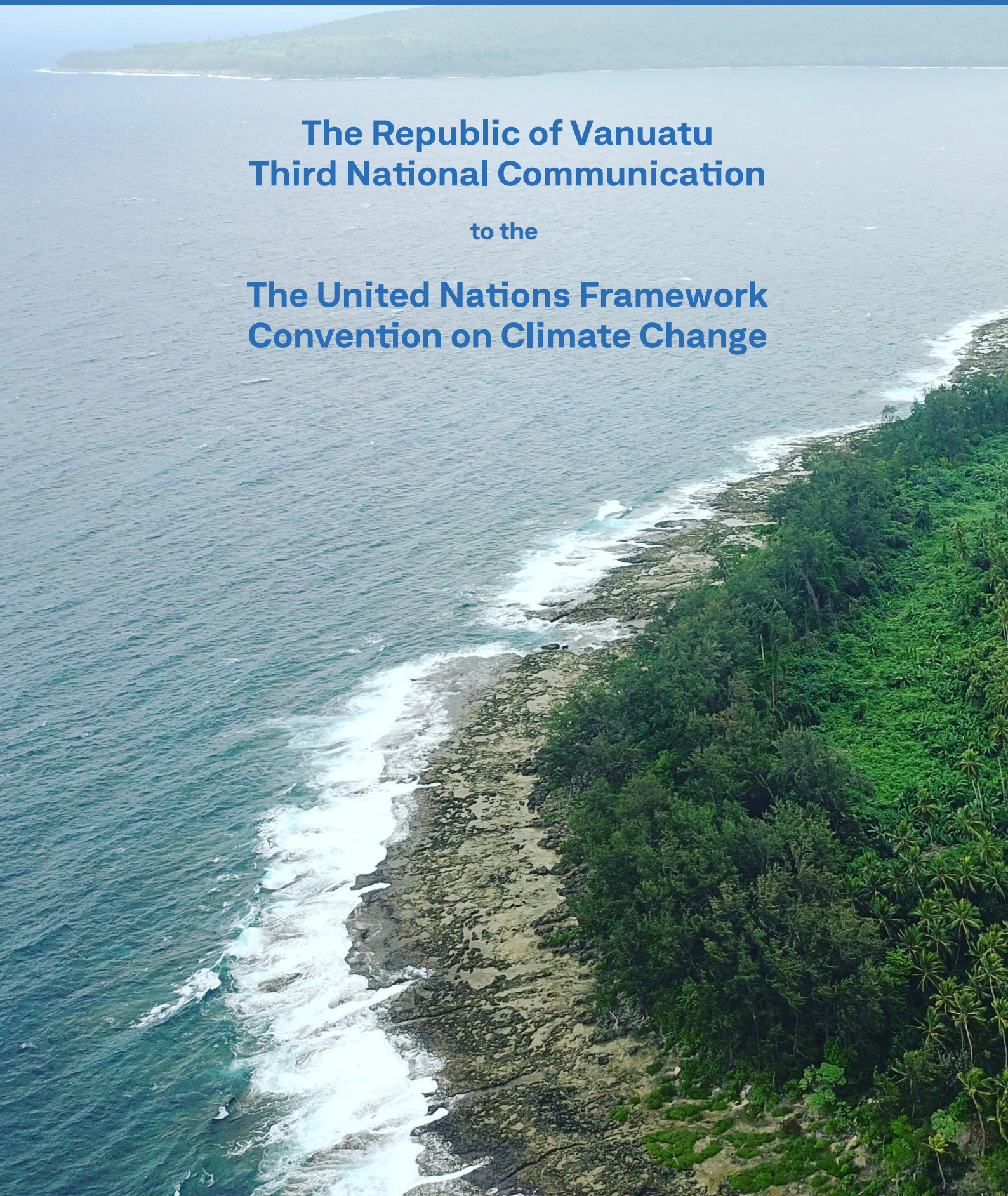
THE GOVERNMENT OF
THE REPUBLIC OF VANUATU

THE MINISTRY OF CLIMATE CHANGE

The Republic of Vanuatu Third National Communication

to the

The United Nations Framework Convention on Climate Change



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Foreword

Climate change is the most critical existential threat of our time, and its adverse impacts pose significant threats to the sustainable livelihoods and wellbeing of Vanuatu's people. It is against this critical conditions that Vanuatu urges committed global action against climate change. Most importantly this will also entail strengthening the implementation of the Paris Agreement and limiting global temperature rise to 1.5°C above the pre-industrial level.

Vanuatu's Third National Communication is an essential document for Vanuatu to fulfill its reporting obligation as a Party to the UNFCCC. This report shows how Vanuatu is progressing in meeting its' international commitments on climate change. The Third National Communication report, lays out the level of vulnerability and risks we face to the current impacts of climate change, how we are coping with these impacts, and what the future might look like as the climate rapidly changes. Furthermore, this report describes Vanuatu's greenhouse gas emissions and documents the mitigation actions the nation is taking in the pursuit of low-carbon and climate-resilient development.

Vanuatu has taken significant policy and institutional reforms as evidence of its' continued support to the UNFCCC and the Paris Agreement. The National Sustainable Development Plan to attain overall sustainable development goals, National Energy Roadmap to achieve clean energy targets by 2030, and, the National Climate Change and Disaster Risk Reduction Policy for increasing resilience and adaptive capacity are central elements of Vanuatu's efforts to cushion the impacts of climate change. Moreover, Vanuatu has been partnering and working with expertise at both global and national levels in assessing and resourcing various sectors to climate-proof its' economy and secure a sustainable future for the country.

I would like to convey my sincere gratitude for the efforts of the various partners and stakeholders for their contributions to make this national report are reality. Through their comprehensive efforts this report will inform the global community of the gravity of the issue of climate change and the urgent need for their support and action to mitigate the adverse impacts in this country. As demonstrated through this report, Vanuatu's commitment augments our push towards meeting the essential goals of the UN Climate Convention and Paris Agreement obligations.

Hon. Bruno Lengkon
Minister of Climate Change,
Meteorology & Geo-Hazards, Environment, Energy and Disaster Management

Executive Summary

National Circumstances

Vanuatu comprises of 83 islands, and lies in the middle of Fiji, Solomon Islands and New Caledonia. The indigenous people of Vanuatu, or ni-Vanuatu, are Melanesians. About 7–8% of the population are immigrants or descendants from Europe, Asia and countries in the Pacific Islands region. The independence of the sovereign state of Vanuatu was celebrated on 30 July 1980, and the country became the 155th member of the United Nations in September 1981.

Vanuatu's national political structure consists of legislative, executive and judiciary branches. The legislative branch consists of a single chamber, parliament, with 52 seats. Members of parliament are elected every four years.

Only 12 islands could be called significant in terms of their economy and population. The largest are Espiritu Santo (4010 Km^2), Malekula (2,069 Km^2), Efate (980 Km^2) and Erromango (900 Km^2). Santo also boasts the country's highest peak: 1,879m Mt Tabwemasana. Ambae, Ambrym and Tanna have peaks over, 1000m high. The largest of the islands, Espiritu Santo and Malekula cover 50% of the country's land mass and harbor the majority of Vanuatu's population.

Vanuatu's climate varies from wet tropical in the north to subtropical in the south, with much drier rain-shadow areas in between. The northern islands receive on average over 4000mm if annual rainfall, while the southern parts of the archipelago receive average annual rainfalls of 1500mm. Rainfall in the country is generally affected by the South Pacific Convergence Zone (SPCZ). The SPCZ intensifies during the wet season and moves further south bringing higher rainfall to Vanuatu. Low pressure systems embedded in this band of heavy rainfall often become tropical cyclones during the cyclone season. Tropical cyclones tend to affect Vanuatu between November and April. The number of cyclones varies widely from year to year, with none in some seasons but up to six in others.

Seventy-four percent (74%) of land in Vanuatu is covered with natural vegetation. Forest types include tropical lowland evergreen rain forest, broad-leaved deciduous forest, closed conifer forest, montane rain forest, cloud forest and coastal forest. There are about 1,000 vascular plant species in Vanuatu of which around 150 are endemic. There is high diversity of orchids with 158 species and palms with 21 species, including 14 endemic species (GOV, 2014). There are 121 bird species, 28 species of reptiles and 12 species of Chiropterae (Flying Foxes and Bats). Invertebrate diversity is not fully described but includes the coconut crab (Birgus latro) the largest land crab, which is an important food resource in Vanuatu (GOV, 2014).

Vanuatu's marine and coastal biodiversity contributes to generating goods and services with a value totaling over VT4.5 billion. The values include the tourism and tuna fishing sectors. The net value of tourism in 2013 was approximately VT850 million. The value of tuna to Vanuatu, mainly from access fees, was about VT160 million in 2013. Coastal habitats are valued in terms of what they contribute to subsistence fishers (about VT580 million), small-scale inshore commercial fishers (VT290 million), coastal protection (VT1.6 billion) and carbon sequestration (VT760 million) (Pascal et al., 2015).

According to the most recent Mini Census undertaken in 2016, Vanuatu's population was reported to be a total count of 272, 459 compared to a population count of 234,023 in the last 2009 census. Vanuatu's population is largely based within its' rural areas – 75 percent as per 2016 figures. Accordingly, the two provinces of Shefa and Sanma which host Vanuatu's urban centres of Port Vila and Luganville respectively have the highest populations. Vanuatu has a young population where up to 50 percent of its' population is under the age of 40 years. The population make up is such that it is close to a 1:1 male to female ratio although projections indicate a somewhat leveling of ratios by 2050.

Vanuatu is traditionally known for its strong cultural heritage tradition activities and subsistence farming. The four mainstays of Vanuatu's economy are agriculture, tourism, offshore financial services, and raising cattle. Exports include copra, kava, beef, cocoa, and timber, and imports include machinery and equipment, foodstuffs, and fuel. In 2017, Vanuatu's economy grew by 4.4 percent with a strong performance over the last three previous years. Biomass and imported petroleum product are the main energy sources for Vanuatu. Biomass is principally used for residential purposes such as for cooking and crop drying. However, petroleum products are important inputs into major sectors of the economy – electricity, industry, tourism, transportation, fishing and agriculture. Presently, Vanuatu primary needs are mainly met by imported petroleum. Consumption of petroleum has increased substantially, at an annual average rate of 6% over the years.

The bulk of electricity is derived from diesel (71%) and renewable energy (29%). Renewable sources currently being utilized include hydro, solar, wind and biofuel.

Manufacturing sector in Vanuatu is very small and is driven by just few players mainly based in Luganville and Port Vila. It is estimated that Vanuatu has just 3.8% of manufacturing value added as a percentage of its' GDP.

Tourism is a mainstay of the Vanuatu economy. Vanuatu has more recently embarked on a "greener" path as per its' National Sustainable Tourism Policy (VSTP). Given broad growth trends, the total international visitor arrivals to Vanuatu for September quarter 2019 stood at 63,407, reflecting a decline of 16% over the corresponding period in 2018.

Subsistence farming makes up more than 75% of all agriculture in Vanuatu. This type of farming centres around root crops such as Taro, Yam, Cassava and Sweet Potato. Additionally, subsistence farming focuses on consumption and cultural purposes. There is also small scale semi commercial farming that is concentrated around the urban areas. In general, the agricultural sector accounts for more than 75 percent of exports, of which the most important agricultural product is copra, which is the dried meat or dried kernel of the coconut used to extract coconut oil.

Compared to other Pacific island countries, inshore marine areas are not extensive in Vanu-

atu. Inner reef areas are limited to narrow fringing reefs and the area covered by mangroves is relatively small. A total of 161 vessels were reported in 2016 with just over half under 12 m length overall (LOA).

In 2016, the aquaculture sector employed 34 women and 173 men. An estimated 38% of the people engaged in marine fishing and subsistence fisheries were women.

The average amount of solid waste generated per capita has increased steadily from 0.43 kg/person/day in 2011 to about 1.5 kg/person/day in 2017. Both the urban centers of Port Vila and Luganville have controlled disposal sites or landfill in as in Port Vila's case. Aside from disposal within the urban controlled sites, common disposal methods include open backyard dumpsites, disposal at sea or on unused land, and burning. Liquid waste is not treated effectively via a reticulated system. Most houses and establishments have individual onsite disposal systems to manage liquid or sanitation waste water.

Life expectancy in Vanuatu has increased and now stands at 69.6 and 72.7 years for males and females, respectively (VNSO, 2009). But the country faces the dual challenges of dealing with both communicable diseases and the rapidly growing incidence of Non-Communicable Disease (NCD), notably diabetes and hypertension. People are living longer, but often with the burden of chronic illness and disability. Overall the health system faces significant challenges in its quest to achieve Universal Health Coverage.

Vanuatu operates a bilingual education system, with English and French languages being taught to According to the statistics of the ECCE sector in 2016, the number of enrolment and teachers shows increases compared to 2017 data. Overall the government's push for school grants has enables the increase of school enrolments across the education sector.

Vulnerability and Adaptation

Vanuatu faces a range of natural hazards (geophysical and climatic), and is also subjected to climatic variability and extremes. Vanuatu's latitude places it in the warm pool of the SPCZ, making highly exposed to tropical cyclone activity and ENSO cycles which increase the risks of droughts and floods. Other main climate hazards include rising sea levels threatening coastal environments and property, sea temperature increases and ocean acidification putting pressure on highly valuable coastal ecosystems and resources

The country is also located in a seismically and volcanically active region and has high exposure to geologic hazards, including volcanic eruptions, earthquakes, tsunamis, and landslides. To address climate and disaster risks, Vanuatu has prioritized the development of institutional frameworks and structures. The establishment of the National Advisory Board for Climate and Disaster Risk Reduction (NAB) with its' Secretariat has enhanced governance of these two issues. Implementation of Vanuatu's obligations of the UFCCC has further benefited from strengthened engagement and implementation of actions by government agencies, civil society, academia, the private sector and development partners.

Vanuatu has a tropical climate, moderated by southeast trade winds from May to October; moderate rainfall from November to April often affected by cyclones from December to April. As per the future climate scenarios, further warming is expected over Vanuatu. Under all Representative Concentration Pathways (RCPs), the warming is up to 1.0°C by 2030,

relative to 1995, but after 2030 there is a growing difference in warming between each RCP.

The models show a range of projected annual average rainfall change from an increase to a decrease, and the model average is near zero. The range is greater in the highest emissions scenarios. There is a range of projections for May–October rainfall from an increase to a decrease, and a slight projected increase in November–April rainfall.

The temperature of the 1-in-20-year hot day is projected to increase by approximately 0.6°C by 2030 under the RCP2.6 scenario and by 0.7°C under the RCP8.5 scenario. By 2090 the projected increase is 0.7°C for RCP2.6 and 3°C for RCP8.5.

Also, while all models project the same direction of change there is a wide range in the projected magnitude of change among the models.

The current 1-in-20-year daily rainfall amount is projected to increase by approximately 9 mm by 2030 for RCP2.6 and by 8 mm by 2030 for RCP8.5. By 2090, it is projected to increase by approximately 1 mm for RCP2.6 and by 40 mm for RCP8.5.
For Vanuatu the overall proportion of time spent in drought is expected to decrease slightly under RCP8.5 and stay approximately the same under all other scenarios.

In Vanuatu the aragonite saturation state has declined from about 4.5 in the late 18th century to an observed value of about 3.9±0.1 by 2000. All models show that the aragonite saturation state, a proxy for coral reef growth rate, will continue to decrease as atmospheric CO2 concentrations increase.

As the ocean warms, the risk of coral bleaching increases (very high confidence). There is medium confidence in the projected rate of change for Vanuatu because there is medium confidence in the rate of change of SST, and the changes at the reef scale (which can play a role in modulating large-scale changes) are not adequately resolved.
Mean sea level is projected to continue to rise over the course of the 21st century. There is very high confidence in the direction of change. The CMIP5 models simulate a rise of between approximately 8–19 cm by 2030 (very similar values for different RCPs), with increases of 42–89 cm by 2090 under the RCP8.5.

Vanuatu, like all Small Island Developing States (SIDS), is extremely vulnerable to the adverse impacts of climate change. According to the World Risk Index 2018, Vanuatu ranked highest, out of 172 countries, in the subcategory for overall risk and exposure to natural hazards. Estimations of the report, indicate that over 50 percent of the country's population could potentially become victims of natural disasters.

Particularly vulnerable to climate-induced impacts are Vanuatu's coastal areas where the majority of the country's population are residing, and a large share of infrastructure is being located. Sea level rise in combination with tectonic subsidence have led to extensive coastal erosion processes and increasingly frequent inundations in some islands.

Agriculture: Due to the large amount of the population, around 80%, being dependent on subsistence agriculture the climate change impacts pose a tremendous risk to Vanuatu's agriculture sector and food security. Agricultural activities in Vanuatu are particularly susceptible climate change induced changes in precipitation patterns (as most cropping practices are rain-fed), extreme rain or drought events, salinization processes, increases in

evapotranspiration, seasonal variations, and reduction in fresh-water availability.

Fisheries: The fisheries sector is of high importance for the country for income generation and as a food source, particularly for fisher communities. Climate change poses a significant threat towards Vanuatu's fisheries and marine life. The changing ocean temperature regime can lead to migration of fish populations and habitat impacts. Changes in ocean circulation patterns, furthermore, may affect the aquatic food web as species seek conditions suitable for their lifecycle. Climate-induced ocean acidification processes could impact the marine environment through deficiency in calcium carbonate, affecting shelled organisms and coral reef calcification.

Forestry: With a total of 36% of Vanuatu's landmass the forest coverage is high and makes the country a net carbon sink. Forests, as fisheries, always been an integral part of lives of the people of Vanuatu and contribute to the welfare and economic development. There are limited assessments been done on the effects of climate change on the forestry in Vanuatu.

However, drawing on relevant impact projections it can be expected that climate-induced changing precipitation trends, temperature and seasonal variability, and intensified extreme weather events create significant additional stress to many tree species and biodiversity of Vanuatu's forests. This can lead to changed ecosystem composition and decline in plant density or migration of some species.

