.9 t/ha at Makapa concession in Western province. It is considered most appropriate to apply the above ground biomass for logged over lowland tropical rainforest reported in Fox et al. (2010) to logged forests of the five forest type (low altitude forest on plains and fans, low altitude forest on uplands, littoral forest, seral forest and swamp forest) in PNG. There is no information on aboveground biomass of the forests disturbed by anthropogenic activities other than commercial logging. This information will be available as National Forest Inventory proceeds. In this FRL submission, the same aboveground biomass used for estimating carbon stock of logged over forest is also used for the forest disturbed by anthropogenic activities other than commercial logging for the five forest types of lowland tropical rainforest discussed above. These five forest types consist of 64% of PNG's forest.

These data represent an average condition of degraded forests in PNG. Such an average condition results from an initial loss of carbon during a logging event and the regrowth of carbon during subsequent forest recovery. Using these data to build emission factors for forest degradation, as is undertaken below, results in estimating a net of losses from disturbance and gains from subsequent recovery.

The data represent logging in concessions primarily, and for small-scale logging activities may not be fully adequate. No high-quality information is currently available to estimate the degrading effects of small-scale activities, which is the data from large-scale logging activities were used in lieu. The impact of this simplification is deemed to be small, since small-scale logging accounts for only <1% of all logging by area.

IPCC Guidelines

Other than five forests type discussed in the above section, no sufficient information on above ground biomass is available. IPCC Guideline (2006: Table 4.12) provides above ground biomass per unit forest area of each Global Ecological Zone described by FAO (2001). Global Ecological Zone and the PNG forest classification provided in PNGRIS (1995) are correlated well. Figure 13 shows similar distribution of montane vegetation and dry vegetation between the PNG Forest Base Map (PNGFA 2014) and Global Ecological zone (FAO 2001). The description of Ecological Zone in tropical climate is summarised in table 14.

Table 14 Summary of Climate Domains and Ecological Zone (FAO 2001) relevant to PNG's environment

Climate domain		**Ecological zone**	
Domain	Domain criteria	Zone	Zone criteria
Tropical	all months without frost; in marine areas, temperature >18°C	Tropical rain forest	wet: ≤ 3months dry, during winter
		Tropical moist deciduous forest	mainly wet: 3-5 months dry, during winter
		Tropical dry forest	mainly dry: 5-8 months dry, during winter
		Tropical shrubland	semi-arid: evaporation > precipitation
		Tropical desert	arid: all months dry
		Tropical mountain systems	altitudes approximately > 1000 m, with local variations

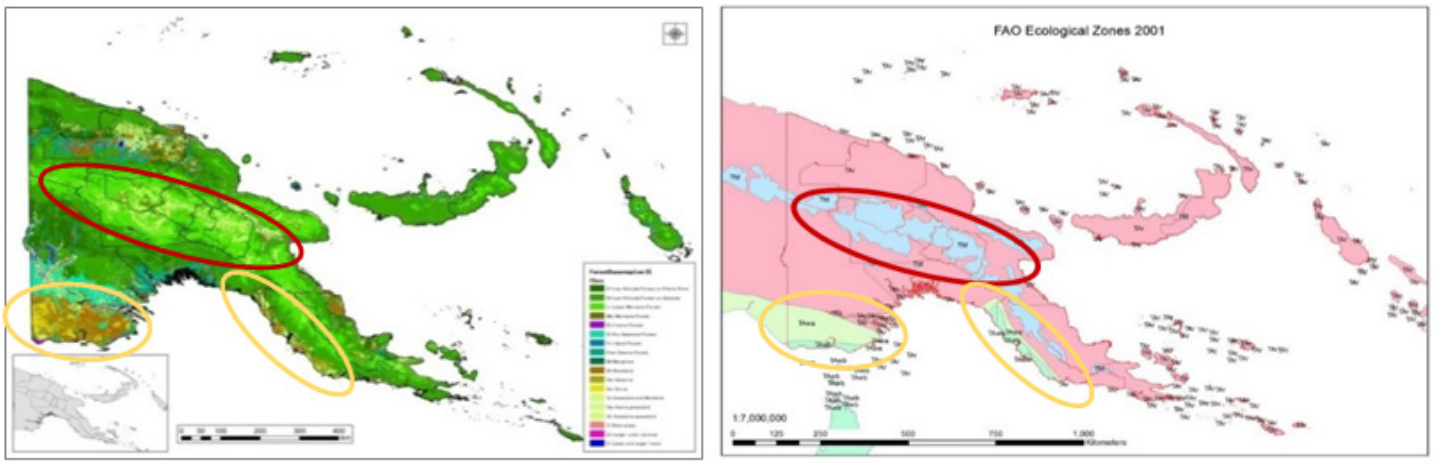


Figure 13 Correlation between PNG forest classification in Base Map (Left: PNGFA/JICA 2014) and Global Ecological Zone (Right: FAO 2001). The red ellipse show the distribution of montane vegetation and the yellow ellipse shows the distribution of dry vegetation

The default values of IPCC Guidelines for above ground biomass for associated Ecological Zone were applied to each of all other forest type as shown in table 15. Root to shoot ratio and carbon fraction of IPCC guidelines (2006) were also applied to estimate below ground biomass and carbon contents of above and below ground biomass (table 15). Several carbon pools are not included in the scope of this FRL submission and appropriate values will become available as the National Forest Inventory progresses. In the future, all the Emission Factors used in this FRL submission should be replaced with the country specific values obtained through the National Forest Inventory, which is currently being implemented. After National Forest Inventory is completed then PNG will be able to report near Tier 2-3 level of GHG emission of LULUCF sector.

Table 15 Above and belowground biomass Above and below ground biomass in a unit area of PNG forests

Forest type	Human impact	Aboveground biomass			Belowground biomass	
		Source	Ecological zone as per IPCC guidelines	Dry matter (tonnes/ha)	Dry matter (tonnes/ha)	Root to shoot ratio
Low altitude forest on plains and fans	Primary	Fox *et al.* (2010)	Tropical rainforest	223	83	0.37
	Logged			146	54	0.37
	Other disturbance			146	54	0.37
Low altitude forest on uplands	Primary			223	83	0.37
	Logged			146	54	0.37
	Other disturbance			146	54	0.37
Littoral forest	Primary			223	83	0.37
	Logged			146	54	0.37
	Other disturbance			146	54	0.37
Seral forest	Primary			223	83	0.37
	Logged			146	54	0.37
	Other disturbance			146	54	0.37
Swamp forest	Primary			223	83	0.37
	Logged			146	54	0.37
	Other disturbance			146	54	0.37
Lower montane forest	Primary			140	38	0.27
	Logged			92	25	0.27
	Other disturbance	IPCC Guideline (2006)	Tropical mountain system	92	25	0.27
Montane forest	Primary			140	38	0.27
	Logged			92	25	0.27
	Other disturbance			92	25	0.27
Mountain coniferous forest	Primary			140	38	0.27
	Logged			92	25	0.27
	Other disturbance			92	25	0.27
Dry seasonal forest	Primary		Tropical dry forest	130	36	0.28
	Logged			85	24	0.28
	Other disturbance			85	24	0.28
Woodland	Primary			130	36	0.28
	Other disturbance			85	24	0.28
Savanna	Primary			130	36	0.28
	Other disturbance			85	24	0.28
Scrub	Primary		Tropical shrubland	70	28	0.4
	Other disturbance			46	18	0.4
Mangrove	Primary		Tropical wet Mangrove	192	94	0.49
	Other disturbance			126	62	0.49
Forest plantation	Primary		Tropical rainforest (plantation)	150	56	0.37
	Other disturbance			98	36	0.37

For some of the forest types, the carbon stock in degraded forests had to be estimated as a percentage reduction from the primary forest carbon stock. The percentage reduction was estimated at 65.47% based on the measurements for low altitude forest on plains and fans.

Carbon stock in non-forest land

In line with the IPCC guidelines, the calculations of emissions from deforestation deduct the removals from post-deforestation regrowth in cropland and grasslands with trees. To approximate such removals in croplands and grasslands, IPCC default values are used since no country specific data on the biomass and the increment in biomass of land use other than forest is available in PNG.

The relative areas of different land-use types after deforestation are the starting point for calculating post-deforestation biomass and its growth. The IPCC guidelines include default values for biomass and the growth duration, which allows to recover mean annual increments for these.

Table 16 Aboveground biomass and mean annual increment of Cropland used for post deforestation GHG removal

		coconut	oil palm	shifting cultivation	permanent subsistence	other
Relative area	%	1%	31%	63%	3%	2%
AGB	t d.m. /ha	196	136	45	45	45
Source		Table 5.3, IPCC 2006	Table 5.3, IPCC 2006	Table 5.1, IPCC 2006	Table 5.1, IPCC 2006	same as subsistence
Growth duration	Years	20	20	8	8	8
Mean annual increment in AGB	t d.m. /ha /yr	9.80	6.80	5.59	5.59	5.59

The average mean annual increment in living biomass 8.11 t d.m. /year /ha, based on a weighted mean of the mean of the annual increments in AGB and a root-shoot ratio of 0.37.

The approach taken to determining removal factors for post-deforestation land use represents an approximation. In reality, the land uses have different growth rates for different time frames. The summary removal factor is applied regardless of the age of post-deforestation regrowth. In theory, applying this increment factors across a very long-time span (>50 years) could result in considerable carbon removals, potentially excluding biomass in some kinds of natural forests. In practice this will not occur because of the limited duration of the reference period and future accounting periods.

The expected duration of growth for shifting cultivation is given in the IPCC guidelines. The expected duration of growth for the other land uses was taken to correspond to 20 years in accordance with the default IPCC time horizon for conversion between land use types.

Calculation of emission factors

The Emission Factors for emissions in primary deforestation, secondary deforestation and forest degradation are calculated as follows:

Carbon stock = (Aboveground biomass + belowground biomass) x 0.47 (IPCC Guidelines 2006)
Emission factor = (Carbon stock before land use conversion – Carbon stock after land use conversion) x 44/12 (IPCC Guidelines 2006)

Table 17 Emission Factor of deforestation of primary forest, deforestation of degraded forest and forest degradation

			(tCO_2e /ha /yr)
Forest type	EF deforestation (primary forest)	EF deforestation (degraded forest)	EF forest degradation
Low altitude forest on plains and fans	526.50	344.70	181.79
Low altitude forest on uplands	526.50	344.70	181.79
Low Montane Forest	306.41	200.61	105.80
Montane forest	306.41	200.61	105.80
Montane Coniferous forest	306.41	200.61	105.80
Dry Seasonal forest	286.76	187.75	99.02
Littoral Forest	526.50	344.70	181.79
Seral forest	526.50	344.70	181.79
Swamp Forest	526.50	344.70	181.79
Savannah	286.76	187.75	99.02
Woodland	286.76	187.75	99.02
Shrub	168.89	110.57	58.32
Mangrove	493.01	322.78	170.23
Plantation Forest	354.15	231.86	122.28

The Removal Factors for removals in carbon stock enhancement and for post-deforestation regrowth are established as follows. Removal factor = (Increment in above-ground biomass + increment in below-ground biomass) x 0.47 (IPCC Guidelines 2006) x 44/12 (IPCC Guidelines 2006)

For carbon stock enhancement, this calculation is carried out for plantations since only there the conversion from non-forests to forests was observed. The removal factor amounts to 24.7 tCO_2e /ha /yr, based on a default increment of 9.5 m3 merchantable volume /ha /yr, an average biomass conversion and expansion factor of 1.1 and a root-to-shoot ratio of 0.37 as per the 2006 IPCC guidelines.

For post-deforestation regrowth, the calculation is carried out drawing on the mean annual increment calculated above. Applying a mean annual increment is a simplification because of two reasons. First, for some of the vegetation types considered growth levels off after relatively short periods of eight years. Second, once that happens, the relate areas of individual vegetation types should give greater weight for vegetation types with longer growth periods for establishing a weighted mean. Calculations of post-deforestation regrowth may be refined in future iterations.

Values for post-deforestation land use types were derived from IPCC default values. The values of "cropping systems containing perennial species" were applied to PNG's land use categories "shifting cultivation" and "subsistent agriculture, permanent". This match of categories was undertaken in a group discussion among sector experts from the CCDA and the PNGFA.

6. Uncertainty

The activity data and emissions factors used in the construction of PNG's FRL and REDD+ results underwent both quantitative and qualitative uncertainty analysis. This has made it possible to identify opportunities for improvement.

6.1 Qualitative uncertainty analysis

In terms of activity data, several major sources of error in estimating past land-use trends from the Collect Earth exercise are expected.

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

To reduce the uncertainty of "classification error", PNG defines the land use subdivision based on the existing classification system described in "Emission Factors" and "Historical land use" sections of the FRL report (see http://unfccc.int/8414). The stratification based on the carbon stock amount will be considered in future based on the progress and result of current ongoing national forest inventory.

The major potential sources contributing to uncertainty of the sampling assessment 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 land use and land use change and forest.

In terms of emission factors, there are also several most important error sources to be considered in estimating carbon stocks for PNG's land-use types. The set of emission factors used is taken from literature and only little direct information is available on the error. Nonetheless, PNG expects a set of typical errors to occur for the emission factors:

- Measurement error (random and systematic error) since the literature values were all derived from primary measurements, usually plot-based measurements where measurements can have error.
- Sampling error (random and systematic error) since the plot-based measurements that underlie estimates reported in literature and in the IPCC guidelines only sample the forests.
- There is representation error from using IPCC default values that might be imperfectly suitable for PNG's forests (systematic error).
- There is a representation error from approximating forest carbon stocks in all of PNG's forest types from literature values developed only for the most abundant types of forests (systematic error).
- There is model error from inferring on forest degradation carbon stocks from measurements in one type of forest only (systematic error).

6.2 Quantitative uncertainty analysis

Uncertainty analysis for Activity Data

In terms of activity data, the "sampling error" was estimated by using the spreadsheet developed by FAO for the Landuse Category and Conversion during 2000-2015 assessment (updated) by Collect Earth. The standard error of an area estimate is obtained as A*sqrt(pi* (1-pi)/(n-1)) (equation; taken from Chapter 3, volume 4 (AFOLU), of 2006 IPCC Guidelines, pp 3.33-3.34).

2001-20013 (FRL Reference Period 1)

The uncertainties of Stable Forest, Stable Non-Forest, Deforestation, and Forest Degradation from 2001 to 2013 are respectively 0.75%, 2.42%, 18.59%, and 5.70%. After QA/QC process, it is confirmed that removals associated with Forest Restoration in this period are assessed at zero.

Land Use Change Stratification	Plot Count	Area	pi	Area [Ai] (mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (mil. ha)	Uncertainty %
Stable Forest	18,320.00	34,066,149	0.727	33,530,246.0	0.002807	129,503.9	± 253,827.7	± 0.75%
Stable Non-Forest	5,747.00	9,892,213	0.228	10,518,467.5	0.002642	121,914.8	± 238,953.0	± 2.42%
Deforestation	101.00	193,569	0.004	184,855.6	0.000398	18,357.3	± 35,980.3	± 18.59%
Forest Degradation	1,041.00	1,986,932	0.041	1,905,294.0	0.001253	57,821.3	± 113,329.7	± 5.70%
Forest Restoration	0.00		0.000	0.0	0.000000	0.0	± 0.0	

2009-2013 (FRL Reference Period 2)

The uncertainties of Stable Forest, Stable Non-Forest, Deforestation, and Forest Degradation from 2009 to 2013 are respectively 0.70%, 2.40%, 23.52%, and 8.53%. After QA/QC process, it is confirmed that removals associated with Forest Restoration in this period are assessed at zero.

Land Use Change Stratification	Plot Count	Area	pi	Area [Ai] (mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (mil. ha)	Uncertainty %
Stable Forest	18,892.00	35,150,366	0.749	34,577,151.1	0.002729	125,932.1	± 246,826.9	± 0.70%
Stable Non-Forest	5,785.00	9,964,856	0.229	10,588,017.1	0.002648	122,197.7	± 239,507.5	± 2.40%
Deforestation	63.00	120,926	0.002	115,306.0	0.000314	14,509.3	± 28,438.3	± 23.52%
Forest Degradation	469.00	902,715	0.019	858,388.9	0.000851	39,267.1	± 76,963.4	± 8.53%
Forest Restoration	0.00		0.000	0.0	0.000000	0.0	± 0.0	

2014-2015 (REDD+ Results Period 1)

The uncertainties of Stable Forest, Stable Non-Forest, Deforestation, and Forest Degradation from 2014 to 2015 are respectively 0.68%, 2.38%, 32.82%, and 14.31%. After QA/QC process, it is confirmed that removals associated with Forest Restoration in this period are assessed at zero.