Tourism: With a contribution of around 40% to Vanuatu's GDP (in 2014), tourism is one of the most important economic sectors with the highest growth potential for the nation. Climate change could, however, be a threat to the industry and its growth potential. The industry is likely being impacted through a reduced attractiveness as a tourist destination due to loss of destination habitats such as coral reefs (e.g. due to thermal bleaching) and reduced biodiversity.

Transport & Infrastructure: Almost all major services, settlement and tourism infrastructure in Vanuatu are coastal. This focus on the coastal zone makes the populations extremely vulnerable to sea level rise, erosion and inundation.
Health: Climate change effects on human health are both direct and indirect, and are expected to exacerbate existing health risks, especially in the most vulnerable communities, where the burden of disease is already high.

Extreme weather and climate events such as tropical cyclones, storm surges, flooding, and drought can have both short and long-term effects on human health, including drowning, injuries, increased disease transmission, and health problems associated with deterioration of water quality and quantity.

Water security: Freshwater supply in Vanuatu has always presented challenges. On high volcanic and granitic islands, small and steep river catchments respond rapidly to rainfall events, and watersheds generally have restricted storage capacity.

Gender Impacts: Due to prevailing gender inequalities and social norms, women and girls are disproportionately affected by climate change and disaster impacts.

According to the Vanuatu National Statistics Office (2016), more women than men (49% and 41%, respectively) are involved in the subsistence economy, and there are more female

headed single parent households with children, grandchildren or extended family members compared to men. Women consequentially are more vulnerable and face higher poverty risks as a result of climate change in areas of food security, energy access and water scarcity.

Adaptation and Sustainable Development

Vanuatu recognizes the inextricable linkages between climate change and development. Climate change impacts can set back years of development gains and withhold people or communities into a vicious cycle of poverty. In 2016 Vanuatu launched its' National Sustainable Development (NSDP) Plan 2016 – 2030, the People's Plan. This plan serves as the country's highest-level policy framework.

The third target of the environment pillar (ENV 3) addresses the climate change links stating that they seek to build "A strong and resilient nation in the face of climate change and disaster risks posed by natural and man-made hazards". Accordingly, the Vanuatu SDG Voluntary National Review report (GoV 2019), highlights steady progress made by the country in its' climate action development related goals especially in the areas of climate change governance, climate change monitoring and early warning systems, adaptive capacities and climate finance access.

In addition to the NDSP, the government of Vanuatu published a monitoring and evaluation framework in which they outline on how they want to measure progress towards reaching the development goals. The document provides information on the baseline situation of each indicator and the aspired measurable target by 2030. Some objectives for the ENV 3 goal are, for example a 100% mainstreaming of CC and disaster risks in public policies, budgets, and legislation by 2030, as well as a 100% coverage of all provinces by a multi-hazard warning system.

Numerous climate change programmes and projects have been implemented by various regional and national stakeholders over the years. These have generated knowledge, experience and best practices on local climate change impacts, on local options for adaptation and mitigation, and on awareness-raising.

The GoV is already taking proactive steps to address climate change in their development planning and some degree of budgeting, both on national and sub-national levels. However, there are still many barriers and gaps (policy, regulatory, institutional, technical, financial, business, social and cultural in nature) that need to be addressed in order to be able to shift the paradigm to transform the development and address climate change into tangible solutions, pragmatic actions, investments and inclusive business opportunities on the ground in driving towards a resilient and low carbon economy, community, and nation.

Adaptation is therefore vital to transform Vanuatu's development paradigm and build resilience to climatic impacts. Equally a number of government, donor and civil society are being implemented to strengthen adaptive capacity to climate change impacts. On the other hand, it is also critical that additional resources are mobilized to better support effective adaptation actions at all governance levels using a "no regrets" and climate risk informed

approach for Vanuatu's sustainable development journey.

Green House Gas (GHG) Inventory

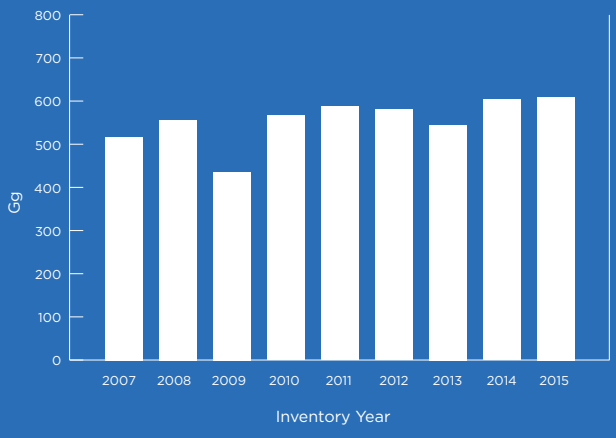
The third National Greenhouse Gas (GHG) Inventory of Republic of Vanuatu is a part of Vanuatu's Third National Communication (TNC) to the United Nations Framework Convention on Climate Change (UNFCCC) and Conference of Parties (COP).

The third national communication (TNC), details out anthropogenic Greenhouse Gases (GHGs) emissions and removals from Vanuatu for the years 2015 (including emissions for year 2007-2014) as per the 2006 IPCC Guidelines for Greenhouse Gas Inventories, IPCC Good Practice Guidance (GPG) ; and using the IPCC Inventory Software (Version 2.54-June 2017). The preparation of national GHG inventories for the years 2007-2015 uses both Tier1 and Tier2 methodologies (as appropriate) of 2006 IPCC guidelines.

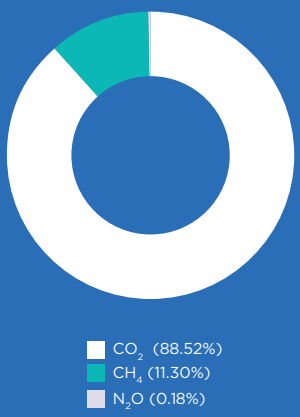
The thematic working groups were formed to assist with the preparation of various components of the national communication viz National Greenhouse Inventory and Mitigation Analysis, Vulnerability and Adaptation, Research and systematic observation; and Education, training, public awareness and information and networking and Capacity-building. Each thematic working group was comprised of a number of experts drawing both from public and private sectors, communities, and NGOs, as appropriate.

The republic of Vanuatu remains the net carbon negative in terms of GHG emissions including the removals. However, the total national GHG emissions excluding removals in year 2015 reached to 610.204 Gg CO2e (in comparison to 299.387 Gg CO2e estimated for year 1994 under the first national communication and 585.387 Gg CO2e estimated for year 2000 under the second national communication); This comprises direct CO2 emission 128.206 Gg, CH4 emission 14.818 Gg and N2O emissions 0.253 Gg during 2015. Emissions of other GHGs like per fluorocarbons (PFCs), hydro fluorocarbons (HFCs) and Sulphur hexafluoride (SF6) not estimate for Vanuatu since negligible application and nil manufacturing of the products containing these gases.

Vanuatu's Total GHG Emission (excluding removals), Gg CO2eq : 2007 -2015



Vanuatu's Total GHG Emissions by Gas (Gg): Average 2007-2015

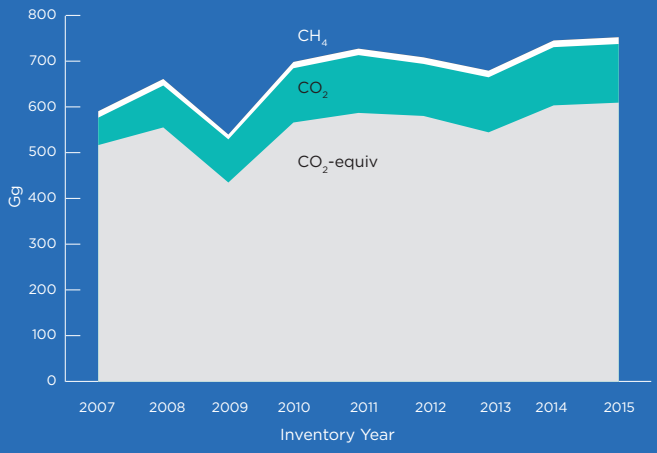


As can be seen the total GHG emissions from Vanuatu is increasing over the years and indicative increase in CO2 emission followed by CH4 and N2O emissions. Evidently the main GHG emissions from Vanuatu comprises of mainly Carbon Dioxide (CO2) as major contributor from combustion of fossil fuel for generation of electricity, transportation and other sectors; Methane (CH4) and Nitrous Oxide (N2O) emissions from agriculture-livestock (Enteric fermentation and Manure management), Waste Sector (Solid waste and waste water) and Land. Livestock is a major source of Methane emission in Vanuatu.

Vanuatu's Total GHG Emission (excluding removals), Gg CO2eq : 2007 -2015

Year	69.61	-7,913.16	15.85	0.58
	CO_2-equiv	CO_2	CH4	N_2O
2007	517.412	59.959	14.057	0.241
2008	556.059	91.603	14.272	0.245
2009	435.648	94.324	10.531	0.175
2010	566.818	118.590	13.776	0.236
2011	587.786	126.320	14.180	0.243
2012	581.133	113.719	14.366	0.246
2013	545.299	120.290	14.492	0.073
2014	604.257	127.251	14.663	0.251
2015	610.204	128.206	14.818	0.253
Average	**556.068**	**108.918**	**13.906**	**0.218**

Vanuatu's Total GHG Emissions by Gas (Gg): Average 2007-2015



As discussed above the republic of Vanuatu is net carbon negative, since the land-use change and forestry sector is a net sink of CO2 in Vanuatu. The CO2 removals from the forestry sector were estimated -1.1534 Gg of CO2e for the year 1994 and -7,913.14 Gg of CO2e for the year 2000.

Training and Capacity Building programme was designed and delivered to TWGs and key stakeholders. A technical training and hand-holding workshop on development of GHG inventories, mitigation assessment and vulnerability assessment & adaptation was organized for the TWGs and other relevant key stakeholders in Vanuatu. The overall objective was to empower the stakeholders in Vanuatu to achieve the necessary level of expertise to develop national GHG inventory, carry-out mitigation assessment and V&A analysis through data collection, analysis, monitoring and reporting procedures as required by UNFCCC.

The data for GHG inventory for the years 2007-2015 for different sectors and sub-sectors were collected using the two approaches i.e. first the "top down" or reference approach and second the "bottom up" or sectoral approach.
The key categories for the Vanuatu's national GHG inventory has been identified in terms of their contribution to the absolute level of national GHG emissions and removals. Basic Approach 1 has been adopted for quantitative analysis in objective manner, accounting uncertainties and suggested aggregation level of analysis.

In Vanuatu, key uncertainties are associated with data availability, missing data, lack of com-

prehensive information, data archiving and lack of country specific emission factors. It is recognized that having country specific emission factors and more detailed activity data will help reduce uncertainty in future inventory.

The compilation of the GHG inventory continues to be a challenge, especially in the availability of activity data for computation of GHG emissions. The key findings and recommendations of this inventory development exercise have been identified during and highlighted in previous sections of the report; however data collection, monitoring and verification for GHG emission sector is key takeaway of this exercise. For the future GHG inventory Vanuatu shall minimise the data gaps and uncertainty specifically Livestock, Forestry, Energy and Waste sector.

Mitigation Assessment

Energy is one of the crucial development indicators in any country and, like the other Pacific Island Countries, Vanuatu's primary energy needs are mainly met by imported petroleum fuel. The nation's primary energy supply is dominated by petroleum products for urban energy production and transportation, as well as firewood for cooking purposes. It is estimated that approximately 80% of urban households and only less than 17% of rural households have access to electricity.

The small number of households per community, combined with large distances between the communities, results in high upfront installation costs that cannot be recovered through operation in a commercially viable time span. The economic barriers mentioned above are heightened by the limited ability to pay for energy services in rural communities. In general, the rural population has very little disposable income. With its population distributed over many islands distribution of energy services is both technologically challenging and costly. This results in very low electrification rates and high fuel prices. The result of these factors is that energy services are available only to a small share of the population, and at high prices. The retail price for diesel is among the highest in the region, which is partly due to taxes, as prices before tax are about the same as in comparable countries in the region. The key development challenge is lack of access to sustainable and affordable energy supply for rural communities in Vanuatu exacerbated by impacts of climate change.

The National Energy Roadmap (NERM) clearly identifies the issues in the energy sector as a challenge to the country's economy, and as restricting economic and social development. In the NERM, access to electricity is identified as one of the country's five development priorities, from remote rural areas to those who are already serviced by a utility under an existing concession. The goal of NERM is to increase electricity access for the rural population and extend the existing grid to reach an increasing number of people.

The updated NERM (2016-2030) which was endorsed by the Government in June 2016 has the same vision as the earlier NERM, and its objectives, targets, and actions are intended to be consistent. The update was meant to provide more detail on particular areas (especially energy efficiency and green growth), and improve consistency of the priorities and objectives. The updated NERM focuses on five priorities: accessible energy, affordable energy, secure and reliable energy, sustainable energy, and green growth.

Vanuatu parliament ratified the Paris climate change agreement on 18th June 2016. Upon

ratification, the INDCs with emission reduction targets has become Nationally Determined Contributions (NDCs). The new Paris agreement on climate change entered into force on 4th November 2016.

The mitigation contribution for the Vanuatu NDC submission is a sector specific target of transitioning to close to 100% renewable energy in the electricity (energy) sector by 2030. Vanuatu has also developed an implementation roadmap and associated institutional framework including a Monitoring, Reporting and Verification (MRV) tool which aims to enhance Vanuatu's ability to achieve its mitigation NDC target. The overall impact of the programme is that Vanuatu can effectively reduce and monitor its GHG emissions in the energy sector and achieve its NDC commitment.

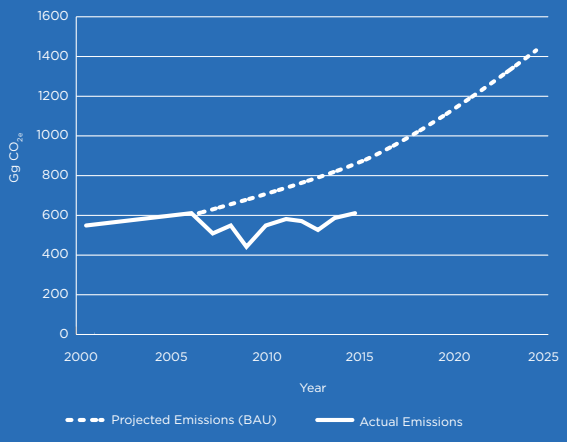
The Ministry of Climate Change Adaptation (MCCA), Meteorology & Geo-Hazards, Energy, Environment and National Disaster Management is the nodal agency as part of the Government's efforts to streamline Vanuatu's climate change response, natural disasters and sustainable development of the environment.

The ministry includes the Vanuatu Meteorological and Geo-hazards Department (VMGD), the National Disaster Management Office (NDMO), the Department of Energy (DoE), the Department of Environment and the Project Management Unit (PMU). The Ministry and the National Advisory Board (NAB) are mandated with coordinating all government and non-government initiatives addressing climate change and disaster risk reduction in the country. Vanuatu is committed to formulating strategies, national policies and best practices for addressing GHG emissions and making a practical contribution to the global mitigation efforts. While at the same time the country is also pursuing its national and regional development priorities and sustainable development objectives. The development objectives are planned to be achieved by integrating GHG abatement efforts with other social, environmental and economic priorities.

For mitigation, in common with other countries, Vanuatu sees replacing diesel generation with renewable energy sources as a high priority. For the future, BAU projections show emissions (excluding removals) rising to over 1400 Gg by 2025.

Vanuatu has submitted its INDC to United Nations Framework Convention on Climate Change (UNFCCC) on 29 September 2015 and the same document was endorsed and submitted as the first Nationally Determined Contribution (NDC) on 21 September 2016. Although being a Small Island State with a small carbon footprint, Vanuatu has committed to a challenging mitigation target in its NDC of transitioning to close to 100% renewable energy in the electricity sector by 2030. Achieving this target would replace nearly all fossil fuel requirements for electricity generation in the country. The NDC Implementation Roadmap (NDC-IR) developed during 2019 provides a pathway

BAU Scenario Projected Total GHG Emissions (excl. Removal - Year 2000-2025)



for the implementation of specific mitigation actions in Vanuatu. In the business as usual (BAU) electricity demand scenario, an increase in electricity demand from 77.9 GWh in 2017 to 100.7 GWh in 2030 is projected. This is a total increase of 29.4%.

Vanuatu has been very active in implementing renewable energy projects for electricity generation, including solar PV, wind and coconut oil. Coconut for Fuel Strategy: is the key element in providing a sizeable contribution to achieving the NDC target and is the first implementation step to be carried out. Revision of the Electricity Supply Act is a key step for stronger involvement of the private sector and should allow attracting private capital for the investment into renewable energy projects.

In addition to these basic interventions, 2 options are suggested for achieving the NDC target.

Option 1 includes the installation of 7.6 MW solar PV and 5.1 MW wind, which together can contribute around 30% to the target. The majority of the contribution towards the target (57%) will come from the use of coconut oil. Option 2 includes the installation of 7.6 MW solar PV, which is seen as the renewable energy source with lowest generation costs. The main contribution in Option 2 will come from geothermal (36%), which requires successful drilling and considerable investment for the implementation.

The Department of Energy with the technical assistance from the Pacific Community and funding from the Australian Department of Foreign Affairs and Trade (DFAT) have developed the Energy Efficiency of Electrical Appliances, Equipment's and Lighting Products Act No. 24 of 2016.

From a key sector analysis land transport is the single largest source of GHG emissions. e-Vehicles: In recent years there have been considerable advances in the use of electric vehicles that could be considered for the main populated areas (Port Vila and Luganville). Personal transport in Port Vila has been much more focussed on cars and mini bus options making electrified transport even more of a good opportunity. The updated NERM implementation plan also aims to develop pilot projects for hybrid/electric vehicles for government vehicle fleet. There an opportunity exists to use the bio-diesel in the road transportation vehicles. Bio-diesel can be manufactured from the copra-oil and easily used in the internal combustion engines.