Land Use Change Stratification	Plot Count	Area	pi	Area [Ai] (mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (mil. ha)	Uncertainty %
Stable Forest	19,146.00	35,653,390.98	0.759	35,042,035.5	0.002692	124,200.9	± 243,433.8	± 0.68%
Stable Non-Forest	5,848.00	10,085,782.43	0.232	10,703,323.1	0.002659	122,661.9	± 240,417.3	± 2.38%
Deforestation	32.00	61,784.18	0.001	58,568.1	0.000224	10,347.1	± 20,280.3	± 32.82%
Forest Degradation	183.00	337,905.46	0.007	334,936.4	0.000535	24,669.7	± 48,352.6	± 14.31%
Forest Restoration	0.00		0.000	0.0	0.000000	0.0	± 0.0	

2016-2018 (REDD+ Results Period 2)

The uncertainties of Stable Forest, Stable Non-Forest, Deforestation, and Forest Degradation from 2016 to 2018 are respectively 0.69%, 2.37%, 29.44%, and 13.47%. After QA/QC process, it is confirmed that removals associated with Forest Restoration in this period are assessed at zero.

Land Use Change Stratification	Plot Count	Area	pi	Area [Ai] (mil. ha) [A*pi]	Standard Error (proportion)	Standard Error (mil. ha)	Confidence Intervals (mil. ha)	Uncertainty %
Stable Forest	19,102.00	35,551,493.18	0.758	34,961,504.3	0.002699	124,507.5	± 244,034.7	± 0.69%
Stable Non-Forest	5,880.00	10,147,566.61	0.233	10,761,891.2	0.002664	122,895.3	± 240,874.9	± 2.37%
Deforestation	44.00	80,765.68	0.002	80,531.2	0.000263	12,130.2	± 23,775.1	± 29.44%
Forest Degradation	183.00	359,037.59	0.007	334,936.4	0.000535	24,669.7	± 48,352.6	± 13.47%
Forest Restoration	0.00		0.000	0.0	0.000000	0.0	± 0.0	

PNG also has been implementing landuse assessment by the wall-to-wall mapping method using TerraAmazon software adjusted to PNG situation (called TerraPNG). Although the assessment has been completed only for the base year of 2015, the relative comparison between the results of sampling-based method (CollectEarth 2015) and wall-to-wall mapping method (TerraPNG 2015) has been conducted as the accuracy assessment of TerraPNG. The overall accuracy (agreement rate) of Forest/non-Forest was 89% and IPCC land-use category was 83%. It should be noted that Collect Earth sampling-based assessment is not always interpreting the land-use over the exact sampling point location, instead using the hierarchy rule for the plot (see section 5.2).

Uncertainty analysis for Emission Factors

In terms of emission factors, there is incomplete quantitative information available on error in estimating forest carbon stocks and emission factors. Those estimates of forest carbon stocks taken from Fox et al. (2010) are used for a bit more than half of PNG's forests and come with a quantification of sampling error. These sampling errors amount to around 20-30%, and for the exact value used from Fox et al, the sampling error amounts to 28.3% and 21.4% for degraded and primary forest respectively (see Table 3 in Fox et al, 2010, the values for lowland forest). There is no information on other error sources available there. Those estimates taken from the IPCC guidelines do not come with detail quantitative information on errors.

Based on the situation and understanding described above, the following causes were considered for the uncertainty analysis of Emission (and Removal) Factors.

a. Uncertainty of AGB due to the use of Fox et at. (2010) and IPCC default values (IPCC GL 2006)

b. Uncertainty of Root - to - Shoot ratios due to the use of IPCC default values (IPCC GL 2006)

c. Uncertainty of Carbon Fraction value due to the use of IPCC default values (IPCC GL 2006)

Estimation method for multiple uncertainties

After the uncertainty of each parameter is assessed, the total uncertainty of carbon stock was calculated through 'propagation of error approach' and by using the following generic equations given in the IPCC GL 2006.

EQUATION 3.1
COMBINING UNCERTAINTIES – APPROACH 1 – MULTIPLICATION

$$U_{total} = \sqrt{U_1^2 + U_2^2 + \ldots + U_n^2}$$

Where:

U_{total} = the percentage uncertainty in the product of the quantities (half the 95 percent confidence interval divided by the total and expressed as a percentage);

U_i = the percentage uncertainties associated with each of the quantities.

EQUATION 3.2
COMBINING UNCERTAINTIES – APPROACH 1 – ADDITION AND SUBTRACTION

$$U_{total} = \frac{\sqrt{(U_1 \bullet x_1)^2 + (U_2 \bullet x_2)^2 + \ldots + (U_n \bullet x_n)^2}}{|x_1 + x_2 + \ldots + x_n|}$$

Where:

U_{total} = the percentage uncertainty in the sum of the quantities (half the 95 percent confidence interval divided by the total (i.e., mean) and expressed as a percentage). This term 'uncertainty' is thus based upon the 95 percent confidence interval;

x_i and U_i = the uncertain quantities and the percentage uncertainties associated with them, respectively.

Uncertainty of carbon stock for forest class

The following table shows the total uncertainty of carbon stock for each forest class estimated through the propagation of error approach. For AGB error for Fox et al. (2010), the values 18.8/66.3 = 28.3% and 22.7/106.3 = 21.35% in Table 3 of the literature were assigned for degraded and primary forest respectively. All the other values are based on the IPCC GL 2006.

LU	STR	Land Use Subdivision	Global Ecological Zone	Source	tC/ha	tCO2/ha	Area(ha) 2013	a	b	c	Uncertainty (%)
Forest	Primary	Low altitude forest on plains and fans	Tropical rain forest	Fox et al. (2010)	305.5	526.5	5,817,288	21.4%	7.4%	2.7%	22.8%
		Low altitude forest on uplands			305.5	526.5	8,872,771	21.4%	7.4%	2.7%	22.8%
		Lower montane forest	Tropical mountain system	IPCC GL (2006)	177.8	306.4	6,671,087	30.0%	0.9%	2.7%	30.1%
		Montane forest			177.8	306.4	361,131	30.0%	0.9%	2.7%	30.1%
		Montane coniferous forest			177.8	306.4	3,995	30.0%	0.9%	2.7%	30.1%
		Dry seasonal forest	Tropical dry forest		166.4	286.8	2,064,756	30.0%	0.9%	2.7%	30.1%
		Littoral forest	Tropical rain forest	Fox et al. (2010)	305.5	526.5	130,533	21.4%	7.4%	2.7%	22.8%
		Seral forest			305.5	526.5	287,277	21.4%	7.4%	2.7%	22.8%
		Swamp forest			305.5	526.5	2,209,544	21.4%	7.4%	2.7%	22.8%
		Savanna	Tropical dry forest	IPCC GL (2006)	166.4	286.8	339,379	30.0%	0.9%	2.7%	30.1%
		Woodland			166.4	286.8	687,956	30.0%	0.9%	2.7%	30.1%
		Scrub	Tropical shrubland		98.0	168.9	178,511	30.0%	0.6%	2.7%	30.1%
		Mangrove	Tropical wet Mangrove		286.1	493.0	226,989	30.0%	5.6%	2.7%	30.6%
	Degraded	Low altitude forest on plains and fans	Tropical rain forest	Fox et al. (2010)	200.0	344.7	3,150,143	28.4%	14.9%	2.7%	32.1%
		Low altitude forest on uplands			200.0	344.7	2,272,738	28.4%	14.9%	2.7%	32.1%
		Lower montane forest	Tropical mountain system	IPCC GL (2006)	116.4	200.6	1,335,164	30.0%	0.9%	2.7%	30.1%
		Montane forest			116.4	200.6	29,684	30.0%	0.9%	2.7%	30.1%
		Montane coniferous forest			116.4	200.6	0	30.0%	0.9%	2.7%	30.1%
		Dry seasonal forest	Tropical dry forest		108.9	187.7	286,554	30.0%	0.9%	2.7%	30.1%
		Littoral forest	Tropical rain forest	Fox et al. (2010)	200.0	344.7	15,693	28.4%	14.9%	2.7%	32.1%
		Seral forest			200.0	344.7	33,263	28.4%	14.9%	2.7%	32.1%
		Swamp forest			200.0	344.7	255,234	28.4%	14.9%	2.7%	32.1%
		Savanna	Tropical dry forest	IPCC GL (2006)	108.9	187.7	296,410	30.0%	0.9%	2.7%	30.1%
		Woodland			108.9	187.7	369,765	30.0%	0.9%	2.7%	30.1%
		Scrub	Tropical shrubland		64.2	110.6	41,650	30.0%	0.6%	2.7%	30.1%
		Mangrove	Tropical wet Mangrove		187.3	322.8	54,860	30.0%	5.6%	2.7%	30.6%
	Plantation	Eucalyptus Plantation	Tropical rainforest (plantation)	IPCC GL (2006)	205.5	354.1	17,637	30.0%	14.9%	2.7%	33.6%
		Balsa Plantation			205.5	354.1	3,922	30.0%	14.9%	2.7%	33.6%
		Araucaria Plantation			205.5	354.1	9,764	30.0%	14.9%	2.7%	33.6%
		Pinus Plantation			205.5	354.1	7,809	30.0%	14.9%	2.7%	33.6%
		Acacia Plantation			205.5	354.1	5,964	30.0%	14.9%	2.7%	33.6%
		Terminalia Plantation			205.5	354.1	3,913	30.0%	14.9%	2.7%	33.6%
		Rubber Plantation			205.5	354.1	11,697	30.0%	14.9%	2.7%	33.6%
Non-Forest		Cropland	-	-	0.0	0.0	5,080,707	N/A	N/A	N/A	0.0%
		Grassland	-	-	0.0	0.0	2,436,667	N/A	N/A	N/A	0.0%
		Wetlands	-	-	0.0	0.0	2,128,512	N/A	N/A	N/A	0.0%
		Settlements	-	-	0.0	0.0	384,545	N/A	N/A	N/A	0.0%
		Other lands	-	-	0.0	0.0	55,352	N/A	N/A	N/A	0.0%

Uncertainty of Emission / Removal Factors

For the uncertainty analysis which will be estimated per REDD+ activity (e.g. Deforestation, Forest Degradation etc.), the land use subdivisions were stratified into simple strata; Forest (Primary), Forest (Degraded/Plantation) and Non-Forest. The uncertainty for each stratum was calculated by using a weighted value based on area proportion. The following table shows the uncertainty for each stratum.

Uncertainty in carbon stock/ha by stratum

Strata	Mean tCO_2/ha	Uncertainty (tCO_2/ha)	Uncertainty (%)
Forest(Primary)	441.7	52.1	11.8%
Forest(Degraded)	301.2	53.6	17.8%
Non-Forest	0.0	N/A	N/A

Strata Change and REDD+ Activity

		Current		
		Forest(Primary)	**Forest(Degraded)**	**Non-Forest**
Previous	Forest(Primary)	Stable Forest (SF)	Forest Degradation (DG)	Deforestation (DF)
	Forest(Degraded)	Forest Restoration (RS)	Stable Forest (SF)	Deforestation (DF)
	Non-Forest	Reforestation (RF)	Reforestation (RF)	Stable Non-Forest (SNF)

Emission/Removal Factors (tCO_2/ha)

		Current		
		Forest(Primary)	**Forest(Degraded)**	**Non-Forest**
Previous	Forest(Primary)	0.0	-140.5	-441.7
	Forest(Degraded)	140.5	0.0	-301.2
	Non-Forest	441.7	301.2	0.0

Emission/Removal Factor Uncertainty (%)

		Current		
		Forest(Primary)	**Forest(Degraded)**	**Non-Forest**
Previous	Forest(Primary)	0.0%	10.1%	11.8%
	Forest(Degraded)	10.1%	0.0%	17.8%
	Non-Forest	11.8%	17.8%	0.0%

Note: The calculation errors (figures) in the table above reported in BUR1 were corrected in this BUR2

Aggregated / Total Uncertainty Analysis

Based on the uncertainty assessment of Activity Data (AD) and Emission Factors (EF), the uncertainty of the emissions and removals through changes among the REDD+ activities using propagation of error approach. The following tables show the results of the calculation. EF Uncertainty does not have time series analysis so the same information is used for all the periods.

2001-20013 (FRL Reference Period 1)

	SF	SNF	DF	DG	RF	RS
AD Uncertainty	0.75%	2.42%	18.59%	5.70%	N/A	N/A
EF Uncertainty	N/A	N/A	10.07%	10.07%	10.07%	10.07%
Total Uncertainty	N/A	N/A	21.14%	11.57%	N/A	N/A

2009-2013 (FRL Reference Period 2)

	SF	SNF	DF	DG	RF	RS
AD Uncertainty	0.70%	2.40%	23.52%	8.53%	N/A	N/A
EF Uncertainty	N/A	N/A	10.07%	10.07%	10.07%	10.07%
Total Uncertainty	N/A	N/A	25.58%	13.19%	N/A	N/A

2014-2015 (REDD+ Results Period 1)

	SF	SNF	DF	DG	RF	RS
AD Uncertainty	0.68%	2.38%	32.82%	14.31%	N/A	N/A
EF Uncertainty	N/A	N/A	10.07%	10.07%	10.07%	10.07%
Total Uncertainty	N/A	N/A	34.33%	17.50%	N/A	N/A

2016-2018 (REDD+ Results Period 2)

	SF	SNF	DF	DG	RF	RS
AD Uncertainty	0.69%	2.37%	29.44%	13.47%	N/A	N/A
EF Uncertainty	N/A	N/A	10.07%	10.07%	10.07%	10.07%
Total Uncertainty	N/A	N/A	31.11%	16.81%	N/A	N/A

Finally, the uncertainty in emissions from deforestation and emissions from forest degradation are combined using again IPCC 2006 Equation 3.2. This results in the following uncertainty estimates:

	95% CI (%)
Uncertainty FRL (2001-2013)	10.20%
Uncertainty FRL (2009-2013)	11.77%
Total uncertainty results (2014-2015)	15.69%
Total uncertainty results (2016-2018)	14.98%

Note: The calculation errors (figures) in the table above reported in BUR1 were corrected in this BUR2.

Areas for Improvement

PNG used the Error propagation (IPCC Tier 1) method in this BUR2 but PNG will consider to improve the uncertainty analysis by using Monte Carlo Simulation (IPCC Tier 2) method for next report.

7. National Forest Monitoring System

The activity data and emissions factors used in the construction of PNG's FRL and REDD+ results underwent both quantitative and qualitative uncertainty analysis. This has made it possible to identify opportunities for improvement.

7.1 Summary of NFMS and MRV efforts to date

In so far as the design of a National Forest Monitoring System (NFMS) for REDD+, PNG has managed to finalise the NFMS and submitted 1st FRL to the UNFCCC for technical assessment in January 2017 (http://redd.unfccc.int/submissions.html?country=png). PNG's REDD+ efforts and readiness in the area of NFMS and FRL have been led by PNGFA, with close support and collaboration from CCDA and technical assistance from FAO and JICA. Alongside the technical support and development work, numerous stakeholder events on NFMS and FRL have been held to bring together all relevant parties. Information drawn from these meetings has informed the development of an NFMS Roadmap for PNG which has been implemented.