In a bid to protect its marine life and also manage the problem of plastic litter and pollution around its islands, the Vanuatu government passed a legislation to ban the use, manufacture and importation of single use plastic bags in the country. The legislation, which came into effect on 1 February 2019, also extends to polystyrene takeaway food containers. Vanuatu has implemented long-term policies and strategies for the environment, pollution control, and waste management. Limited human resource capacity and lack of access to government funding, however, are challenges that continue to hamper attempts to govern waste management. Improved domestic shipping services and infrastructure, as a result of the Inter-Island Shipping Support Project, will offer significant opportunities to recover recyclable materials from the outer islands. Communities also will be able to participate in future CDSs and extended producer responsibility schemes. On the livestock waste front, it is thought that mitigation measures will be difficult without reducing animal numbers. It is envisaged GoV intends a planned cooperation with New Zealand and other nations interested in mitigating methane (CH4) and associated emissions for ruminant and pasture management.

In Vanuatu, the Department of Forests is the implementing agency with its REDD+ Unit taking the coordinating role. The programme also support the Civil Society Organization (CSO) to be part of implementing the National REDD+ Programme.

Under the REWDD+ programme Vanuatu has chosen to pursue the Forest Carbon Partnership Facility (FCPF) format. This offered the most realistic and short term potential for funding. In order to access this funding, the countries needed to formulate a Readiness - Preparation Proposal (R-PP). These were basically strategic plans on how to achieve REDD+ Readiness and served also as the basis for funding from FCPF to assist in getting to Readiness (implementation of the Readiness strategy).

Vanuatu's past emissions have been miniscule and have only become locally significant in the past decade or two. In general development issues dominate rather than climate change mitigation.

Vanuatu is a small developing nation with absolute levels of CO2eq emissions very small at under 0.0016% of world emissions. The country is also one of the most vulnerable to the effects of climate change and has much to lose should the worst predictions from increased temperature levels eventuate. As such the country will do its best to mitigate but would require financial, technical and capacity building support to do so.

There are many barriers for effective mitigation options in Vanuatu, many of which are common to developing countries in general and some are country specific. Some of the key barriers include:

Capital/Finance: The main barrier to mitigation options being realise in Vanuatu (and most developing countries) has been the slow progress of finance transfer from the international UN mitigation effort. To date there has been an emphasis on obtaining market finance and on market mechanisms to pay for mitigation options.

Vested interests: These constitute a considerable barrier in several areas. One is in terms of data sharing. In the Vanuatu it has been difficult to extract sectoral and sub-sectoral data from the major stakeholders. Another is in the transport sector where the vehicle importing companies have considerable interest in increasing the number of vehicles. Finally, the vested interest of the private sector in growing the economy is often at odds with serious emissions reduction.

Institutional and administrative difficulties: Such in country difficulties can be serious obstacles to easy technology transfer. Also included here might be the difficulty in retaining qualified people in administrative positions in government.

Regional cooperation: This has generally not been a large problem in the Pacific as there are a number of regional organisations (SPC, SPREP etc.) fostering cooperation all with good intentions in terms of assisting with climate change mitigation and adaptation.

Access to information: There appear to be difficulties, however, in country in terms of sharing information between government departments in Vanuatu improvements could be looked into here.

Differing needs: The differing needs of all developing countries compared to the developed nations is a serious barrier globally to emissions reduction, a barrier that has played out at all of the major UN meetings designed to encourage countries to cooperate on emissions reductions. The issue is one of equity and of who has been responsible for past emissions. In almost all cases developing countries insist that climate change must be integrated with development not subservient to development.

Economic incentives: The problem of attracting aid transfers was covered in the lack of capital barrier but in addition there has been a problem of private sector participation in Vanuatu, particularly in terms of the on-grid electricity sector.

Other Information Considered Relevant to the Achievement of the Convention's objectives Capacities in research, systematic observation and data analysis

The earliest climate observation in Vanuatu dates back to 1800's. Climate analysis started during the 19th century but climate change research is very recent. The Vanuatu Meteorological and Geo-hazards Department (VMGD) operates a well-established network of eight (8) synoptic stations and one (1) climate station that are in line with WMO's Guide to Climatological Practices.

Where Automated Weather Stations (AWS) are concerned, the VMGD has ten (10) AWSs in operation. Additionally, the VMGD operates a rainfall network consisting of fifty-two (52) manual rain gauges and four (4) automatic rain gauges (ARGs).

Whilst there is one (1) upper air observation station that has established, this station has been non-operational for some time now.

The VMGD also utilises the services of a Himawari satellite which transmits imagery on a three (3) to ten (10) minutes interval range. Vanuatu at present does not undertake any ambient air quality monitoring or oceans observations.

The following table highlights areas that need to be addressed where systematic observations are concerned.

Areas to be addressed where systematic observations are concerned

Data type	Requirements to fill gaps and needs in systematic observations
Atmospheric observations	Upper air station capabilities Ambient air monitoring Cello metre – cloud based
Terrestrial observations	Flooding and landslide observations – technical, human and financial capacity Need to invest in laser displacement meters to measure land subsidence potential
Ocean observations	Wave buoys Weather stations infrastructure especially on ship vessels ocean buoys Storm surge forecasting capabilities
Vulnerability assessment and Climate Change impacts	Inter – sectoral linkages required including modelling capabilities

Research on climate change

More systematic research efforts are now underway especially relative to climate information systems within the agriculture, fisheries, tourism, infrastructure and water sectors.

Gaps and needs in climate change research

There is the substantive need for Vanuatu to invest in a number of areas when it comes to climate change related research such as;

- Socio economic impacts
- Modelling – downgrade of global or regional scale models to properly accommodate local scale conditions.
- Sectoral – health and trade
- Adaptation and mitigation
- Climate policy
- Climate finance

Capacity Building, Education and Training

Numerous climate change programmes and projects have been implemented by various regional and national stakeholders over the years. These have generated knowledge, experience and best practices on local climate change impacts, on local options for adaptation and mitigation, and on awareness-raising.

Key government departments such as the Vanuatu Meteorology and Geo-hazards Department (VMGD) undertake climate change awareness programs (generally relative to climate science and climate variability) using a number of dissemination means to schools and other climate dependent sectors e.g. agriculture, water, infrastructure and tourism.

Moreover, major donor projects such as the VAN KIRAP and V-CAP have been active in supporting the VMGD and key development sectors with capacity building oriented adaptation initiatives.

In the education sector, regional projects such as the CCCPIR have provided substantive support to the Vanuatu government to embed climate change into national curriculum. CCCPIR has supported the Department of Education and the Curriculum Development Unit (CDU), to train teachers on how to teach the climate change elements of K-13 new Vanuatu Curriculum.

The Vanuatu Skills Partnership program, is an initiative that is mainly involved with building capacity at the vocational level by integrating climate change adaptation into its' relevant training activities across the tourism, handicraft and agribusiness sectors.

NGOs and civil society organizations are also playing an active role in building capacity at the local level. Organizations such as the Vanuatu Red Cross, Care International, Oxfam and the Vanuatu Christian Council have been over the years conducting climate change awareness or skills based adaptation training within their target intervention sites.

Constraints and Gaps, Finance, Technology and Capacity Needs

Finance

To roll out the key planned NDC mitigation interventions, a substantial amount of approximately US$180 million is required to proceed at the time frame needed.

While specific adaptation targets are not established with Vanuatu's current NDC, a Climate Public Expenditure and Institutional Review (CPEIR) report carried out in 2013 estimates adaptation costs to be at approximately 1.5% of a country's GDP. For Vanuatu, this equates to an investment of US$9.5million per year.

Overall, the target of Vanuatu for implementing its' conditional NDC targets is at least USD400 million.

Furthermore, under the Green Climate Fund Country Programme initiative an estimated amount of USD 710,312,106 was earmarked to undertake a pipeline of 43 projects (75 percent adaptation and 25 percent in nature).

Technology

Vanuatu has recently, in 2019, embarked on its' technology needs assessment as part of the Global Technology Needs Assessment (TNA) project. Agriculture and water are the principal adaptation sectors being assessed. While under the mitigation sector, energy and waste to energy are the sub sectors being considered with regards to technology assessment. The technology prioritization phase, using a Multi-Criteria Analysis process, has been undertaken with prioritized technologies listed in the table below.

Prioritized sub-sector climate technologies

Adaptation		Mitigation	
Agriculture	Water	Energy	Waste to energy
• Crop diversification and new varieties • Agro-forestry • Farmer field schools	• Rainwater harvesting from roof tops • Water safety plans • Flood hazard mapping	• Efficiency wood stoves • Battery electric vehicle • Solar electric boat	• Manure based biogas digester • Compact biogas digester • Anaerobic digestion biogas plant

Capacity

Vanuatu continues to face a multitude of barriers for the scaling up of effective climate responsive actions for achieving the climate and development goals and for meeting its UNFCCC obligations. The various obstacles include insufficient institutional and financial resources; lack of research data; information management problems and; inadequate human resources and infrastructure. More needs to be done to build awareness both within the Government and the community about Vanuatu's vulnerability to climate change. There is also an apparent need to feed information, knowledge and technologies to enable improved decision-making and environmental management.

CHAPTER 1

National Circumstances

National Circumstances

Vanuatu is an archipelago of volcanic islands and submarine volcanoes located between latitude 12° and 23° south and longitude 166° to 173° east. There is a distance of roughly 1,300 km from the northernmost island to the southernmost islands. The country's coastline extends for 2,528 km long with a total land area of 12,336 km2, set within a 200-mile exclusive economic zone (EEZ) of approximately 680,000 km2.

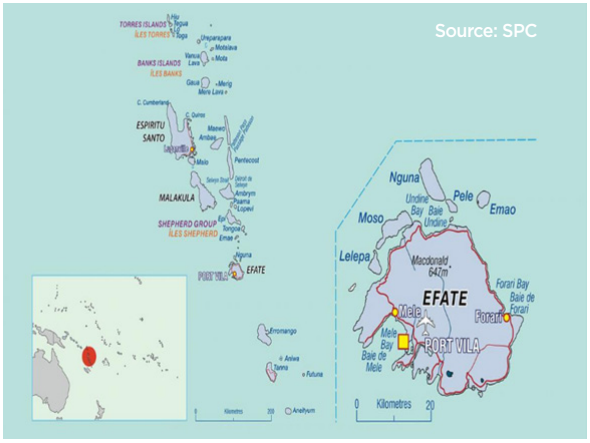
The country comprises of 83 islands, and lies in the middle of Fiji, Solomon Islands and New Caledonia. The country was first visited by Europeans in the early 17th century. James Cook explored the islands in 1774, giving them the name "New Hebrides", which lasted until independence on 30 July 1980. The first European settler was a cattle rancher who arrived in 1854. He was soon followed by cotton growers from Australia, and later by the French, who outnumbered the British three to one by the mid-1880s.

The ni-Vanuatu are culturally heterogeneous, a fact that is reflected in the large number of languages spoken in the country. With over 100 distinct tongues for its relatively small population, Vanuatu is thought to be the most linguistically diverse country (per capita) in the world. Vanuatu's national language, Bislama, is a form of Pidgin-English. Besides Bislama, the country's two official languages of government are English and French.

Prior to independence in 1980, Vanuatu was known as the New Hebrides and had been governed for 74 years by a joint Anglo-French Condominium. The first free and open elections were held in November 1979, after the various political parties and the Condominium powers within the country agreed to a constitution for the Republic. The independence of the sovereign state of Vanuatu was celebrated on 30 July 1980, and the country became the 155th member of the United Nations in September 1981.

Vanuatu's national political structure consists of legislative, executive and judiciary branches. The legislative branch consists of a single chamber, parliament, with 52 seats. Members of parliament are elected every four years. The executive consists of the prime minister and the Council of Ministers, all of whom are members of parliament (there are 13 ministers). The Judiciary consists of a Supreme Court with a Chief Justice and three judges. The Head of State is the President of the Republic and is elected for a period of five years by an electoral college consisting of members of parliament and presidents of provincial governments. There is a National Council of Chiefs that is mainly an advisory body to the government and is comprises custom chiefs elected by their peers sitting in the Island Council of Chiefs. The Council of Chiefs advises on custom and tradition as well as the preservation and promotion of the country's culture and indigenous languages.

Figure 1.1: Map of Vanuatu



Geography and Climate

Geography

Vanuatu is an archipelago of volcanic islands and submarine volcanoes located between latitude 12° and 23° south and longitude 166° to 173° east. There is a distance of roughly 1,300 km from the northernmost island to the southernmost islands. The country's coastline extends for 2,528 km long with a total land area of

12,336 km2, set within a 200-mile exclusive economic zone (EEZ) of approximately 680,000 km2.

From low coral atolls to majestic volcanoes, Vanuatu is one of the most geographically diverse nations in the pacific region.

Only 12 islands could be called significant in terms of their economy and population. The largest are Espiritu Santo (4010 Km^2), Malekula (2,069 Km^2), Efate (980 Km^2) and Erromango (900 Km^2). Santo also boasts the country's highest peak: 1,879m Mt Tabwemasana. Ambae, Ambrym and Tanna have peaks over, 1000m high. The largest of the islands, Espiritu Santo and Malekula cover 50% of the country's land mass and harbor the majority of Vanuatu's population.

Most islands are either mountainous or steeply undulating, with 35 per cent of the country being above 300m (highest point: Tabwemasana 1,879m) and 55 per cent having slopes greater than 20 degrees. Some areas are so deeply dissected by gullies that they're virtually impenetrable. Generally, the steeper country is covered with lush forest and secondary growth, while coconut plantations and other agricultural pursuit dominate the usually narrow plains.

Geology

Vanuatu emerged from the sea about 22 million years ago, when a series of earth movements on the ocean floor forced huge underwater mountains to surface. This event created the northern islands of Santo, Malekula and the Torres group. Next to appear were Maewo and Pentecost, between 5 and 11 million years ago. All the remaining islands resulted from two separate phases of earth movements that took place less than five million years ago.

Until about two million years ago the islands covered only a fraction of their present area. The dramatic increase during this geological blink of an eye has largely resulted from slow continued uplift, together with the formation of fringing coral reef. On some islands, ancient reefs have been raised several hundred meters above sea level. As well, new land is continuously being created as a result of volcanic activity.

Vanuatu lies squarely on top of the Pacific Ring of Fire. In fact, it is on the edge of the Pacific tectonic plate, which as being forced up and over the Indo-Australian plate. This action causes frequent earthquakes and volcanic eruptions.

Some areas of Vanuatu are being uplifted at a rate of 2cm a year, while others are subsiding. Seismographs record numerous earth tremors each day, though only a small number are strong enough to be noticed by the general population. An earthquake in 2001 rated over seven on the Richter scale caused considerable damage.

Vanuatu has nine active volcanoes, with seven being on land and two under the sea. The most famous is the easily accessible Mt Yasur on Tanna. Mt Garet, on Gaua, is potentially the most dangerous because of the thin layer of rock that separates its large crater lake from the molten magma underneath.

Climate

Vanuatu's climate varies from wet tropical in the north to subtropical in the south, with much drier rain-shadow areas in between. The northern islands receive on average over 4000mm if annual rainfall, while the southern parts of the archipelago receive average annual rainfalls of 1500mm. Rainfall in the country is generally affected by the South Pacific Convergence Zone (SPCZ). The SPCZ intensifies during the wet season and moves further south bringing higher rainfall to Vanuatu. Low pressure systems embedded in this band of heavy rainfall often become tropical cyclones during the cyclone season. Tropical cyclones tend to affect Vanuatu between November and April. The number of cyclones varies widely from year to year, with none in some seasons but up to six in others.

Mountains also play a role in the variations in rainfall across some islands. During the wet season, rainfall is particularly high on the windward (south-east) side of the mountain ranges of the bigger islands, and scarce on the leeward (north-west) sides, especially during the dry season.
Across Vanuatu the annual average temperatures are between 23.5–27.5°C. Changes in the temperature from season to season are strongly tied to changes in the surrounding ocean temperature.

From year to year, the El Nino Southern Oscillation (ENSO) creates variability to Vanuatu's climate. El Niño events tend to bring drier conditions as well as a late start to the wet season and cooler than normal dry seasons. The opposite occurs during La Niña events.

Environment and Ecosystem

Terrestrial biodiversity

Seventy-four percent (74%) of land in Vanuatu is covered with natural vegetation. Forest types include tropical lowland evergreen rain forest, broad-leaved deciduous forest, closed conifer forest, montane rain forest, cloud forest and coastal forest. Other notable vegetation includes swamp forest on Efate, kauri pine strands on Erromango and scattered mangrove forests covering around 3,000 ha (most of which occur on Malekula Island).

Lowland forest has largely been cleared and replaced by anthropogenic vegetation but forested areas remain the dominant landscape element on most islands. High forests are restricted on most of the islands (especially those that are densely populated, such as Pentecost, Ambae, Tanna and Shepherd; or have active volcanoes, such as Ambrym). However low montane forests are generally well preserved and occupy large areas. Secondary forests (often consisting of a Hibiscus community) are dense and in Vanuatu.

There are about 1,000 vascular plant species in Vanuatu of which around 150 are endemic. There is high diversity of orchids with 158 species and palms with 21 species, including 14 endemic species (GOV, 2014). There are 121 bird species, 28 species of reptiles and 12 species of Chiropterae (Flying Foxes and Bats). Invertebrate diversity is not fully described but includes the coconut crab (Birgus latro) the largest land crab, which is an important food resource in Vanuatu (GOV, 2014).

Invasive animal species are a threat in Vanuatu and include the Indian Mynah (Acridotheres tristis), the Giant African Snail (Achatina fulica) and the Rosy Wolf Snail (Euglandina rosea). E. rosea was introduced as a biological control agent for Achatina fulica but the species has caused the extinction of numerous native snails in other countries.

Another species of concern in Vanuatu is the Little Fire Ant (Wasmannia auropunctata), which has reduced arthropod species diversity in other locations, and may threaten crab species, including the coconut crab (GOV, 2014).

Vanuatu has one recorded extinction: the Tanna Ground Dove (Gallicolumba ferruginea). Extinction drivers for this species are believed to have been hunting and predation by domesticated and feral mammals.