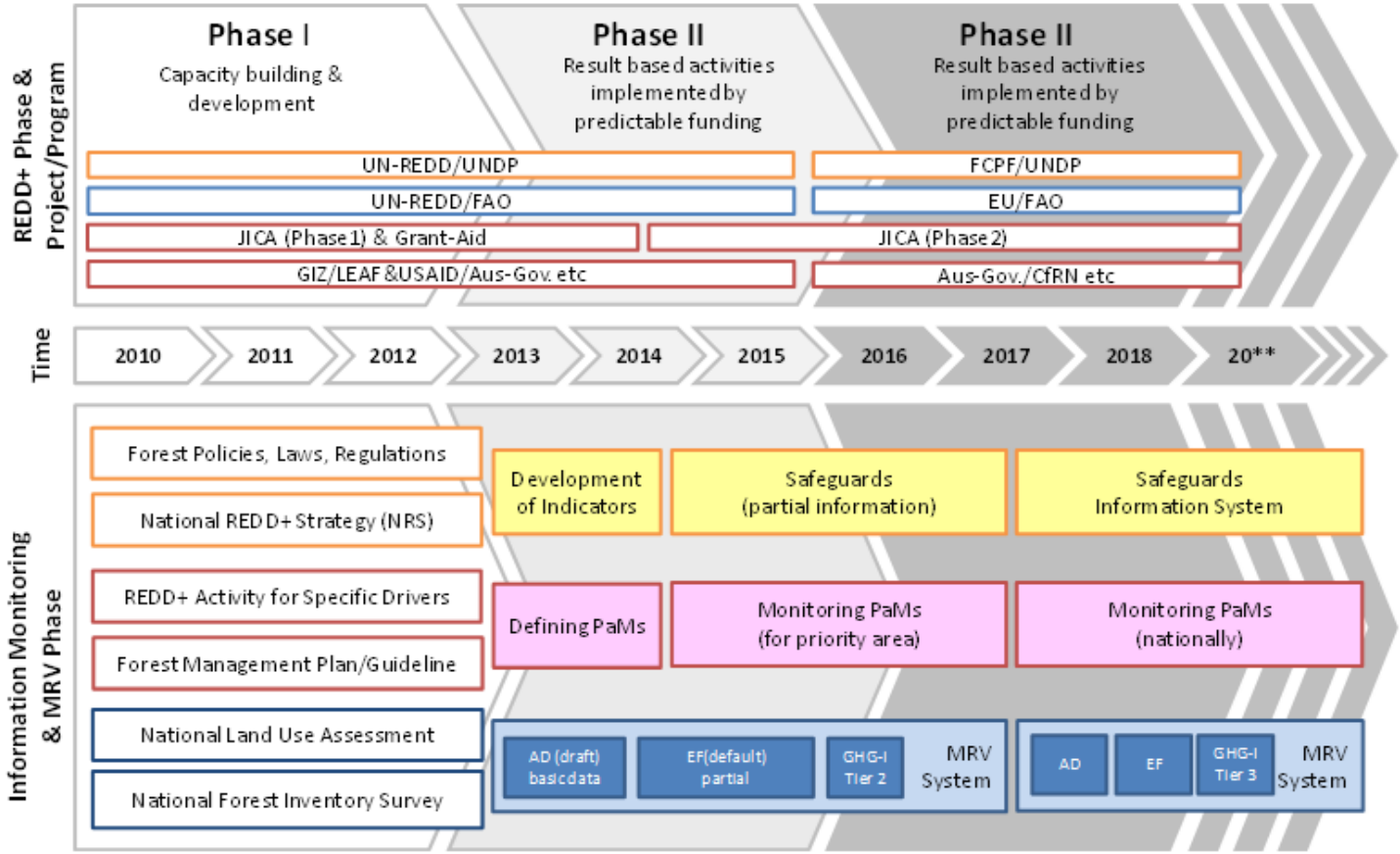


Figure 14 NFMS roadmap for Papua New Guinea

The capacity on forest monitoring of PNG using remote sensing technology has significantly improved in recent years with enormous advances made through the technical support from FAO under the UN-REDD Programme, EU funded NFI project and close collaboration with JICA project. One of the most significant achievements being the development of a forest monitoring GIS web-portal (https://png-nfms.org/portal/) through which numerous land use layers can be visualised. The GoPNG through PNGFA also completed national land use change assessments using the FAO developed Open Foris Collect Earth in 2015 and 2019.

Alongside this, PNG has undertaken a national-level Land Use, Land Use Change and Forestry (LULUCF) assessment by point sampling based approach, a wall-to-wall approach through a system called TerraPNG, housed and managed within the CCDA. Full-time GIS operators are in place in both PNGFA and CCDA to ensure the sustainability of this support.

7.2 Operational NFMS and MRV system in PNG

PNG developed and has been improving NFMS including MRV (Measurement, Reporting and Verification) function using FAO developed Open Foris Tool (Collect Earth, Collect, Collect Mobile and Calc) as well as mapping function using TerraAmazon as TerraPNG. PNG developed FRL using the data from NFMS and submitted it to UNFCCC in January 2017. Technical Assessment by UNFCCC had been conducted throughout 2017 and the revised FRL was officially published by UNFCCC at early 2018. PNG had also prepared NRS and officially released it in 2017. PNG currently working on Safeguard Information System.

PNG has made great progress on the REDD+ readiness and is now moving to its implementation and the results based payment. As a base for implementation and monitoring, PNG had prepared GHG-Inventory and Biennial Update Report (BUR) with Technical Annex on REDD+ in 2018 and submitted the compiled summary reports to UNFCCC in April 2019. Technical Assessment by UNFCCC had been conducted for PNG BUR and Technical Annex on REDD+ from August to the end of 2019 then a technical assessment report had been released by UNFCCC in early 2020.

Under the Cancun Agreement, NFMS should have two functions; "Monitoring" function to monitor REDD+ activities and "MRV" function to measure and report the performance of REDD+ activities to UNFCCC; which then undergoes verification. PNG established a robust domestic MRV system, which contains in-country verification using two different methods (point sampling and wall-to-wall mapping) with tools (Collect Earth and TerraPNG) hosted by different government organizations; PNG Forest Authority (PNGFA) and Climate Change and Development Authority (CCDA).

As part of the monitoring function, PNG established and officially released PNG REDD+ and Forest Monitoring Web-Portal (http://png-nfms.org/portal/) in 2017 by Prime Minister to disseminate forest and land use information related to REDD+ to the public ensuring transparency of PNG REDD+ progress. This portal is recognized as an achievement by various government and private organizations in PNG to share the REDD+ related information in one single platform for the first time in PNG. Anybody and organizations can utilize this portal to promote the achievements related to REDD+ in PNG.

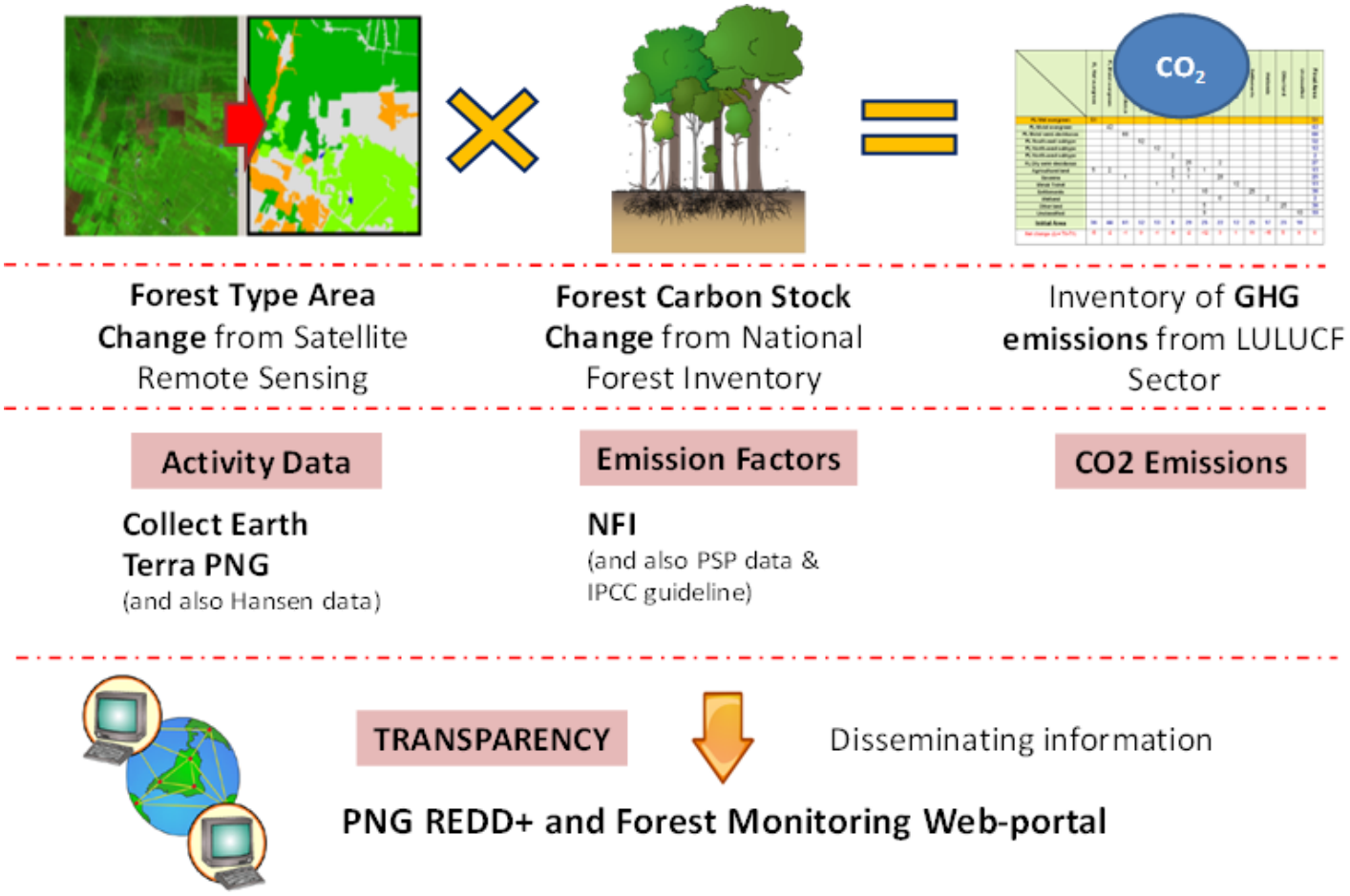


Figure 15 Papua New Guinea's NFMS for REDD+ under UNFCCC

PNG's REDD+ and Forest Monitoring Web-Portal was established for disseminating forest and land use information to public for ensuring the transparency of PNG REDD+ process. The web portal was developed jointly by CCDA and PNGFA. Other government agencies and private sectors (Conservation and Environmental Protection Authority, Mineral Resources Authority, National Statistics Office, etc) are responsible for providing all the necessary data needed for the web-portal. The web-portal is managed by CCDA who is responsible for publishing and updating the online information.