Inland Waters Biodiversity

Large rivers are present on the larger islands but the most common freshwater habitats are steep gradient mountain streams. Unique and rare habitats include freshwater lakes on several islands (including crater lakes on inactive volcanic islands) and subterranean streams in karst areas.

Exploration of caves on Santo revealed four species of invertebrate that were new to science and confined exclusively to these caves. Atolls and coral islets generally have underground freshwater lenses due to the porosity of the rock.

Most islands of Vanuatu contain a dense network of seas, lakes and rivers. The larger islands are well watered by rapid mountain rivers and creeks. Other freshwater systems include low gradient lowland streams, deep pits called blue holes, some lakes and swamps/marshes on plains. Most of the 25-30 lakes are crater lakes, with Lake Letas on the volcanic island of Gaua, being the largest freshwater system in the Pacific at 19 km2 in area and 350 m deep. The caldera lakes of Ambae lie at an altitude of over 1,300m and are the highest of the South Pacific. Freshwater swamps and swamp forests are generally restricted to fringing areas around lakes (Efate, Thion), in depressions on plateaux (Efate, Epi, Maewo and Gaua), in extinct volcanoes (Vanua Lava) or on floodplains (East Santo). Dasheen (taro) fields may sometime host freshwater species.

Streams and rivers in Vanuatu are highly variable in size and length and can be divided into six zones depending on altitude and water velocity: spring zone (over 800 m); higher course (450-800 m; steep); middle course (150-450 m; less than 10% slope), upper lower course (50-150 m) and lower course (less than 50 m; tidal). Understanding this typical zonation allows un-

derstanding of the distribution of freshwater species. While the majority of species are found in low velocity reaches, high velocity reaches often contain unique species adapted to this type of environment (e.g. Sicyopterus spp, Gobiidae). The estuarine zone is also an important thoroughfare for a freshwater fauna dominated by migratory species.

All freshwater fishes in the identified important biodiversity areas are amphidromous (i.e. with a marine larval stage), providing a clear linkage between freshwater and marine ecosystems. Diversity is dominated by gobies and some endemism is known in the subfamily Sicydiinae. However, these are very small fish, which are not currently utilised by local communities or represented in indigenous taxonomies. The larger but non-endemic species like eels (Anguilla spp.), Spot-tail Bass (Lutjanus fuscescens), Mullets (Mugilidae) and Grunters (Terapontidae) are utilised for food, as are neritid snails and prawns, and reduction in their populations is of direct concern to villagers. Surveys in Vanuatu indicate there may be some endemism in freshwater crustacea (Marquet et al. 2002). The intense utilisation of freshwater species for protein in some areas is having an impact on freshwater ecosystems but there is little to no research in this area.

Freshwater fish biodiversity can be highly localised and even small lake or stream systems may harbour unique locally evolved forms of life. The numbers of different species in any given freshwater habitat can be high even if the population numbers of the individual species are low. Generally speaking, the fauna of riverine systems has been better studied than other systems. The number of endemic species is greater in older islands that have retained a good natural vegetation cover and where flows have not been altered. Of the 96 known crustacean and fish species (29 decapod crustaceans and 67 fish), 5 are endemic to Vanuatu and 7 to both Vanuatu and New Caledonia.

Marine and Coastal Biodiversity

Vanuatu has a range of marine habitats and species, from inshore coral reefs to deepwater seamounts and canyons that generate these values and some are described in more detail here.

Vanuatu's coral reefs are categorised as either fringing, barrier or atoll reefs. Within each of these categories there are patch reefs, where the coral reef forms patches within a matrix of sand or seagrass. Coral species generally have wide geographic ranges in the Indo-Pacific region, but many are listed as globally threatened due to reef damage and bleaching, and will suffer additional impacts from sea temperature and pH changes associated with climate change. Reefs support a variety of mollusks, crustaceans and fishes, which in turn provide the main source of protein for people living in coastal villages. Coral reefs are also the habitat for most of the threatened coastal fishes of the region, such as Humphead Wrasse (Cheilinus undulatus), Green Bumphead Parrotfish (Bolbometopon muricatum) and Hump-backed Rock Cod (Cromileptes altivelis). White sand beaches adjacent to coral reefs are important nesting sites for Green Turtle (Chelonia mydas) and Hawksbill Turtle (Eretmochelys imbricata).

Seagrass beds occur in soft-bottom areas and, like coral reefs, require clear water (low turbidity) away from sediment plumes of large rivers. Seagrass beds are the habitat of Dugong (Dugong dugon), which reaches the eastern limits of its distribution in Vanuatu.
Results of aerial and postal surveys conducted at least 17 years ago (in 1987) indicated that dugongs occur in small groups (single or pairs of animals) throughout the sheltered waters of Vanuatu. Tame dugong are known to reside in Lamen Bay (Epi Island) and Tanna Bay (Tanna Island).

Mangroves are a marine habitat and widely recognised as an important nursery for juvenile fish. They also provide coastal buffering against tropical cyclones and other extreme weather events. As with terrestrial forests, mangroves and seagrass meadows remove and store carbon from the atmosphere.

Other ecosystem services include tourism, wood extraction and bioremediation and sediment trapping. In 2009, the Mangrove Ecosystems for Climate Change Adaptation and Livelihoods (MESCAL) project conducted an economic valuation of nine ecosystem services in Crab Bay, Malekula and Eratap on Efate Island. The study found that in 2012, 136.5 ha of mangroves in Crab Bay produced ecosystem services worth US$586,000, while in Eratap, 31.2 ha produced ecosystem services worth US$266,000.

Rocky shorelines occur along the coasts of islands of recent volcanic origin, or where rapid uplift or steep

drop-offs preclude the development of coral reefs. The intertidal zones are frequented by people collecting gastropods for food.

Vanuatu's marine and coastal biodiversity contributes to generating goods and services with a value totalling over VT4.5 billion. The values include the tourism and tuna fishing sectors. The net value of tourism in 2013 was approximately VT850 million. The value of tuna to Vanuatu, mainly from access fees, was about VT160 million in 2013. Coastal habitats are valued in terms of what they contribute to subsistence fishers (about VT580 million), small-scale inshore commercial fishers (VT290 million), coastal protection (VT1.6 billion) and carbon sequestration (VT760 million) (Pascal et al., 2015).

According to the most recent Mini Census undertaken in 2016, Vanuatu's population was reported to be a total count of 272, 459 compared to a population count of 234,023 in the last 2009 census. Vanuatu's population is largely based within its' rural areas – 75 percent as per 2016 figures. Accordingly, the two provinces of Shefa and Sanma which host Vanuatu's urban centres of Port Vila and Luganville respectively have the highest populations.

Provincial breakdown – Sanma, Malampa and Tafea

Outside of the Vanuatu's two urban sites, Malampa and Tafea provinces both have substantial population numbers and growth rates – refer to Tables 2 and 3.

Vanuatu has one of the highest growth rate in the Pacific region. This is more pronounced in the urban settings of Port Vila and Luganville. Refer to Table 3.

Population

Table 1.1: Population of Vanuatu

Place of Resi-dence	Population Count	Male	Female	Number of Households
Vanuatu	272,459	138,256	134,194	55,527
Urban	67,749	34,506	33,243	14,048
Rural	204,710	103,759	100,951	41,479

Source: Vanuatu National Mini Census 2016

Table 1.2: Total population by province per year, 2009 – 2016

Place of Resi-dence	Population Count	Male	Female	Number of Households	Population Count	Male	Female
Vanuatu	**234,023**	**239,374**	**244,847**	**250,445**	**264,652**	**271,087**	**272,459**
Torba	9,359	9,527	9,700	9,875	10,053	10,234	10,161
Sanma	45,855	39,978	40,360	40,749	41,090	41,476	54,184
Penama	30,819	31,249	31,685	32,127	32,575	33,030	32,534
Malampa	36,724	37,135	37,547	37,964	38,386	38,813	40,928
Shefa	78,723	81,544	84,468	87,499	90,644	93,893	97,602
Tafea	32,540	32,894	33,251	33,613	33,979	34,348	37,050

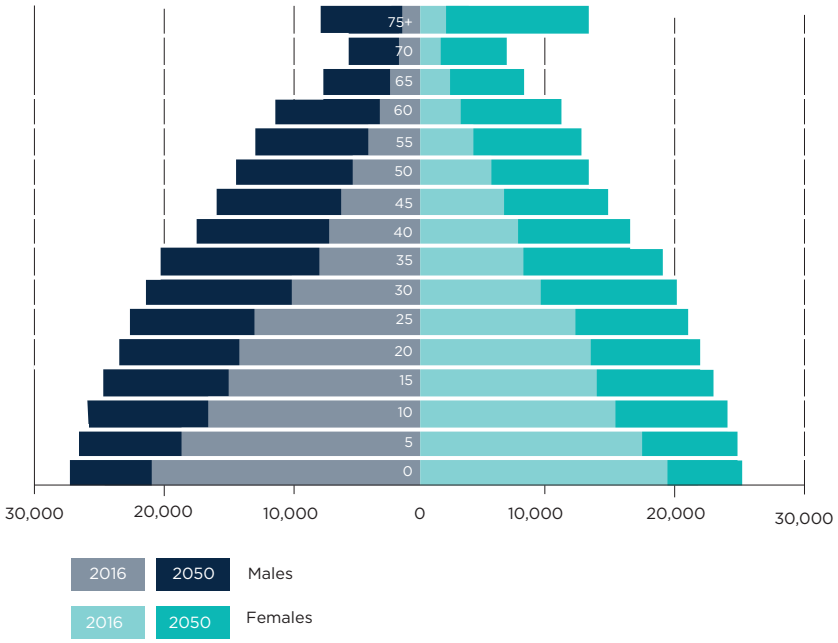
Source: Vanuatu National Mini Census 2016

Table 1.3: National average annual growth rate and population density with province breakdown

Indicator	Vanuatu	Urban	Rural	Torba	Sanma	Penama	Malampa	Shefa	Tafea
Av. Annual population growth rate (%)	2.3	2.6	2.3	1.2	2.6	0.8	1.6	3.4	2.0
Population density (number of people/km^2)	22			12	13	27	15	65	23

Source: Vanuatu National Mini Census 2016

Figure 1.2: Population distribution by age and sex, 2016 and 2050



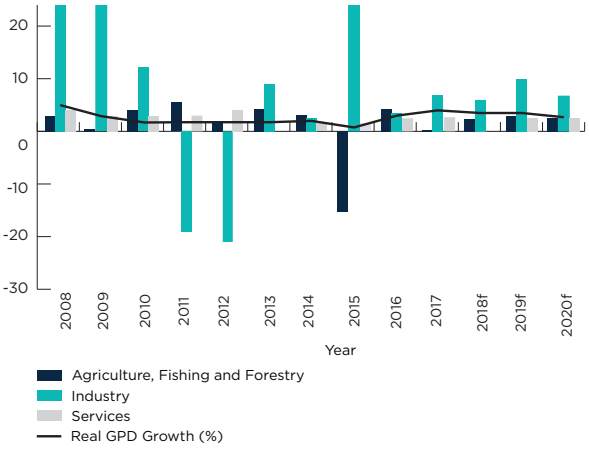
Source: Secretariat of the Pacific Community 2020
https://sdd.spc.int/vu

Vanuatu has a young population where up to 50 percent of its' population is under the age of 40 years. The population make up is such that it is close to a 1:1 male to female ratio although projections indicate a somewhat leveling of ratios by 2050.

Ecomony

Vanuatu is traditionally known for its strong cultural heritage tradition activities and subsistence farming. The four mainstays of Vanuatu's economy are agriculture, tourism, offshore financial services, and raising cattle. Exports include copra, kava, beef, cocoa, and timber, and imports include machinery and equipment, foodstuffs, and fuel.

Figure 1.3: Real GDP Growth and Major Sector Growth



Source: Reserve Bank of Vanuatu September 2018 Quarter Economic Review

In 2017, Vanuatu's economy grew by 4.4 percent with a strong performance over the last three previous years. Subsequently it was further projected for the economy to grow by 3.4 percent in 2018 from 2017 growth levels. Growth was primarily driven by construction activities related to the on-going infrastructure development projects and reconstruction projects from TC Pam (VNSO 2019; RBV 2018).

The GDP growth of 4.4 percent in 2017 was mainly driven by industry, followed by services and agriculture. Though the overall performance in industry has continued from the strong growth in two previous years, its contribution to GDP growth is less than services and agriculture. In terms of contribution by industries, services have the largest share of 65 percent which contributes to a positive growth of 1.8 per cent in 2017 followed by agriculture fishing and forestry

Table 1.4: Real GDP Growth (%)

Sector	2016	2017	2018f	2019f
Agriculture, Fisheries and Forestry	5.1	0.4	2.1	3.1
Industry	4.2	7.1	7.0	10.6
Services	2.9	2.9	3.2	2.6
Vanuatu	**3.5**	**4.4**	**3.4**	**3.6**

Source: VNSO 2017 National Accounts

Energy

The principal objective in Vanuatu's energy sector is to reduce dependency on fossil fuels, encourage use of renewable sources and increase energy security while managing demand through energy efficiency measures. Under the National Energy Road Map (2016 – 2030), Vanuatu's government has set targets of attaining 100 percent electricity generation from renewable sources and the accomplishment of 100 percent electricity by households by the year 2030.

Biomass and imported petroleum product are the main energy sources for Vanuatu. Biomass is principally used for residential purposes such as for cooking and crop drying. However, petroleum products are important inputs into major sectors of the economy – electricity, industry, tourism, transportation, fishing and agriculture. Presently, Vanuatu primary needs are mainly met by imported petroleum. Consumption of petroleum has increased substantially, at an annual average rate of 6% over the years.

The bulk of electricity is derived from diesel (71%) and renewable energy (29%). Renewable sources currently being utilized include hydro, solar, wind and biofuel.

Transport and Infrastructure

Vanuatu's geographic and demographic structure poses obstacles to efficient development. People are scattered over about 80 widely distributed islands, of which 64 have residents (2009 National Census). This makes travel difficult and costly. The distance from the southernmost to northernmost islands is over 800 km. Vanuatu's geography also makes it difficult to build infrastructure efficiently and economically. Small population clusters make economic and financial justification difficult. Logistical problems of moving large construction equipment from island to island deter contractors and increases prices.

Once built, limited capacity and resources to maintain infrastructure leads to asset deterioration. Consequently, there are significant gaps in providing and operating physical infrastructure, particularly in poor and remote rural areas.

Roads

Vanuatu is estimated to have 1,800 km of roads. Of these 234 km are sealed and 1,142 km are gravel. The remaining 400km are simple earth roads (VISP 2014).

Port Vila and Luganville urban areas account for the majority of sealed roads, and the recently improved Efate ring road and Santo East Coast Road represent the first extensive sealed roads outside the two main towns. On most islands other than Efate, Santo, and Tanna road links have developed largely to service remote communities administrative and economic needs. There are still many locations where separate stretches of road on a particular island do not link.

Aviation

There are 29 airfields in Vanuatu. Airports Vanuatu Limited (AVL) operates the three main airports at Port Vila (Bauerfield), Luganville (Pekoa), and Tanna (Whitegrass). The other 26 are regulated by the Civil Aviation Authority of Vanuatu (CAAV) and run by the Public Works Department (PWD).

The Bauerfield airport is Vanuatu's principal international gateway and handles around 250,000 international passengers per year. At present the runway is long enough to accommodate most commercial aircraft, although

for some (Boeing 767, 777 and Airbus A330) has weight restrictions.

Shipping

Vanuatu depends on water transport with its population spread over 64 populated islands. However, limited infrastructure restricts cargo and passenger movement. Inadequate wharves and jetties constrain vessels from calling at many destinations in all but ideal weather conditions, including the main jetty for Isangel in Tanna.

The principal wharves are in Port Vila and Luganville. There are also wharves on Malekula and Tanna that are adequate for conventional ships, but not in all sea conditions. The majority of calls to outer islands are made directly to a beach, or by lighters.

Industry

Manufacturing sector in Vanuatu is very small and is driven by just few players mainly based in Luganville and Port Vila. It is estimated that Vanuatu has just 3.8% of manufacturing value added as a percentage of its' GDP (National Industrial Development Strategy, 2018)

The industry sector overall grew by 7.1 percent in 2017 and with subsequent growth for 2018 placed at 7.0 percent, reflecting the slowdown and waning down of construction projects as they draw to completion. Forecast for 2019 was upgraded to 10.6 percent driven mostly by new projects.

There were improvements in the manufacturing sector with growth rate of 3.3 percent in 2018 from 2.0 percent in 2017 with increased output from leading bottled water, beverages and coconut oil industries in Port Vila.

Tourism

Tourism is a mainstay of the Vanuatu economy. Vanuatu has more recently embarked on a "greener" path as per its' National Sustainable Tourism Policy (VSTP). The policy seeks to strike a balance between economic viability, social acceptability and environmental responsibility. The VSTP also focuses on enhancing the resilience of Vanuatu's cultural, social and ecological systems in the face of the changes, complexity and uncertainty. The Tropical Cyclone Pam event in 2015 particularly had significant impacts in slowing growth however the tourism sector is gradually recovering.

Given broad growth trends, the total international visitor arrivals to Vanuatu for September quarter 2019 stood at 63,407, reflecting a decline of 16% over the corresponding period in 2018. On the other hand, tourism recorded an increase of 19% over the previous 2018 quarter. The decline of visitor arrivals over corresponding period were attributed by the fall in number of visitor arrivals by sea.

Visitors by air made up 58% of all international visitors to Vanuatu. This stood at 36,587, indicating an increase of 9% over corresponding quarter in 2018 and also by 29% over June quarter 2019 (National Statistics Office, 2019).

Agriculture and Fisheries

Subsistence farming makes up more than 75% of all agriculture in Vanuatu. This type of farming centres around root crops such as Taro, Yam, Cassava and Sweet Potato. Additionally, subsistence farming focuses on consumption and cultural purposes. Subsistence farming is highly dependent on rain for irrigation and basic tools are used.