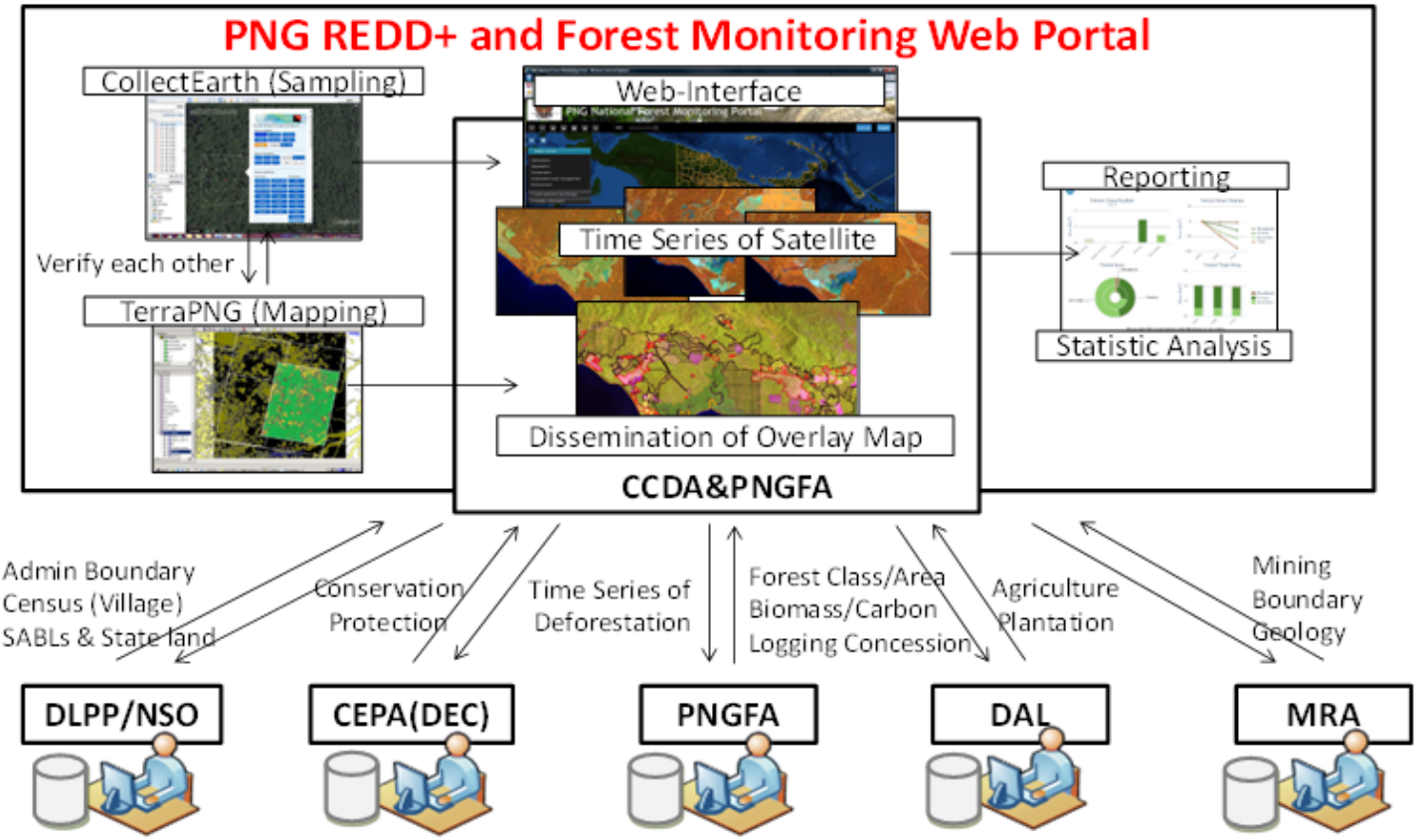


Figure 16 PNG REDD+ and Forest Monitoring Web-Portal (Source: CCDA)

After the Web-Portal was launched in 2017, PNG had made a lot of new achievements (products with publications) related to the forest and land use in PNG, such as "Forest and Land Use Change in Papua New Guinea 2000 - 2015", which explains the results and method of Collect Earth assessment in PNG, which was used as a base data for FRL and BUR. There are also several new achievements related to REDD+ and land use in PNG initiated by CCDA with support of FCPF/UNDP. The updating and enhancement of the Web-Portal were completed in 2021 and released as "PNG Climate Change and Forest Monitoring Web-Portal" in 2022.

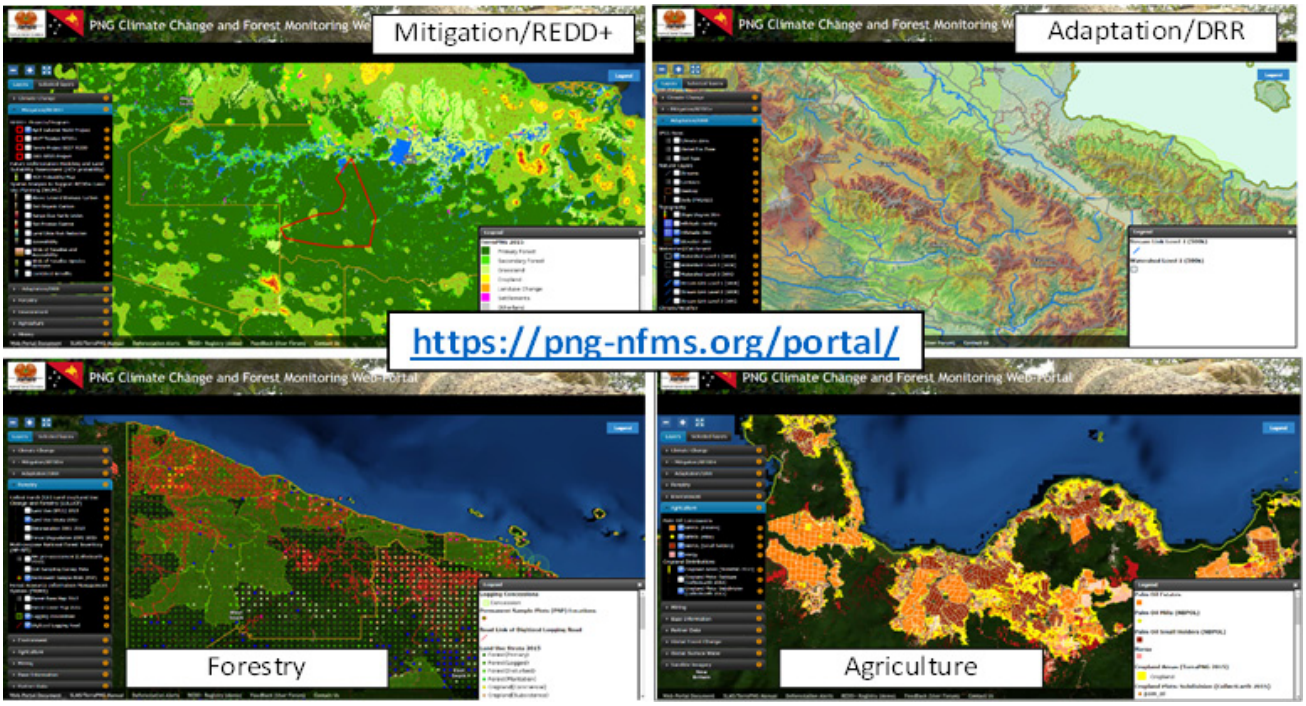
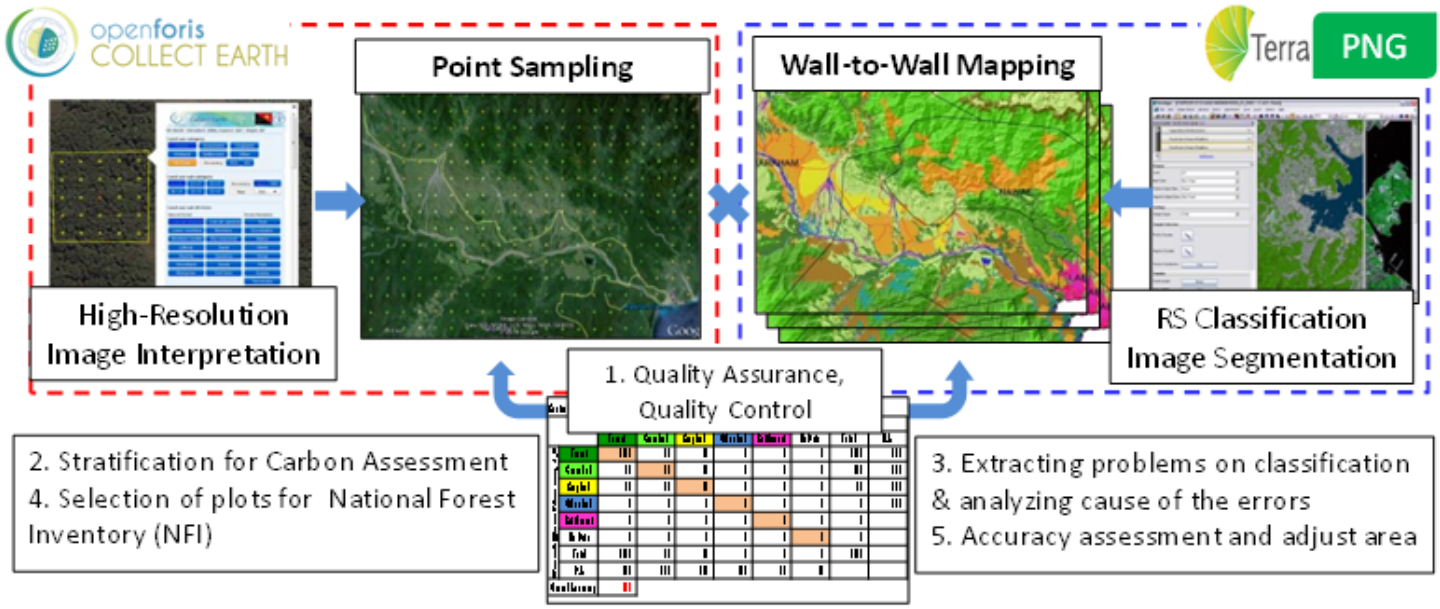