There is also small scale semi commercial farming that is concentrated around the urban areas. Semi commercial farming consists mainly of the following crops - green leafy vegetables, local island cabbage, Chinese cabbage, capsicum, eggplants, spices and herbs.

In general, the agricultural sector accounts for more than 75 percent of exports, of which the most important agricultural product is copra, which is the dried meat or dried kernel of the coconut used to extract coconut oil. Coconut, cocoa, kava and coffee are the main cash crops. The production of beef and timber has grown in importance for the economy. Coconut oil is also used as fuel, a trend that has major implications for the cultivation and sale of locally grown coconuts.

According to the Reserve Bank of Vanuatu's Quarterly Economic Review report (2018), kava exports contributed approximately 45.1 percent of total exports (USD 4.3 million estimate), followed by copra exports at 19.9 percent (USD 2 million estimate), coconut oil at 9.3

percent (USD 900,000 estimate), cocoa at 8.6 percent (USD 800,000 million estimate), other products at 11.1 percent (USD 1 million estimate) and the rest contributed by other exports. In line with domestic production, kava, cocoa, beef and coffee exports improved despite a fall in other commodities.

The impact of natural disasters (Tropical cyclones and Ambae volcanic eruptions) impacted the production of kava, copra, root crops and vegetables produces in northern islands of Vanuatu, attributing to an expected weaker growth in the agriculture sector in 2018.

Fisheries

Fisheries contribution to the GDP in 2012 was estimated as USD 5.5 million, 0.7 percent of the national GDP. The fisheries export value in 2015 was estimated at USD 100 million and import value at USD 5.1 million. Annual per capita consumption was 32.1 kg in 2013.

Compared to other Pacific island countries, inshore marine areas are not extensive in Vanuatu. Inner reef areas are limited to narrow fringing reefs and the area covered by mangroves is quite small. A total of 161 vessels were reported in 2016 with just over half under 12 m length overall (LOA).

Vanuatu has industrial scale distant water fisheries operating in the Atlantic Ocean, the Indian Ocean and the eastern Pacific Ocean in addition to its own EEZ and surrounding area with at least 96 longliners, 3 purse seiners and 2 trawlers active fishing vessels in 2015. However, total catch in distant waters has significantly reduced after the peak of almost 144 000 tonnes reached in 2006 and it was about 77 tonnes in 2016, in addition to 43 000 tonnes taken in the western central Pacific fishing area where Vanuatu is located. Coastal fishing is primarily carried out for subsistence purposes and for sales for local markets. Subsistence fishing activities include coastal line and net fishing targeting demersal and small pelagic reef and lagoon fish, as well as reef gleaning and collection of shellfish and other invertebrates.

In 2016, the aquaculture sector employed 34 women and 173 men. An estimated 38% of the people engaged in marine fishing and subsistence fisheries were women. In addition, there are some coastal fisheries that are export oriented, including trochus, bêche-de-mer, and aquarium fish. The aquarium fishery has been in existence in Vanuatu for the last 15 years. In 2015, Vanuatu exported ornamental fish valued at USD 224 000 and corals and shells valued at USD 92 000.

Aquaculture efforts in Vanuatu have included attempts at raising oyster, rabbitfish, freshwater shrimp, trochus, green snail and tilapia in the past. In mid-1999 some spawning trials of giant clams were carried out, and some experimental culture of Eucheuma seaweed was also undertaken. Vanuatu aquaculture produced 16 tonnes of fish and shrimp in 2016, a drastic drop from 2014 due to devastation caused by cyclone Pam in 2015. Vanuatu leaders had shown interest in introducing more intensive fish farming techniques from Asian countries.

Vanuatu is a signatory to the UN Convention on the Law of the Sea, the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and central Pacific Ocean and the Washington Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Vanuatu is also a party to the following treaties and agreements relating to the management of regional fisheries.

Waste

The average amount of solid waste generated per capita has increased steadily from 0.43 kg/person/day in 2011 to about 1.5 kg/person/day in 2017. Both the urban centers of Port Vila and Luganville have controlled disposal sites or landfill in as in Port Vila's case. Aside from disposal within the urban controlled sites, common disposal methods include open backyard dumpsites, disposal at sea or on unused land, and burning.
The management and control of a landfill, such as the Port Vila landfill has been and continues to be a challenge. The problem of solid waste disposal is particularly pronounced in the urban areas as the waste from

rural areas is generally scattered and does not pose much hazard. The Vanuatu government is currently working with JICA to improve the solid waste management situation in the country.
Reuse and recycling measures have been initiated for materials such as glass, metals and PET bottles. In 2018 Vanuatu introduced regulations to ban the importation and use of single use non-biodegradable plastics including shopping bags and polystyrene containers. Through the Department of Environment and Conversation, there has been a recent expansion of the ban to include plastic cutlery and grocery packaging.

Liquid waste is not treated effectively via a reticulated system. Most houses and establishments have individual onsite disposal systems to manage liquid or sanitation waste water.

Health and services sector

Life expectancy in Vanuatu has increased and now stands at 69.6 and 72.7 years for males and females, respectively (VNSO, 2009). But the country faces the dual challenges of dealing with both communicable diseases and the rapidly growing incidence of Non-Communicable Disease (NCD), notably diabetes and hypertension. People are living longer, but often with the burden of chronic illness and disability.
At all levels of the health system and in the community, people are concerned about the impacts of NCDs in terms of premature death and increasing levels of disability – e.g. stroke, amputation, blindness and mental illness. For the health system, the costs of managing the NCD crisis are huge and growing daily.

While there are now fewer malaria cases, Vanuatu still has worrying levels of other communicable diseases such as Tuberculosis (TB) and Sexually Transmitted Infections (STIs). The challenge is to maintain the significant gains made as resistant strains of disease emerge, population mobility increases and development partner support decreases. And although 90% of people now have improved water supply, almost half the population does not have proper sanitation. Along with poor hygiene, this helps spread infectious diseases such as TB, Acute Respiratory Infection (ARI), diarrhoea and skin diseases.
Vanuatu still lags behind in terms of maternal and child health. Although nine out of ten women giving birth now have skilled birth attendants, too many women still die in childbirth. Numbers of maternal deaths have actually increased over the past 3 years although this may be due to improvements made in reporting processes.
The Vanuatu health system is mainly classed into three (3) focus areas being Public Health, Curative Services and Corporate Services. The current health system structure is based on the Role Delineation Policy developed in 2004. While this is still a workable system, it is not able to achieve the first policy objective of ensuring equitable access to quality, affordable health services.
There are obvious physical challenges. Vanuatu has a small population (just over 270,000 in 2015) that is dispersed across 83 islands. Villages in remote areas are often small and isolated, and people who live there pay high transport costs (via boat or truck) to reach health facilities. In the wet season, travel by sea is often dangerous and roads may be cut by flooding. Overall the health system faces significant challenges in its quest to achieve Universal

Education

Vanuatu operates a bilingual education system, with English and French languages being taught to students throughout the country at Early Childhood Education (ECCE), Primary and Secondary schools.

Table 1.5: Total number of schools in Vanuatu by School type, 2016 - 2018

Education Sector Level	2016	2017	2018
Early Childhood Education	566	520	838
Primary School	438	436	455
Secodary School	93	93	104
Post School Education and Training	7	7	7
Vanuatu	**1,104**	**1,056**	**1,404**

Source: Open VEMIS, 2018

According to the statistics of the ECCE sector in 2016 as outlined in table 6 and 7 below, number of enrolment and teachers shows big jumped compared to 2017 data. Reasonably this was due to the missing or incomplete data captured in Open Vanuatu Education Management Information System (VEMIS).

The number of enrolled children in the ECCE centres throughout Vanuatu has increased by 4.9% in 2018 compared to 2017. At primary level, the number of stu-

dents has increased by 7.7% in 2018 compared to 2017 and 3.9% at secondary level in 2018 compared to 2017. In terms of teaching staff, the number of teachers in ECCE and primary schools has also increased in 2018. However, Ministry of Education and Training (MoET) is still recording the number of the ECCE, Primary and Secondary school teachers by their qualification in the Open VEMIS. It is expected that 100% of these teachers will be recorded in the system by 2019.

Overall, school grants are the major incentive that has contributed to the increase of school enrolment across the three education sector. Many other programs may have also contributed in one way or another but the fact that more children are going to school is mainly because parents in the communities are no longer paying for their children tuition fees since 2010.

Table 1.6: School enrolment trend by sector level, 2016 - 2018

Year	ECCE	Primary 1-6	Secodary 7+	Post School Education and Training	Total
2016	8,800	44,965	18,408	2,122	74,295
2017	14,921	49,005	19,231	2,291	85,448
2018	15,661	52,789	19,983	2,055	90,488

Source: Open VEMIS, 2018

Table 1.7: Total number of Teachers/Trainers by school type, 2016 - 2018

Year	ECCE	Primary 1-6	Secodary 7+	Post School Education and Training	Total
2016	311	1,548	761	174	2,794
2017	1,033	1,780	1,013	87	4,013
2018	1,306	1,908	980	166	4,360

Source: Open VEMIS, 2018

National Communications Institutional Arrangements

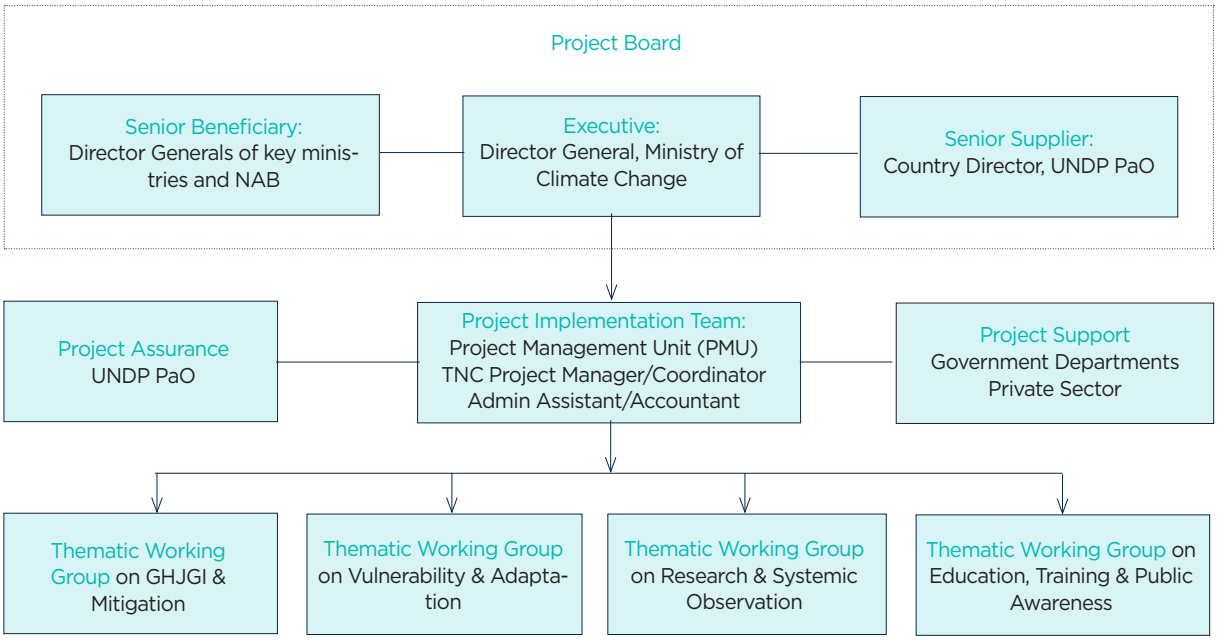
The third national communication of the Republic of Vanuatu is being implemented by the Ministry of Climate Change (MoCC), Government of Vanuatu in collaboration with United Nations Development Programme (UNDP). United Nations Development Programme (UNDP) is also supporting the Ministry of Climate Change, to build Vanuatu's national system for developing regular greenhouse gas (GHG) inventories, developing mitigation assessments and conducting vulnerability assessments as part of the Third National Communications (TNC) initiative.

Key steps towards the preparation of third national communication and national GHG inventory for the years 2007-2015 was as follows:

- Project Organization Structuring
- Thematic Working Group (TWGs) formation
- Stakeholder Consultation Process
- Training and Capacity building Programme
- Data collection, Identification of data gaps and uncertainty assessment
- Documents/data review for quality assurance
- Preparation of GHG Inventory Report
- Review and approval of the GHG Inventory Report

The TNC is being managed by the Project Board, mainly responsible for making by consensus, management decisions when guidance is required by the Project Manager, including recommendation for UNDP/Implementing Partner approval of project plans and revisions. The Project Board is comprised of: Director Generals of key stakeholder ministries and NAB representative as Senior Beneficiaries, Director-General, Ministry of Climate Change as the Executive and the Country Director, PaO as the Senior Supplier. The project assurance role shall be provided by the Fiji UNDP Country Office. Additional quality assurance shall be provided by the UNDP Regional Technical Advisor as needed. The structure of the project team is as follows:

Figure 1.4: Institutional Arrangement and Organization Structure for TNC



The Department of Energy (DoE), Climate Change Project Management Unit (PMU), TNC project coordinator and consultants formed the project implementation team. The Ministry of Climate Change undertook tasks of consultation with other relevant government departments, the private sector and NGOs. The DoE was also responsible for central coordination of the development of the energy and climate change mitigation sector, provided technical and policy oversight etc.

Thematic Working Groups (TWGs)

The thematic working groups were formed to assist with the preparation of various components of the national communication viz National Greenhouse Inventory and Mitigation Analysis, Vulnerability and Adaptation, Research and systematic observation; and Education, training, public awareness and information and networking and Capacity-building.

Each thematic working group was comprised of a number of experts drawing both from public and private sectors, communities, and NGOs, as appropriate.

The following table presents the key agencies within the TWGs

Table 1.8: Thematic Working Groups

TWGs	Members
TWG - National Circumstances	Department of Strategic Policy Planning and Aid Coordination (DESPAC)
	Department of Environmental Protection and Conservation (DEPC)
	Department of Finance and. Treasury (DFT)
	Department of Foreign Affairs and External Trade (DFET)
	National Advisory Board on Climate Change (NAB Sec)
	Department of Women Affairs (DWA)
	Department of Agriculture (DARD)
	Fisheries Department
	Department of Energy (DOE)

TWG GHG- Green House Gas (GHGI)	Department of Energy (DOE)
	Department of Forests (DoF)
	Department of Agriculture (DARD)
	Livestock Department
	Port Vila Municipality Council (PVMC)
	Utilities Regulatory Authority (URA)
	Vanuatu National Statistics Office (NSO)
	Department of Environmental Protection and Conservation (DEPC)
	Department of Biosecurity
TWG - Vulnerability Assessment and Adaptation (V&A)	Department of Environmental Protection and Conservation (DEPC)
	National Disaster Management Office (NDMO)
	Vanuatu Meteorology & Geohazards Division (VMGD)
	Department of Agriculture (DARD)
	Department of Geology, Mines &Water Resources (DGMWR)
	Department of Forests (DoF)
	Fisheries Department
	Ministry of Health (MoH)
	Public Works Department (PWD)
	Department of Local Authorities (DLA)
	Lands Survey
	Vanuatu Meteorology & Geohazards Division (VMGD)
TWG - Mitigation	Vanuatu Meteorology & Geohazards Division (VMGD)
	Ministry of Agriculture
	Ministry of Climate Change (MoCC)
	Ministry of Education and Training(MoET)
	National Disaster Management Office (NDMO)
	Vanuatu Meteorology & Geohazards Division (VMGD)
	Department of Environmental Protection and Conservation (DEPC)
	Department of Forests (DoF)
	Lands Survey
TWG - Research & Systematic Observation	Vanuatu Meteorology & Geohazards Division (VMGD)
	Vanuatu Meteorology & Geohazards Division (VMGD)
	National Disaster Management Office (NDMO)
	Vanuatu Meteorology & Geohazards Division (VMGD)
	Department of Agriculture (DARD)
	Fisheries Department
	Department of Geology, Mines &Water Resources (DGMWR)
	Ministry of Health (MoH)

Stakeholder Participation

Focused stakeholder consultation was carried out with in the government, public and private sectors, local and international development partners, NGOs and public groups. The first phase of the stakeholder consultation focused on the key objective of the third national communication and national GHG inventory project, inception and processes. The stakeholders were updated on the key steps of TNC and consulted on various aspect of GHG inventory sectors e.g. data collection process, climate change mitigation, adaptation and V&A man-

agement. The second phase of stakeholder consultation involved the presentation of the results i.e. National GHG Inventory of Vanuatu for the years 2007-2015, data, standards and assumptions applied for Vanuatu's National GHG inventory, data gaps and uncertainties etc. The objective of this phase was also to validate the assumptions and standards used for GHG inventory and seeks the inputs from wide stakeholders.

Gender Analysis

Vanuatu is traditionally a male-dominated and largely patriarchal society. Women's gendered roles as mothers and housewives in the traditional context have seen few women enter the public domain, including politics and positions of seniority for decision-making in both public and private sectors. Women have very low representation in Parliament and in other decision-making bodies. There are still prevailing social and cultural perceptions of leadership and male dominance of political parties and decision making.20 However, there has been notable progress with an increase of women in senior management in the public sector of 3.4 per cent in 2016 compared to 0.3 per cent in 2010. Despite still not having any women in Parliament, the Vanuatu Parliament passed a historical amendment to the Municipalities Act providing for reserved seats for women in the municipal councils. The quota provision is regarded as a 'special temporary measure' and was implemented for the first time in the Port Vila Municipal Council elections that took place in December 2013.

Considerable progress was achieved with five women elected to the Port Vila Municipal Council and another five to the Luganville Municipal Council for 2014. This is a positive step to increase women's participation in high-level decision making forums with access to and control over resources relevant to climate change and the impact on gender and socially vulnerable groups.

There has been other evident progress for women in Vanuatu in the past two decades. According to the 2009 National Population and Housing Census: Gender Monograph, the gender gap in literacy and education has narrowed. The child mortality rate has significantly declined in the decade between 1999 and 2009 and there has been a notable drop in teenage pregnancy across the country.

In terms of labour participation, the proportion of women in waged employment has substantially increased. A significant achievement over the recent years has been the introduction of the Family Protection Act (FPA) (approved in 2008 and in effect in 2009), which provides legal protection for victims of violence. Furthermore, various government ministries, including agriculture, public works, environment, health, education and lands have developed gender strategies and are taking proactive steps to integrate gender into their sector policies and plans.

Nevertheless, more women than men (49% and 41%, respectively) are involved in the subsistence economy and there are more female-headed single parent households with children, grandchildren or extended family members compared to men (Vanuatu National Statistics Office 2016).

A particular community based study by Care International (CARE 2015), where climate change resilience is concerned, on Tafea province revealed the following observations:

- Gardening is taking up a lot of time for both women and men but female headed households are facing particular challenges as they cannot draw on additional labour to help them.
- Gender distribution in the collection of water is most equitable in Tafea Province compared with other provinces.
- The presence of grandchildren can further increase women's workload, as well as alleviate the burden for older women.
- Slightly fewer girls than boys are enrolled in primary school in Tafea Province, whereas at secondary schools this is more or less equal. Women and men share concerns about the impacts of the cyclone on their children's education as many school buildings suffered extensive damage, lack regular access to water and most importantly children do not have enough to eat.
- Livelihood options for both women and men are extremely limited due to the scarcity of resources (especially so in Enimah village, Tanna island).

Other Information Considered Relevant to the Achievement of the Objective of the Convention

Capacities in research, systematic observation and data analysis

Introduction

The earliest climate observation in Vanuatu dates back to 1800's. Climate analysis started during the 19th century but climate change research is very recent. In line with Article 5 of the Convention, the status of climate observation and climate change research as well as the need to strengthen these are discussed in this chapter. The strategies and action plans to address the gaps and needs in both areas are considered.

Current systematic observations and requirements

Several of the Essential Climate Variables (ECVs) (GCOS, 2016) of the climate system, namely the atmosphere, ocean and land surface are observed in Vanuatu. Observations of the ECV of ocean and land need to be reinforced while new sets of observations in support of climate change mitigation and adaptation, and of sustainable development activities need to be put in place.

A. Atmospheric observations

Weather and climate observations

Systematic weather observations started in Vanuatu in 1952. The network has been extended and modernised gradually to serve a growing number of operational, reporting and research activities. To a large extent, the data meets the requirements of the Convention and other national needs and commitments. The Vanuatu Meteorological and Geo-hazards Department (VMGD) operates a well-established network of eight (8) synoptic stations and one (1) climate station namely [numbers in islands and types] that are in line with WMO's Guide to Climatological Practices

Where Automated Weather Stations (AWS) are concerned, the VMGD has ten (10) AWSs in operation. Additionally, the VMGD operates a rainfall network consisting of fifty-two (52) manual rain gauges and four (4) automatic rain gauges (ARGs). Refer to Map below.

Whilst there is one (1) upper air observation station that has established, this station has been non-operational for some time now.

VMGD has been receiving satellite images from polar orbiting weather satellites since the mid-1960s. At present, imagery from Meteosat geostationary satellites are available every 10 minutes.

Figure 1.5: Vanuatu Rainfall Network Coverage Map showing Synoptic stations, AWS & ARG

mawari satellite which transmits imagery on a three (3) to ten (10) minutes interval range. There are long term plans to utilize Doppler radar under the GCF funded VAN KIRAP project.

In addition, under the VAN KIRAP project, an agrometeorology station is being established at the Vanuatu Agricultural Research and Technical Centre (VARTC) on Santo island.

Vanuatu at present does not undertake any ambient air quality monitoring.

B. Ocean observations

Wave observations – There is yet to be an active wave observations program however the VMGD is looking to have this established under the VanKIRAP project.

Sea level rise monitoring – VMGD has installed a number of tide gauges namely on the four (4) islands of Santo (Luganville wharf), Efate (Port Vila wharf), Malekula (Litzlitz wharf) and Tanna (Lenekal wharf).

Operation ocean services – Currently the VMGD utilizes model outputs from the Australian Bureau of Meteorology to inform its' oceans services particularly in generating tailored climate and ocean products to fit Vanuatu's context.

Needs and gaps in systematic observations

The following table highlights areas that need to be addressed where systematic observations are concerned.

Table 1.9: Areas to be addressed where systematic observations are concerned

Data type	Requirements to fill gaps and needs in systematic observations
Atmospheric observations	• Upper air station capabilities • Ambient air monitoring • Cello metre – cloud based
Terrestrial observations	• Flooding and landslide observations – technical, human and financial capacity • Need to invest in laser displacement meters to measure land subsidence potential
Ocean observations	• Wave buoys • Weather stations infrastructure especially on ship vessels • ocean buoys • Storm surge forecasting capabilities
Vulnerability assessment and Climate Change impacts	• Inter – sectoral linkages required including modelling capabilities

Research on climate change

More systematic research efforts are now underway especially relative to climate information systems within the agriculture, fisheries, tourism, infrastructure and water sectors. These efforts are being supported by the Vanuatu Climate Information System for Resilient Development project (VAN-KIRAP), a Green Climate Fund project.

Gaps and needs in climate change research
There is the substantive need for Vanuatu to invest in a number of areas when it comes to climate change related research such as;

- Socio economic impacts
- Modelling – downgrade of global or regional scale models to properly accommodate local scale conditions.
- Sectoral – health and trade
- Adaptation and mitigation
- Climate policy
- Climate finance

Capacity Building, Education & Training

Numerous climate change programmes and projects have been implemented by various regional and national stakeholders over the years. These have generat-

ed knowledge, experience and best practices on local climate change impacts, on local options for adaptation and mitigation, and on awareness-raising.

Key government departments such as the Vanuatu Meteorology and Geo-hazards Department (VMGD) undertake climate change awareness programs (generally relative to climate science and climate variability) using a number of dissemination means to schools and other climate dependent sectors e.g. agriculture, water, infrastructure and tourism. Similarly, these critical climate dependent sectors are increasingly integrating climate change considerations or adaptation measures into their own core activities via training and knowledge sharing of department/sector personnel. Moreover, major donor projects such as the VAN KIRAP and V-CAP have been active in supporting the VMGD and key development sectors with capacity building oriented adaptation initiatives.

In the education sector, regional projects such as the CCCPIR have provided substantive support to the Vanuatu government to embed climate change into national curriculum. CCCPIR has supported the Department of Education and the Curriculum Development Unit (CDU), to train teachers on how to teach the climate change elements of K-13 new Vanuatu Curriculum.

Workshops were held by the CDU with CCCPIR technical and financial support in the provinces of Malampa, Torba, Sanma and Tafea to teach principals and provincial education officers on the new curriculum as well as specially developed climate change teaching resources which CCCPIR developed including the Learning About Climate Change the Pacific Island Way poster training, the Pou & Miri Climate Change Books and the Cloud Nasara animation on ENSO and training package. CCCPIR worked closely in 2016 with the Ministry of Education, the Vanuatu Qualification Authority and its local experts, the Vanuatu Institute of Technology (VIT) and the EU PacTVET programme, to finalize the region's first accredited Certificate I Course on Climate Change & Disaster Risk Reduction. This course was designed for men and women in rural areas who have a passion to help their communities adapt to climate change and reduce the impacts of disasters, the six-month course contains eleven units that impacts knowledge about climatic changes and disasters that have affected Vanuatu in the past and at present, and are likely to affect the nation in the future. The course covers activities available to reduce the impacts of climate change and natural hazards, both as individuals and in local communities, and to adapt to these changes in the future. Highly practical, course students will upgrade skills in interpreting and drawing maps and graphs and in processing statistical information, as well as demonstrate a number of adaptation measures to others and how to assess a community's level of risk to hazards and climate change. Furthermore, in 2018, SPC in partnership with the ADB supported the creation of Certificate III in Climate Change Resilience as a follow on to the Certificate I course.

The Vanuatu Skills Partnership program, is an initiative that is mainly involved with building capacity at the vocational level by integrating climate change adaptation into its' relevant training activities across the tourism, handicraft and agribusiness sectors.

NGOs and civil society organizations are also playing an active role in building capacity at the local level. Organizations such as the Vanuatu Red Cross, Care International, Oxfam and the Vanuatu Christian Council have been over the years conducting climate change awareness or skills based adaptation training within their target intervention sites.

Figure 5: Department of Meteorology officer undertaking a school awareness session.

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CHAPTER 2

National Greenhouse Gas Inventory Report

Preface

National and international efforts to reduce the human impact on the global climate rely on knowing the amount of anthropogenic emissions by sources and removals by sinks of greenhouse gases (GHGs). National GHG inventories provides information that is vital for the design of policies and measures to reduce anthropogenic emissions and increase removals of greenhouse gases. The quality of inventory data relies on the use of appropriate methodologies, reliable statistical information and representative factors to derive emission and removal estimates from sources and sinks.

United Nations Development Programme (UNDP) is supporting the Ministry of Climate Change (MoCC), Government of Vanuatu (GoV), to build Vanuatu's national system for developing regular greenhouse gas (GHG) inventories, developing mitigation assessments and conducting vulnerability assessments as part of the Third National Communications (TNC) initiative.

The Ministry of Climate Change (MoCC), is a national focal point with overall responsibility for the national inventory of Vanuatu. This support was to help strengthen Vanuatu's institutional arrangements, functions, and ability to manage the TNC project activities. It also enhanced the technical capacity of the ministry and other stakeholders by improving methodological choices in the selection of the appropriate methods, activity data, and emission factors, thus leading to the development of an improved and sustainable GHG inventory, mitigation assessment and vulnerability and adaptation management system. The TNC project also included extensive capacity building, training and knowledge sharing exercises for the diverse stakeholders.

Vanuatu's national inventory report of anthropogenic emissions by sources and removals by sinks of greenhouse gases (GHGs) has been prepared as part of TNC program.

All information contained herein is obtained from authentic sources believed to be accurate and reliable. This report is based on the data made available by the Government departments, public sector and information available in public domain. Reasonable skill, care and diligence exercised in calculating the national GHG inventory and report preparation.

Abbreviation

AFOLU	Agriculture, Forestry and Other Land Use
CH4	Methane
CO2e	Carbon Dioxide equivalent (also for CO2-eq)
CO	Carbon Monoxide
DoE	Department of Energy
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Giga Gram
GHG	Greenhouse Gas
GoV	Government of Vanuatu
GWP	Global Warming Potential
HFCs	Hydro Fluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IPPU	Industrial Processes and Product use
J-PRISM	Project for Promotion of Regional Initiative Solid Waste Management
LPG	Liquefied Petroleum Gas
MW	Megawatt
MWh	Megawatt hour
M&E	Monitoring and Evaluation
NERM	National Energy Road Map
NGOs	Non-Governmental Organizations
NMVOC	Non-methane volatile organic compounds
NOx	Oxides of Nitrogen
N2O	Nitrous Oxide
TNC	Third National Communication
V&A	Vulnerability and Adaptation
VUI	Vanuatu Utility Infrastructure

Background

The Republic of Vanuatu is an island nation located in the Western Pacific Ocean. Vanuatu is an archipelago of over 80 islands stretching 1,300 kilometers from North to South in the Western Pacific Ocean. The archipelago, which is of volcanic origin, is some 1,750 km East of Northern Australia, 500 kilometers Northeast of New Caledonia, West of Fiji, and Southeast of the Solomon Islands, near New Guinea. Vanuatu's total land area is about 12,336km2 with more than 36% (440,000 hectares) covered by tropical forest.

Vanuatu ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1993. Under article 12 of the Convention all parties are required to prepare and submit national communications.

The Government of Vanuatu has submitted its initial national communications (INC) to UNFCCC in 1999 and the Second National Communication (SNC) in 2016. An overview of the Vanuatu's national GHG inventory as part of the first and second national communications submitted to the UNFCCC are discussed below. Following section of this report includes the National Greenhouse Gas (GHG) Inventory of Vanuatu , intended to communicate as part of third National Communication (TNC) to the United Nations Framework Convention on Climate Change (UNFCCC) and Conference of Parties (COP) on the anthropogenic GHGs emissions from Vanuatu by sources and removals by sinks, of all greenhouse gases (GHG) not controlled by the Montreal Protocol.

Figure 2.1: Map of Vanuatu

Table 2.1: National Circumstances

Population	272,469
(2016 Mini-Census)	134,194
Female Population-2016	138,265
Male Population -2016	25% : 75%
% Population (Urban : Rural)	2.3%
Population Growth Rate (Avg)	55,285
Households	25% : 75%
% Households (Urban : Ru-ral)	12,270
Land Area (KM2)	2,870
Land area used intensively (KM2)	4,380
Land area under forest (KM2)	680,000
Exclusive Economic Zone (KM2)	Vatu 79,109 million
Gross Domestic Product -2014	Vatu 301,298
GDP per capita -2014	22%
Agriculture, Fishing and Forestry in GDP (2014)	7.5%
Industry in GDP (2014)	64.7%
Services in GDP (2014)	

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First National Communication–1999

The Republic of Vanuatu submitted its first National Communication (INC) to United Nations Framework Convention on Climate Change (UNFCCC) in July-1999. The first national communication was a component of Vanuatu's participation in the Pacific Islands Climate Change Assistance Programme (PICCAP), a South Pacific Regional Environment Programme (SPREP) initiative funded by the Global Environment Facility (GEF), and executed by the United Nations Development Program (UNDP) in close collaboration with the United Nations Institute for Training and Research (UNITAR) administered CC:TRAIN.

Vanuatu's first national communication was developed by the National Advisory Committee on Climate Change (NACCC) in consultation with the government departments, six provincial councils (Malampa, Penama, Sanma, Shefa, Tafea and Torba) and the two municipalities of Port Vila and Luganville.

The first national communication of Vanuatu highlighted Vanuatu's minimal contribution to man-made global emissions of Greenhouse Gases (GHG) but exposure to high climate related risks and vulnerabilities e.g. impacts of climate change on rain fed agriculture and subsistence gardening, limited surface and ground water resources, social and economic impacts of tropical cyclones and sea-level change.

The FNC was focused on six fronts viz (i) Institutionalise and mainstream climate change preparations, (ii) Build national level understanding, (iii) Improving network for information transfer and coordinate adaptation and mitigation measures, (iv) Increase national capacity to prepare for and adapt to climate change, (v) Minimise increases in national GHG emissions in the medium term, and; (vi) Increase community understanding of climate change and their preparedness. FNC does not cover the holistic assessment of climate change impact, climatic vulnerabilities and mitigation and adaptation requirements, mainly due to lack of information and data availability; however due to Vanuatu's limited technical and financial capacity and the global nature of climate change and sea level impacts, identify and seek role for further international cooperation in meeting the mitigation and adaptation goals and on-going work to minimise increases in emissions.

The first national communication of Vanuatu set 1994 as the base year for the Greenhouse Gas Inventory of Vanuatu(as per IPCC-1996, reference approach). The GHG inventory was focused on energy, agriculture, land-use and forestry sectors; this was mainly due to unavailability of the sufficient data from other sectors, nearly non-existence of industries and small volume of solvent and other product use in Vanuatu, small waste generation and no scientific waste monitoring and treatment. Despite limiting the GHG inventory to these 3 sectors uncertainties and discrepancies in the data were significant.

The Greenhouse Gas (GHG) emissions and removal from sink in Vanuatu for the year-1994 was totaled as:

- The total GHG emission (excluding removals) was 299.3868 Gg CO2eq.
- The total GHG emission (including removals) was 298.2334 Gg CO2eq.
- 21.45% of total GHG emissions was from Energy Sector i.e. combustion of fossil fuel (Diesel and Petrol),
- 78.55% from Agriculture Sector i.e. Livestock emissions from Enteric Fermentation and Manure waste
- Land-Use Change & Forestry sector was net sink of GHG emissions.

Table 2.2: Summary First National Greenhouse Gas Inventory – 1994

GHG Sources & Sinks	Sectoral Total GHG emissions in Gg			
	CO_2-equiv	CO_2	CH_4	N_2O
Energy	64.2267	55.1532	0.0025	0.0291
Industrial Processes	Not Estimated			
Solvent and Other Product Use	Not Estimated			
Agriculture	235.1601	0.0000	11.1981	0.0000
Land-Use Change & Forestry	-1.1534	-1.1534	0.0000	0.0000
Waste	Not Estimated			
Total GHG Emissions (excl. Removals)	**299.3868**	**55.1532**	**11.2006**	**0.0291**
Total GHG Emissions (incl. Removals)	**298.2334**	**53.9998**	**11.2006**	**0.0291**
International Bunkers	5.5632	4.6001	0.0001	0.0031

Table 2.3: Summary Energy Sector Greenhouse Gas Emissions – 1994

GHG Sources & Sinks	Sectoral Total GHG emissions in Gg			
	CO_2-equiv	CO_2	CH_4	N_2O
Energy Industries	12.695	12.6737	0.0010	0.0000
Manufacturing Industries and Construction	0.930	0.9289	0.0001	0.0000
Transport	45.292	36.7777	0.0011	0.0274
Other sectors (commercial, Residential, Agricultural/Forest/Fishing)	5.309	4.7729	0.0004	0.0017
Total GHG Emissions	**64.227**	**55.1532**	**0.0025**	**0.0291**

Second National Communication–2016

The Republic of Vanuatu submitted its second National Communication (INC) to United Nations Framework Convention on Climate Change (UNFCCC) on 30th August 2016. The second national communication was also supported by the UNDP and the GEF.

The second national GHG inventory was estimated for the year 2000 using the revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories. In year 2000, the total GHG emissions by sources and removals by sink comprises:

- The total GHG emission (excluding removals) was 585.387 Gg CO2eq.
- The total GHG emission (including removals) was -7327.775 Gg CO2eq.
- 70.344Gg CO2eq from Energy Sector (12%);
- 502.829 Gg CO2eq from Agriculture Sector (85.9%) and
- 12.213Gg CO2eq from Waste Sector (2.1%).
- Emissions from IPPU sector and fluorocarbons (PFCs), hydro fluorocarbons (HFCs) and sulphur hexafluoride (SF6) were not estimated and considered negligible, as the products containing these gases are not produced in the country.
- CO2 sequestration by the forestry and land use sector in year 2000 amounted to 7,913.162 Gg CO2e.
- Total GHG emissions, including FOLU, are estimated to be (-) 7327.775 Gg CO2eq, indicating that Vanuatu is a net sink for GHG emissions.