Figure 17 Updated PNG Climate Change and Forest Monitoring Web-Portal (Source: CCDA)

Regarding MRV system, PNG was the first country to use Collect Earth for LULUCF assessment and FRL and some of the other countries followed afterwards. On the other hand, many other countries use Wall-to-Wall mapping assessment. Based on the outcomes, challenges and lesson learnt from forest and land use change assessment in PNG 2000-2015, PNGFA organized the advantages and limitations of Collect Earth point sampling method compared with other methods (wall-to-wall mapping, such as TerraPNG). The overview of two different methods is illustrated in Figure below.



	Point Sampling	Wall-to-Wall Mapping
Spatial Coverage	Sampling Plots	Segmented polygons
Area Calculation	Statistical	Geographical
Boundary	No	Yes
Statistical Analysis	Ample	Limited
Driver Analysis	Ample	Limited

Figure 18 Collect Earth Point Sampling and Wall-to-Wall Mapping Method (Source: PNGFA)

In terms of "MRV", measurement frequency is annual based (by Collect Earth) and reporting is biennial based (for BUR). Such national reports need to be produced with great care, based on accurate and scrutinized data. The assessment and analysis require substantial time and resources. Consequently, there will be a considerable time lag before information such as deforestation is announced. In terms of "Monitoring", the needs to monitor the potential deforestation areas in the national protected areas, REDD+ project areas and logging constraints areas more frequently such as monthly or even weekly have been raised by the stakeholders including the government agencies, CSOs and academic institutions. Near-real-time information enable responsible authorities and organizations including the communities to take necessary measures against unplanned or unauthorized forest clearing, and prevent from further expansion.

Considering the situation above, the GoPNG decided to develop prototype PNG Deforestation Alerts and Monitoring System using the latest technologies with FAO assistance with affordable cost in the world and information existing in PNG, as a part of Monitoring Function under NFMS, to consider the potentials and issues/challenges for PNG. This new system is complementing the existing and potential systems in PNG, and collaboratively developed and managed by the several government organizations in PNG.

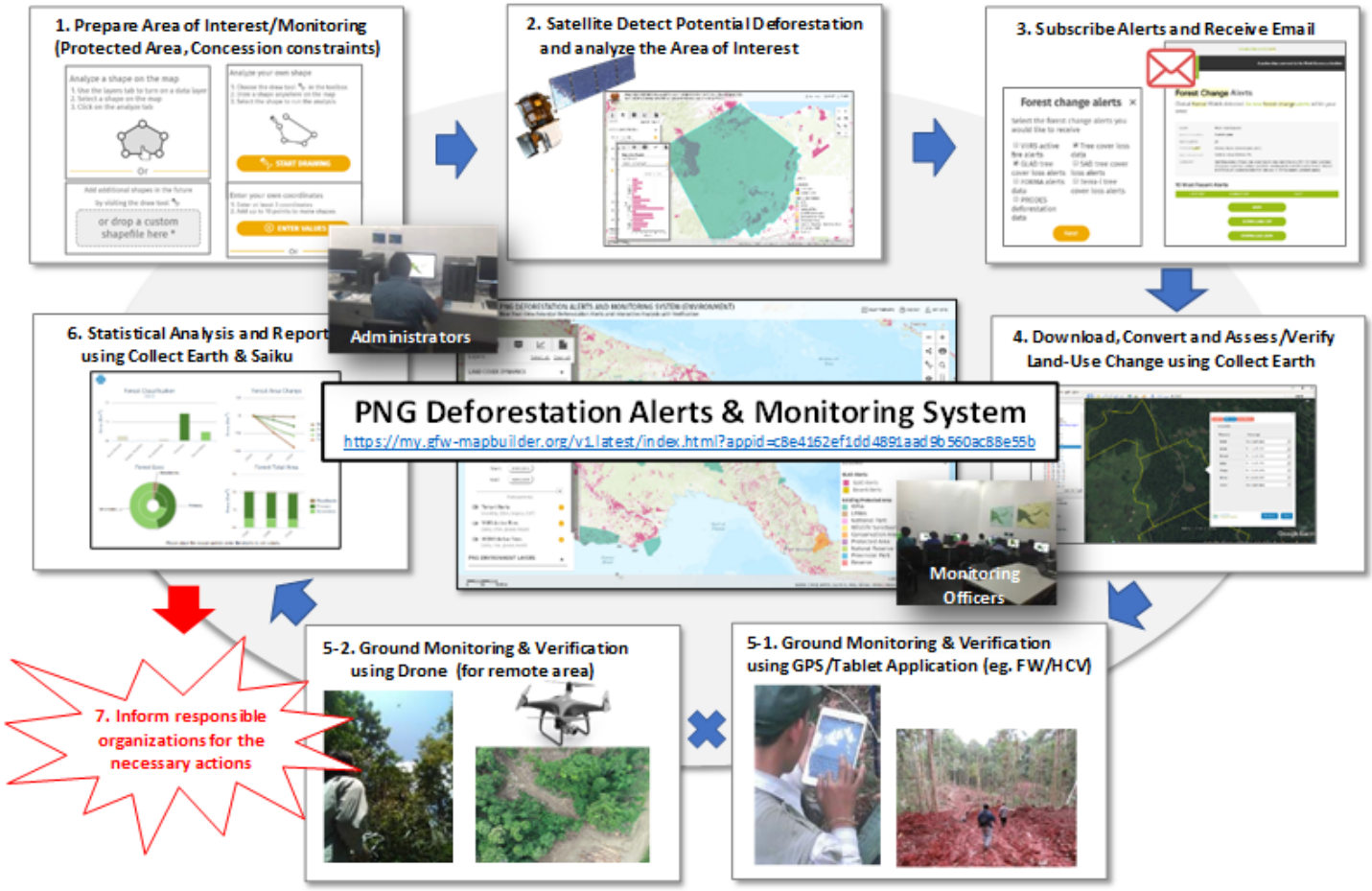


Figure 19 Indicative Work-Flow of PNG Near Real-time Deforestation Alerts and Monitoring System

PNG Near Real-time Deforestation and Degradation Alerts and Monitoring System will be oriented in a part of Monitoring function under NFMS. Figure 20 shows PNG Resource Information Network and the Deforestation Monitoring Alerts System. NFMS with this Deforestation Alerts system is contributing to implementation of Conservation / Environment Protection, Climate Change and Development, and Sustainable Forest Management, by collaborating with existing systems in PNG.