Nearly 99% of GHG emissions in Vanuatu come from five activities: energy, transport, livestock, N2O from agriculture soils and waste. The largest contributor to GHG emissions in year 2000 was livestock sector amounting to 56.5% of total GHG emissions. The next biggest contributor was N2O from agriculture soils with 29.4% of GHG emissions followed by transport sector which contributed to 5.9% of total emissions. Greenhouse gases covered in this analysis include CO2, CH4 and N2O are estimated to be 12% CO2, 31% N2O and 57% CH4 of the total GHG emissions. Emissions

from perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and Sulphur hexafluoride (SF6) in Vanuatu are negligible, as the products containing these gases are not produced in the country.

In 2000, Vanuatu's absolute CO2 emission was 69.16 Gg which is a 26% increase since the first inventory for the base year 1994. The second national communication also estimated the national GHG emission for the year 2005 and 2010. The quantity of CO2 emissions increased from 585.387 Gg CO2eq in 2000 to 728.359 Gg CO2eq in the year 2010.

Below table summarizes the GHG Inventory for the year 2000, 2005 and 2010.

Table 2.4: Summary Second National Greenhouse Gas Inventory – 2000

GHG Sources & Sinks	Sectoral Total GHG emissions in Gg			
	CO_2-equiv	CO_2	CH_4	N_2O
Energy	70.344	69.607	0.022	0.00086
Industrial Processes	0.000	0.000	0.000	0.00000
Solvent and Other Product Use	0.000	0.000	0.000	0.00000
Agriculture	502.829	0.000	15.587	0.56613
Land-Use Change & Forestry	-7913.162	-7913.162	0.000	0.00000
Waste	12.213	0.000	0.422	0.01079
Total GHG Emissions (excl. Removals)	**585.387**	**69.607**	**16.032**	**0.578**
Total GHG Emissions (incl. Removals)	**-7327.775**	**-7843.555**	**16.032**	**0.578**

Table 2.5: Summary Second National Greenhouse Gas Inventory – 2005

GHG Sources & Sinks	Sectoral Total GHG emissions in Gg			
	CO_2-equiv	CO_2	CH_4	N_2O
Energy	93.346	92.425	0.027	0.00112
Industrial Processes	0.000	0.000	0.000	0.00000
Solvent and Other Product Use	0.000	0.000	0.000	0.00000
Agriculture	513.254	0.000	15.908	0.57800
Land-Use Change & Forestry	-7910.687	-7910.687	0.000	0.00000
Waste	14.317	0.000	0.503	0.01208
Total GHG Emissions (excl. Removals)	**620.918**	**92.425**	**16.439**	**0.591**
Total GHG Emissions (incl. Removals)	**-7289.769**	**-7818.262**	**16.439**	**0.591**

Table 2.6: Summary Second National Greenhouse Gas Inventory – 2010

GHG Sources & Sinks	Sectoral Total GHG emissions in Gg			
	CO_2-equiv	CO_2	CH_4	N_2O
Energy	122.399	121.847	0.012	0.00097
Industrial Processes	0.000	0.000	0.000	0.00000
Solvent and Other Product Use	0.000	0.000	0.000	0.00000
Agriculture	587.475	0.000	18.154	0.66528
Land-Use Change & Forestry	-3881.827	-3881.827	0.000	0.00000
Waste	18.484	0.000	0.688	0.01301
Total GHG Emissions (excl. Removals)	**728.359**	**121.847**	**18.854**	**0.679**
Total GHG Emissions (incl. Removals)	**-3153.468**	**-3759.980**	**18.854**	**0.679**

Third National GHG Inventory

Introduction

The third National Greenhouse Gas (GHG) Inventory of Republic of Vanuatu is a part of Vanuatu's Third National Communication (TNC) to the United Nations Framework Convention on Climate Change (UNFCCC) and Conference of Parties (COP). This report is the next in line after Republic of Vanuatu reported its first National GHG inventory as part of the Initial National Communication (INC) submitted in 1999 (based on 1994 data) and its second GHG inventory under the Second National Communication (SNC) submitted in 2016 (based on 2000 data).

The third national communication (TNC), details out anthropogenic Greenhouse Gases (GHGs) emissions and removals from Vanuatu for the years 2015 (including emissions for year 2007-2014) as per the 2006 IPCC Guidelines for Greenhouse Gas Inventories, IPCC Good Practice Guidance (GPG) ; and using the IPCC Inventory Software (Version 2.54- June 2017). The preparation of national GHG inventories for the years 2007-2015 uses both Tier1 and Tier2 methodologies (as appropriate) of 2006 IPCC guidelines. The national GHG Inventory for each year from 2007-2015 has been prepares with all Greenhouse Gas emissions divided into 2006 IPCC Guidelines Categories i.e. Sectoral, Sub-sectors and Gas type categorization.

The sectors and gases assessed for the estimation of third national GHG inventory includes the emissions by sources (excluding removals by sinks) of all anthropogenic GHGs (excluding the precursor gases and gases covered under Montreal protocol). As per the 2006 IPCC guidelines, the inventory estimates the GHG emissions from following sectors which are relevant for Vanuatu:

i. Energy;
ii. Agriculture, Forestry and Other Land Use (AFOLU)
iii. Waste Sector.

The reference approach has also been used to estimate equivalent CO2 emissions from the energy sector for the years 2007-2015. Emissions from International bunker (international Aviation and international waterborne navigation are also estimated and reported as memo items in the inventory; however, the GHG emissions from the international bunker are not included in the Vanuatu's total national GHG emissions. The sector and sub-sectors considered for the sectoral greenhouse gas inventory of anthropogenic emissions of Vanuatu have been listed in the following Table:

Categories	Remarks
Total National Emissions and Removals	
1 - Energy	**Estimated**
1.A - Fuel Combustion Activities	Estimated
1.A.1 - Energy Industries	Estimated
1.A.2 - Manufacturing Industries and Construction	Estimated
1.A.3 - Transport	Estimated
1.A.4 - Other Sectors	Estimated
1.A.5 - Non-Specified	Estimated
1.B - Fugitive emissions from fuels	**Not Occurring (NO)**
1.B.1 - Solid Fuels	
1.B.2 - Oil and Natural Gas	
1.B.3 - Other emissions from Energy Production	

1.C - Carbon dioxide Transport and Storage	**Not Occurring (NO)**
1.C.1 - Transport of CO2	
1.C.2 - Injection and Storage	
1.C.3 - Other	
2 - Industrial Processes and Product Use	**Not Occurring (NO)**
2.A - Mineral Industry	
2.A.1 - Cement production	
2.A.2 - Lime production	
2.A.3 - Glass Production	
2.A.4 - Other Process Uses of Carbonates	
2.A.5 - Other (please specify)	
2.B - Chemical Industry	
2.B.1 - Ammonia Production	
2.B.2 - Nitric Acid Production	
2.B.3 - Adipic Acid Production	
2.B.4 - Caprolactam, Glyoxal and Glyoxylic Acid Production	
2.B.5 - Carbide Production	
2.B.6 - Titanium Dioxide Production	
2.B.7 - Soda Ash Production	
2.B.8 - Petrochemical and Carbon Black Production	
2.B.9 - Fluorochemical Production	
2.B.10 - Other (Please specify)	
2.C - Metal Industry	
2.C.1 - Iron and Steel Production	
2.C.2 - Ferroalloys Production	
2.C.3 - Aluminium production	
2.C.4 - Magnesium production	
2.C.5 - Lead Production	
2.C.6 - Zinc Production	
2.C.7 - Other (please specify)	
2.D - Non-Energy Products from Fuels and Solvent Use	
2.D.1 - Lubricant Use	
2.D.2 - Paraffin Wax Use	
2.D.3 - Solvent Use	
2.D.4 - Other (please specify)	
2.E - Electronics Industry	
2.E.1 - Integrated Circuit or Semiconductor	
2.E.2 - TFT Flat Panel Display	
2.E.3 - Photovoltaics	
2.E.4 - Heat Transfer Fluid	
2.E.5 - Other (please specify)	Not Occurring (NO)
2.F - Product Uses as Substitutes for Ozone Depleting Substances	**Not Estimated (NE)**
2.F.1 - Refrigeration and Air Conditioning	Not Estimated
2.F.2 - Foam Blowing Agents	Not Occurring
2.F.3 - Fire Protection	Not Occurring
2.F.4 - Aerosols	Not Occurring

2.F.5 - Solvents	Not Occurring
2.F.6 - Other Applications (please specify)	Not Occurring
2.G - Other Product Manufacture and Use	**Not Estimated (NE)**
2.G.1 - Electrical Equipment	Not Estimated
2.G.2 - SF6 and PFCs from Other Product Uses	Not Estimated
2.G.3 - N2O from Product Uses	Not Occurring
2.G.4 - Other (Please specify)	Not Occurring
2.H - Other	**Not Occurring (NO)**
2.H.1 - Pulp and Paper Industry	
2.H.2 - Food and Beverages Industry	
2.H.3 - Other (please specify)	
3 - Agriculture, Forestry, and Other Land Use	
3.A - Livestock	**Estimated**
3.A.1 - Enteric Fermentation	Estimated
3.A.2 - Manure Management	Estimated
3.B - Land	
3.B.1 - Forest land	Estimated
3.B.2 - Cropland	Not Estimated
3.B.3 - Grassland	Not Estimated
3.B.4 - Wetlands	Not Estimated
3.B.5 - Settlements	Not Estimated
3.B.6 - Other Land	Not Estimated
3.C - Aggregate sources and non-CO2 emissions sources on land	
3.C.1 - Emissions from biomass burning	Not Estimated
3.C.2 - Liming	Not Estimated
3.C.3 - Urea application	Not Estimated
3.C.4 - Direct N2O Emissions from managed soils	Not Estimated
3.C.5 - Indirect N2O Emissions from managed soils	Not Estimated
3.C.6 - Indirect N2O Emissions from manure management	Estimated
3.C.7 - Rice cultivations	Not Occurring
3.C.8 - Other (please specify)	Not Occurring
3.D - Other	**Not Occurring**
3.D.1 - Harvested Wood Products	Not Occurring
3.D.2 - Other (please specify)	Not Occurring
4 - Waste	
4.A - Solid Waste Disposal	**Estimated**
4.B - Biological Treatment of Solid Waste	**Not Occurring**
4.C - Incineration and Open Burning of Waste	**Not Estimated**
4.D - Wastewater Treatment and Discharge	**Estimated**
4.E - Other (please specify)	**Not Occurring**

5 - Other	Not Estimated (NE)
5.A - Indirect N2O emissions from the atmospheric deposition of nitro-gen in NOx and NH3	
5.B - Other (please specify)	
Memo Items (5)	
International Bunkers	
1.A.3.a.i - International Aviation (International Bunkers)	Estimated
1.A.3.d.i - InteWrnational water-borne navigation (International bunkers)	Estimated
1.A.5.c - Multilateral Operations	Not Occurring

The GHG emissions estimated are: (i) Carbon dioxide (CO2); (ii) Methane (CH4) and (iii) Nitrous oxide (N2O); further, emissions from the following indirect GHGs are not estimated and reported here: Oxides of Nitrogen (NOx), Carbon Monoxide (CO), Non-Methane Volatile Organic Compounds (NMVOC) and Sulphur dioxide (SO2). The indirect GHG emissions are not accounted in the aggregated national GHG emissions. The GHG emissions reported in Giga-grams (Gg) and the aggregated GHG emissions and removals are expressed in CO2 equivalents (Gg CO2e or CO2eq) using the Global Warming Potential (GWP) defined by Fifth Assessment Report (AR5) by the Intergovernmental Panel on Climate Change (IPCC).

Institutional Arrangements and Organization Structure

The third national communication of the Republic of Vanuatu has been implemented by the Ministry of Climate Change (MoCC), Government of Vanuatu in collaboration with United Nations Development Programme (UNDP). United Nations Development Programme (UNDP) is also supporting the Ministry of Climate Change, to build Vanuatu's national Monitoring, Reporting and Verification (MRV) system for developing regular greenhouse gas (GHG) inventories, climate change mitigation assessments, sustainable development (SDG) monitoring and conducting vulnerability assessments as part of the Third National Communications (TNC) initiative.

Key steps towards the preparation of third national communication and national GHG inventory for the years 2007-2015 was as follows:

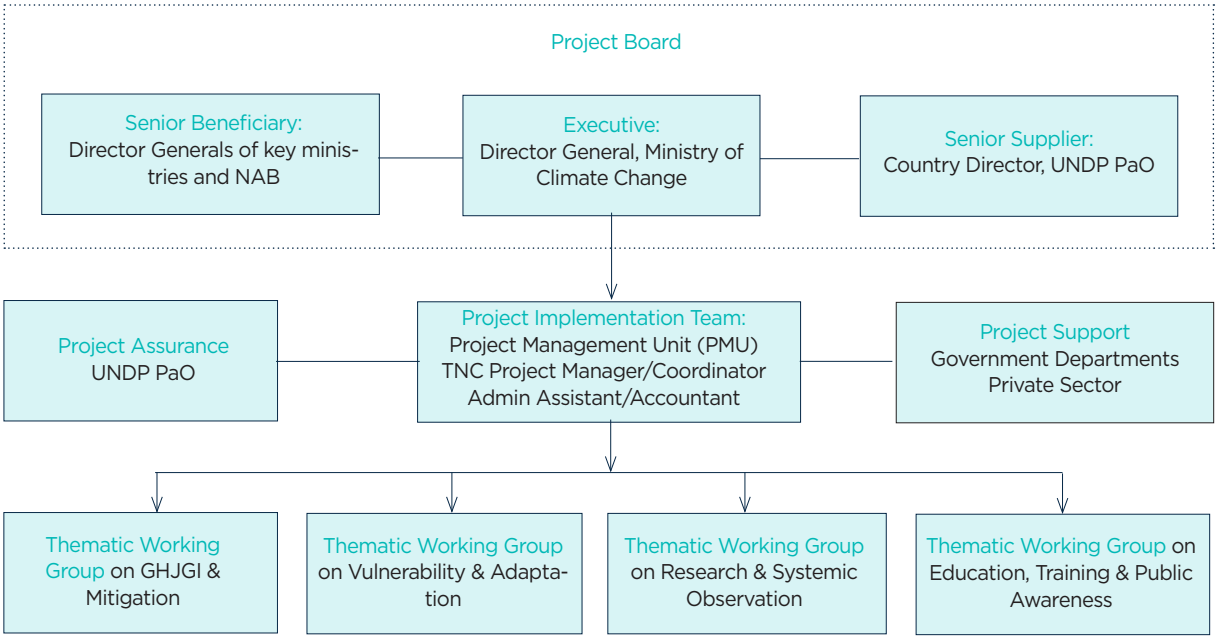
- Project Organization Structuring
- Thematic Working Group (TWGs) formation
- Stakeholder Consultation Process
- Training and Capacity building Programme
- Data collection, Identification of data gaps and uncertainty assessment
- Documents/data review for quality assurance
- Preparation of GHG Inventory Report
- Review and approval of the GHG Inventory Report

The TNC is being managed by the Project Board, mainly responsible for making by consensus, management decisions when guidance is required by the Project Manager, including recommendation for UNDP/Implementing Partner approval of project plans and revisions.

The Project Board is comprised of: Director General (DG) of key stakeholder ministries and National Advisory Board on Climate Change & Disaster Risk reduction (NAB) representative as Senior Beneficiaries, Director-General Ministry of Climate Change as the Executive and the Country Director Pacific Offic (PaO) as the Senior Supplier. The project assurance role shall be provided by the Fiji UNDP Country Office. Additional quality assurance shall be provided by the UNDP Regional Technical Advisor as needed.

The structure of the project team is as follows:

Figure 2.2: Institutional Arrangement and Organization Structure for TNC



The Department of Energy (DoE), Climate Change Project Management Unit (PMU), TNC project coordinator and consultants formed the project implementation team. The Ministry of Climate Change undertook tasks of consultation with other relevant government departments, the private sector and NGOs. The DoE was also responsible for central coordination of the development of the energy and climate change mitigation sector, provided technical and policy oversight etc.