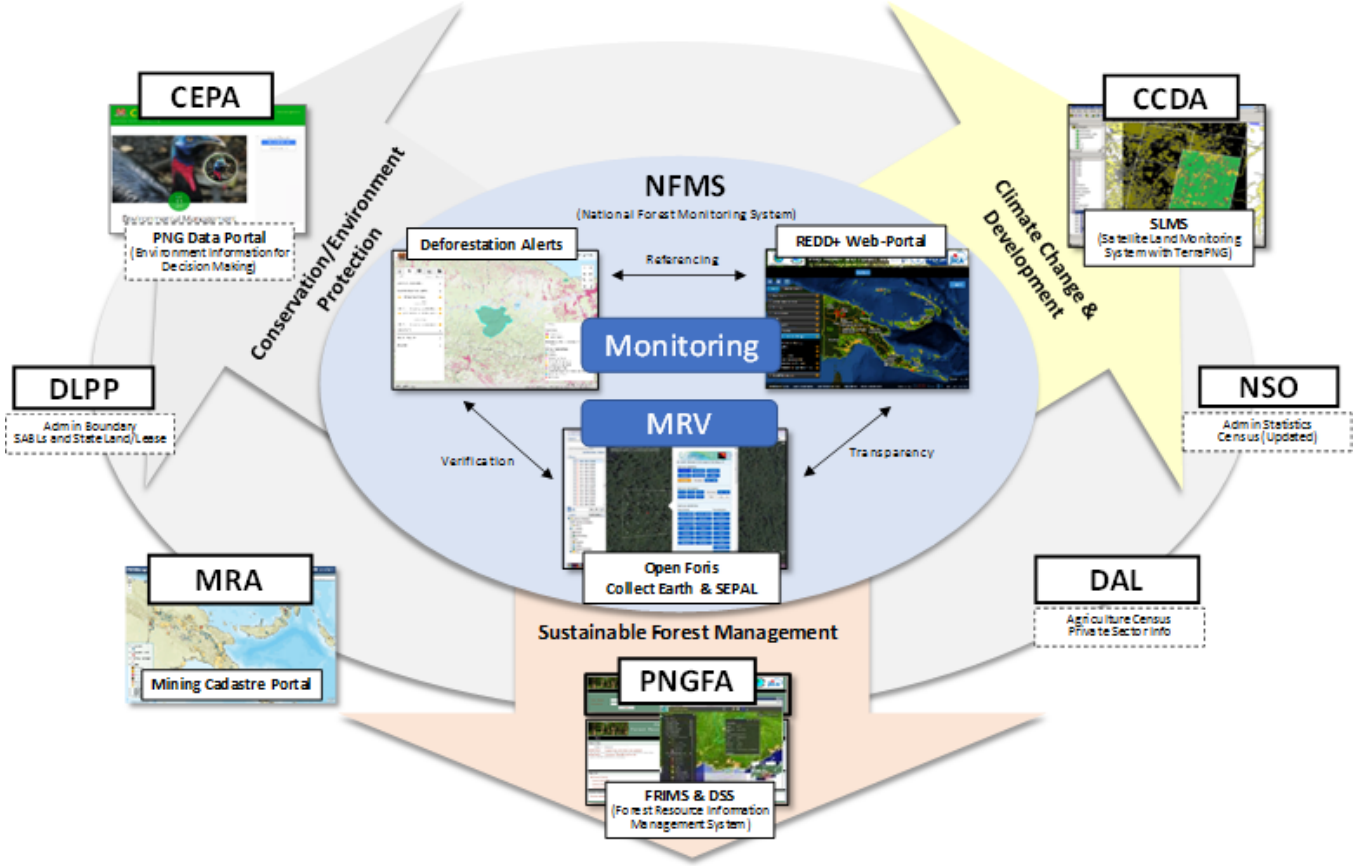


Figure 20 PNG Resource Information Network and Monitoring System

7.3 Multi-purpose National Forest Inventory

PNG launched a first-ever Multipurpose National Forest Inventory (NFI) in March 2016, along with the PNG Forest Monitoring and REDD+ Web-portal receiving national attention and official endorsement from the Prime Minister of PNG. These initiatives aimed to accurately estimate GHG emissions from forest and land use change meeting the requirements of Tier 3 emission factors (as prescribed by the IPCC for REDD+ Measurement, Reporting and Verification (MRV).

The NFI's methodology and approach was built on the methods and capacity developed within the PNG Forest Authority (PNGFA) over a number of years. It was anticipated that the data generated by the NFI would significantly improve the accuracy of GHG estimations in the LULUCF sector and provide essential information related to the REDD+ (environmental and social) safeguards in PNG. The GoPNG and the EU had been financing this work with technical support from FAO. This program ended in 2019 with achieving its objectives with the main deficiencies observed in a number of areas related to the collection of flora and fauna biodiversity information and the development of detailed emission factors for different forest types as well as for different levels of forest degradation.

PNG Multi-Purpose National Forest Inventory Booklet
https://pngfa.gov.pg/images/articledocs/National_Forest_Inventory/NFI_Information_v3_Booklet_20180615_compressed.pdf

1st National Forest Inventory PNG: Field Manual
https://pngfa.gov.pg/images/articledocs/National_Forest_Inventory/PNG_Biophysical_Field_Manual_08_Feb_2018_FINAL_compressed.pdf

PNG's 1st Multi-Purpose NFI: Project Proceeding
https://pngfa.gov.pg/images/articledocs/National_Forest_Inventory/Proceedings_Feb_2018_compressed.pdf

Proceedings of the 2nd NFI Research Conference
https://pngfa.gov.pg/images/articledocs/National_Forest_Inventory/Proceedings_of_the_second_NFI_Research_Conference_compressed.pdf

Figure 21 Multi-purpose National Forest Inventory (source: PNGFA)

So far, only initial data has been derived from the total area earmarked. Information availability on land use and land use change will be a major step forward and a milestone achievement for the country. Based on this forest inventory and via input obtained from respective stakeholders, important measures such as the National Sustainable Land Use Policy (NSLUP), will be a possible future objective and a major advantage for the country.

The capacity on forest monitoring of PNG using remote sensing technology has improved significantly in recent years. However, a large information gap still remains. National scale information on carbon stock in the diverse forests subject to different disturbances is poorly known. Previous studies were too scattered and the estimation of average carbon stock in PNG forests were often contradictory. With the data derived from the NFI these deficiencies will be greatly improved in subsequent reporting periods.

7.4 Roles and responsibilities for MRV of results

The two key government organisations responsible for the measuring, reporting and verifying the results are CCDA and PNGFA. Other government departments provide auxiliary information for the REDD+ implementation. For example, Conservation and Environment Protection Authority (CEPA) is responsible for providing data on conservation and protected area; the Department of Agriculture and Livestock provides information on agriculture plantation area and type; and the information on administrative areas are provided by the National Statistics Office.

Table 18 Stakeholders responsibility for REDD+ MRV in PNG

MRV Components	Responsible Institutions/mechanism	Roles	Platforms use
Measuring	PNGFA[30]	Calculating CO_2 emissions and removals from deforestation, forest degradation and enhancement of forest carbon stocks in PNG based on the Collect Earth land use, land use change assessment.	Open Foris (Collect Earth etc.)
	CCDA[31]	Providing land use information on extent of forest and other land use using TerraPNG wall-to-wall mapping system to support and complement Collect Earth point sampling assessment	TerraPNG system
Reporting	REDD+ and MRV Technical Working Committees	Providing validation and other technical inputs for REDD+ results submissions to the UNFCCC and ensuring the quality of the submissions.	Technical Working Committee meetings and workshops
	CCDA	Reporting country's MRV progress and results to UNFCCC.	National Communication reports and Biennial Update Report (BURs) to UNFCCC
Verifying	UNFCCC International Consultation and Analysis (ICA)	Verifying the submissions from Parties, by appointing two LULUCF experts to assess the FRL submissions and the technical annexes.	FRL submission and BUR to UNFCCC

30. See www.forestry.gov.pg
31. See www.ccda.gov.pg

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