The thematic working groups were formed to assist with the preparation of various components of the national communication viz National Greenhouse Inventory and Mitigation Analysis, Vulnerability and Adaptation, Research and systematic observation; and Education, training, public awareness and information and networking and Capacity-building. Each thematic working group was comprised of a number of experts drawing both from public and private sectors, communities, and NGOs, as appropriate. The following table presents the TWGs and key TWG members:

Thematic Working Groups (TWGs)

Table 2.7: Thematic Working Groups (TWGs)

TWGs	Members	
TWG - National Circumstances	Wycliffe Bakeo	Department of Strategic Policy Planning and Aid Coordi-nation (DESPAC)
	Trinison Tari	Department of Environmental Protection and Conservation (DEPC)
	Nigel Malosu	Department of Finance and. Treasury (DFT)
	Toney Tevi	DFAET
	Anna Bule	National Advisory Board on Climate Change (NAB Sec/CSU)
	Rotina Ilo	Department of Women Affairs (DWA)
	Joshua Mael	Department of Agriculture (DARD)
	Sombert Gereva	Fisheries Department
	Paul Kaun	Department of Energy (DOE)

TWG GHG-Green House Gas (GHGI)	Terry Mael	Department of Energy (DOE)
	Rexon Virana-manga	Department of Forests (DoF)
	Fernando Tor	Department of Agriculture (DARD)
	Alain Simion	Livestock Department
	Michelle Jonas	Port Vila Municipality Council (PVMC)
	Lizzy Taura	Utilities Regulatory Authority (URA)
	Benuel Lenge	Vanuatu National Statistics Office (NSO)
	Waste Manage-ment Officer	Department of Environmental Protection and Conserva-tion (DEPC)
	Leith Viramaeto	Department of Energy (DOE)
	Touasi Tiwok	Biosecurity
TWG - Vulner-ability Assess-ment and Adap-tation (V&A)	Norma Jibe Tor	Department of Environmental Protection and Conserva-tion (DEPC)
	Ian Iercet	National Disaster Management Office (NDMO)
	Moera Y Joseph	Vanuatu Meteorology & Geohazards Division (VMGD)
	Joshua Mael	Department of Agriculture (DARD)
	Erie Sammy	Department of Geology, Mines &Water Resources (DGMWR)
	Ioan Viji	Department of Forests (DoF)
	Sombert Gereva	Fisheries Department
	Nelly Wouloseje	Ministry of Health (MoH)
	James Hakwa	Public Works Department (PWD)
	Jeffrey Kaitip	Department of Local Authorities (DLA)
	Rodson Aru	Lands Survey
	Levu Antfalo	Vanuatu Meteorology & Geohazards Division (VMGD)
TWG - Mitiga-tion	Florence Iautu	Vanuatu Meteorology & Geohazards Division (VMGD)
	Alain Simion	Ministry of Agriculture
	Daryl Abel	Ministry of Climate Change (MoCC)
	Virana Lini	Ministry of Education and Training(MoET)
	Noel Steven	National Disaster Management Office (NDMO)
	Bae Worwor	Vanuatu Meteorology & Geohazards Division (VMGD)
	Trinison Tari	Department of Environmental Protection and Conserva-tion (DEPC)
	Samson Lulu	Department of Forests (DoF)
	Tony Kanas	Lands Survey
TWG - Re-search & Sys-tematic Obser-vation	Joe Mala	Vanuatu Meteorology & Geohazards Division (VMGD)
	Melinda Natapei	Vanuatu Meteorology & Geohazards Division (VMGD)
	Peter Korisa	National Disaster Management Office (NDMO)
	Patricia Mawa	Vanuatu Meteorology & Geohazards Division (VMGD)
	Joshua Mael	Department of Agriculture (DARD)
	Sombert Gereva	Fisheries Department
	Erie Sammy	Department of Geology, Mines &Water Resources (DGMWR)
	Nelly Wouloseje	Ministry of Health (MoH)

Stakeholder Consultation Process

The focused stakeholder consultation was carried out with in the government and government departments, public and private sectors, local and international development partners, NGOs and public groups.

The first phase of the stakeholder consultation focused on the key objective of the third national communication and national GHG inventory project, inception and processes. The stakeholders were updated on the key steps of TNC and consulted on various aspect of GHG inventory sectors e.g. data collection process, climate change mitigation, adaptation and V&A management. The stakeholders were also updated on IPCC 2006 Guidelines and Best Practices to develop the national GHG Inventory.

The second phase of stakeholder consultation involved presentation of the results i.e. National GHG Inventory of Vanuatu for the year 2007-2015, data, standards and assumptions applied for Vanuatu's National GHG inventory, data gaps and uncertainties etc. The objective of this phase was also to validate the assumptions and standards used for GHG inventory and seeks the inputs from wide stakeholders.

An important aspect of the stakeholder consultation was to update on the data gaps, uncertainties etc. and issues and activities to be considered to improve the quality, completeness and transparency of GHG inventory and updates on inventory improvement plan.

Training and Capacity Building Programme

TTraining and Capacity Building programme was designed and delivered to TWGs and key stakeholders. A technical training and hand-holding workshop on development of GHG inventories, mitigation assessment and vulnerability assessment & adaptation was organized for the TWGs and other relevant key stakeholders in Vanuatu. The overall objective was to empower the stakeholders in Vanuatu to achieve the necessary level of expertise to develop national GHG inventory, carry-out mitigation assessment and V&A analysis through data collection, analysis, monitoring and reporting procedures as required by UNFCCC.

Further, the training and capacity building is a continuous exercise and will be conducted on timely basis to incorporate and update appropriate data collection and reporting procedures.

Data Collection

Data collection and validation of the data is the key aspect of the GHG inventory process. The data collection procedure in Vanuatu is yet formalize, the newly formed Department of Climate Change is formalizing the data collection process via suitable instruments e.g. legal contract, MoU, MoAs etc. The data collection procedure adopted for this inventory period was by office notifications issued by the Director General, Ministry of Climate Change to relevant ministries and department, identified organizations, public-private sector and institutions. The data collected and database repository, archives are maintained at the Department of Climate Change.

The data for GHG inventory for the years 2007-2015 for different sectors and sub-sectors were collected using the two approaches i.e. first the "top down" or reference approach and second the "bottom up" or sectoral approach. The data for each sector and sub-sector were compiled from various sources primarily using available national data, data collected and published by the Vanuatu National Statistics Office (VNSO), Census (Population and Agriculture), Quarterly Statistical Indicators (QSI), Utilities Regulatory Authority (URA), Vanuatu Customs Data, Public and Private sector (like Pacific Petroleum, Origin Energy, VUI, UNELCO etc.), and other statistical reports, studies, brochures and other country specific information sources. Where actual data was not available judgment of sectors experts was relied on mainly for AFOLU and Waste Sector.

The challenges and barriers faced during the data collection and methodologies adopted for data collections discussed in detail in the following section of the report and under sectoral and sub-sectoral analysis. Number of country specific and regional assumptions were used to represent the local conditions of country (highlighted in the following section of this report). These assumptions have been verified with the local sector experts and cross checked with other resources for correctness. Wherein no formal data is available, emission for those sectors and sub-sector are not con-

sidered/estimated in this report. Justification on choice of data and limitations discussed in following section of the report and under the sectoral/sub-sectoral analysis.

Completeness, and Uncertainty Assessment

The IPCC Guidelines provides a comprehensive overview and categorization of all potential sources of GHG emissions; however not all of them are relevant to Vanuatu . Furthermore, there is insufficient data on certain sources for them to be included in this inventory exercise.

This has been discussed in the sections below, a detailed assessment of each IPCC category was carried out as part of Vanuatu's national GHG inventory, including each category's relevance to Vanuatu and the availability of data required to estimate emissions from these categories.

The IPCC guidelines provide guidance for an advance and technical uncertainty analysis. Uncertainty estimates are an essential element of a complete inventory of greenhouse gas emissions and removals. The main objective of the uncertainty analysis in the inventory is to identify the categories that have the greatest contribution to the uncertainty in the total inventory and to the trend uncertainty with the objective of prioritizing improvements and distributing resources to reduce their uncertainties as much as possible. Out of the two approaches for the estimation of combined uncertainties are presented in the 2006 IPCC Guidelines; Approach 1 analysis estimates uncertainties by using the error propagation equation have been used for analysis. Approach 1 is based upon error propagation and is used to estimate uncertainty in individual categories, in the inventory as a whole, and in trends between a year of interest and a base year.

The uncertainty analysis and aggregated categories is based on Table 4.1 of Volume 1, Chapter 4 of 2006 IPCC Guidelines. Uncertainties from disaggregated levels are combined by multiplication according to Equation 3.1 of Volume 1, Chapter 3 of 2006 IPCC Guidelines using the default uncertainty values. For this analysis uncertainty in emissions or removals has been propagated from uncertainties in the activity data and other estimation parameters through the error propagation equation.

The overall uncertainty in national emissions i.e. Percentage uncertainty in total inventory was estimated as 22%; and the trend in national emissions between the base year and the current year has been estimated as 11%. The Approach-1 Uncertainty calculation table annexed to this report. The major uncertainty contributed from the AFOLU and Waste sector followed by the Energy sector.

In Vanuatu, key uncertainties are associated with data availability, missing data, lack of comprehensive information, data archiving and lack of country specific emission factors. It is recognized that having country specific emission factors and more detailed activity data will help reduce uncertainty in future inventory. For example, in the energy sector there is good data available on fuel imports into the country but there is lack of information on end usage.

Similarly, for Land Use Change and national forest resources currently there is no national data available. The waste sector also lacks information on waste generation, characterization, composition, disposal and treatment. It can be concluded that with adequate training and capacity building on GHG inventory requirements, Vanuatu can provide more detailed and accurate information in subsequent GHG inventories.

Below is a summary of the gaps and uncertainties for each sector. The detail is presented in the specific chapters.

Energy sector Gaps and Uncertainty: For the energy sector reference approach, there were uncertainties in the data from the pacific petroleum that need to be addressed in future reports as well as instituting some level of quality control and independent assurance of data integrity. No national energy balance available, further energy datasets available are fragmented with irregular data reporting.

For the sectoral approach, it is recognized that there are considerable gaps in information regarding sectoral usage in the energy sector that need to be addressed by obtaining data directly from the fuel supply companies. In addition, having two independent data sources would then lead to better data quality assurance and the ability to cross check quantities. In general uncertainties of around ± 51% would not be unreasonable for the energy sector.

Agriculture Gaps and Uncertainty: Uncertainties in the agricultural sector are inherent due to the lack of detailed census data in livestock population, type of livestock, animal numbers, manure management practices. The uncertainties are suggested to be higher than the energy sector and amount to around ± 30%.

Forestry Sector gap and uncertainty: The forest cover area and removal of biomass are the key data required for the forestry sector. Further, the uncertainty observed in Land Use Change, currently there is no national data available. The extent of the national forest resources is estimated based on reports and studies undertaken in the past and also crosschecked with FAO data.

Waste gaps and Uncertainties: Although there were a number of limitations in the data quality for the waste sector, the overall relatively low emissions from this sector made the final uncertainties not a large problem in terms of the total emissions profile for Vanuatu.

The Inventory Team has also prepared the inventory improvement plan (IIP) to reduce the uncertainties as far as is practicable possible for the future GHG inventories of Vanuatu.

Key Category Analysis

This section addresses procedure adopted to identify key categories in a Vanuatu's national GHG inventory; "Non-Annex I Parties are encouraged in Decisions 17/CP.8 and 2/CP.17, to the extent possible, to undertake any key category analysis (level/trend or both) to assist in developing inventories that better reflect their national circumstances". The key category analysis is an essential element for the national GHG inventory development and driving factor to improve its quality, as well as greater confidence in the national GHG estimates. The KCA also helps in prioritisation of limited resources and time.

The key categories for the Vanuatu's national GHG inventory has been identified in terms of their contribution to the absolute level of national GHG emissions and removals. Basic Approach 1 has been adopted for quantitative analysis in objective manner, accounting uncertainties and suggested aggregation level of analysis, as presented in the table below:

Table 2.8: KCA: Aggression Level of Analysis for Approach-1

IPCC Category code	IPCC Category	Greenhouse gas	Remarks
Energy			
1.A.1	Energy Industries - Fuel Combustion Activities	CO_2, CH_4, N_2O	All fuel All Fuel
1.A.2	Manufacturing Industries and Construction - Fuel Combustion Activities	CO_2, CH_4, N_2O	
1.A.3.a	Civil Aviation - Fuel Combustion Activities	CO_2, CH_4, N_2O	Domestic Aviation only
1.A.3.b	Road Transportation – Fuel Combustion Activi-ties	CO_2, CH_4, N_2O	Road
1.A.3.d	Water-borne Navigation	CO_2, CH_4, N_2O	Domestic Navigation only
1.A.4	Other Sectors		Institutional, Commercial and Residential,
Agriculture, Forestry and Other Land Use			
3.A.1	Enteric Fermentation	CH_4	All category of Livestock
3.A.2	Manure Management	CH_4, N_2O	All category of Livestock
3.B.1.a	Forest land Remaining Forest land	CO_2,	
3.C.6	Indirect N2O Emissions from manure manage-ment	N_2O	All category of Livestock All category of Livestock
Waste			
4.A	Solid Waste Disposal	CH_4	MSW Waste – Urban
4.D	Wastewater Treatment and Discharge	CH_4, N_2O	Domestic Waste Water- Urban

In Approach 1, key categories are identified using a predetermined cumulative emissions threshold. The approach 1 identify key categories assesses the influence of various categories of sources and sinks on the level, and possibly the trend, of the national greenhouse gas inventory. Key categories are those that, when summed together in descending order of magnitude, add up to 95% of the total level; however as per GPG key categories identified between threshold of 95% and 97%.

Since the Vanuatu's national GHG inventory estimates are available for the years 2007-2015; most recent 3 years have been considered for KCA (as per GPG). The result of approach 1 level KCA analysis for Vanuatu's National GHG Inventory for the years 2013-2015 presented in the table below, the detailed reporting table included as Annexure-3:

Table 2.9: KCA - Vanuatu National GHG Inventory -20013-2015

A	B	C	Cumulative Total of Column F (%)		
IPCC Category code	IPCC Category	Greenhouse gas	2013	2014	2015
3.A.1	Enteric Fermentation	METHANE (CH4)	51%	50%	50%
3.A.2	Manure Management	METHANE (CH4)	63%	62%	62%
1.A.3.b	Road Transportation	CARBON DIOX-IDE (CO2)	72%	71%	72%
3.A.2	Manure Management	NITROUS OX-IDE (N2O)	80%	79%	79%
1.A.1	Energy Industries	CARBON DIOX-IDE (CO2)	85%	85%	85%
4.A	Solid Waste Disposal	METHANE (CH4)	90%	90%	90%
1.A.2	Manufacturing Industries and Construction	CARBON DIOX-IDE (CO2)	93%	93%	93%
3.C.6	Indirect N2O Emissions from manure management	NITROUS OX-IDE (N2O)	95%	95%	95%
1.A.3.a	Civil Aviation	CARBON DIOX-IDE (CO2)	97%	97%	97%

The key categories, sub-sector and sector identified for Vanuatu's National GHG Inventory discussed in detailed in the later section of this report

Quality Assurance/Quality Control and Review Mechanism

A quality assurance/quality control (QA/QC), a reviewed mechanism, was an integral part of the process. It was devised to improve transparency, consistency, comparability, completeness, and accuracy of the third national communication and national greenhouse gas inventory. An internal QA/QC plan was developed and roles and responsibilities were defined to all the TNC and GHG Inventory Team Members. The QA/QC process and review mechanism implemented at all level of data collection, inventory preparation and reporting.

The inventory team routinely conducted checks consistency of the data and information provided by the different stakeholders (line ministries, government departments, Organizations, Public and private sector etc), to ensure data integrity, correctness, and completeness. In case of discrepancy or incompleteness, the inventory team consulted the relevant stakeholders and experts to reduce the data uncertainty, appropriate corrections, address errors and omissions. The sub-sectoral and sectoral calculations of GHGs were shared with the TWGs for technical review of categories and sub-category activity data, emission factors, estimation parameters, and calculation methods. The inputs provided by the TWGs were addressed and GHG emission reduction calculation was revised. On finalization of the GHG Inventory calculations, draft report was prepared and shared with the TWGs.

Further, the draft report and GHG inventory calculations presented during the stakeholder consultation to seek inputs and finalize the report.

Independent Third Party Review of National GHG Inventory (NIR) and Third National Communication (TNC):

An independent third party review of NIR was coordinated by the UNDP-UNEP Global Support Programme (GSP) and was conducted by independent consultant (Dr. Carlos López) as per the requirements indicated in the UNFCCC Decision 17/CP.8 Annex, the UNFCCC Decision 2/CP.17 Annex III, and to the advice of the IPCC Guidelines and Guidance indicated in these decisions for the preparation of the inventories to be included in the Second and Third National Communications and Biennial Update Reports from non-Annex I Parties under the UNFCCC. The review also takes into account the requirements and flexibilities established to prepare and report the inventory for Small Island Developing State (SIDS) and Least Developed Countries (LDC).

The Independent reviewer has also examined NIR's adherence to the guidance provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred as to "2006 IPCC Guidelines"); additionally considered criteria and recommendations provided in other key methodological documents and tools related to the inventory process including IPCC, 2017; UNDP, 2005; US-EPA-USAID, 2011; UNFCCC-GCE, 2012; EEA, 2016, UNFCCC, 2014 and UNFCCC, 2017.

The quality of the Vanuatu's GHG Inventory Report was also assessed through the examination of how the principles of transparency, consistency, comparability, completeness and accuracy (TCCCA) on reporting, established in the IPCC Good Practice Guidance 2000 and 2003 and the 2006 IPCC Guidelines. Additionally, the independent reviewer also considered review of the NIRs for 1994 and 2000, 2005, 2010 included respectively in the first (NC1, 1999) and second national communications (NC2, 2016).

The Third National Communication Team of Vanuatu, welcomes the appreciation and positive remarks and observation. The TNC Team also made all the possible corrections and revised the National GHG Inventory Report; further some suggestions will be considered during the next National GHG Inventory and reporting cycle. The quality of national GHG inventory and report improved by addressing the comments, observations and changes suggested by the independent reviewer.

The main outcomes of QA/QC and review process was overall improvement in the quality of data collection, calculations, reporting and inclusion of the key criteria analysis, uncertainty estimates and subsequent improvements in the future GHG Inventory i.e. Inventory Improvement Plan (IIP).

Vanuatu's GHG Emissions: 2007–2015

Overview

The GHG emissions from Vanuatu has been estimated based on the methodology discussed in the previous section for the year 2007–2015; and presented here. The following section includes the total GHG emissions by sources and removals by sinks for the years 2007-2015; further trend analysis also incorporated against the GHG emissions estimated in year 1994 (as a part of First National Communication) and year 2000 (as part of Second National Communication).

The republic of Vanuatu remains the net carbon negative in terms of GHG emissions including the removals. However, the total national GHG emissions excluding removals in year 2015 reached to 610.204 Gg CO2e (in comparison to 299.387 Gg CO2e estimated for year 1994 under the first national communication and 585.387 Gg CO2e estimated for year 2000 under the second national communication); This comprises direct CO2 emission 128.206 Gg, CH4 emission 14.818 Gg and N2O emissions 0.253 Gg during 2015. Emissions of other GHGs like per fluorocarbons (PFCs), hydro fluorocarbons (HFCs) and Sulphur hexafluoride (SF6) not estimate for Vanuatu since negligible application and nil manufacturing of the products containing these gases.

By way of comparison, the total global greenhouse gas (GHG) emissions continue to show a steady increase, reaching approximately 53.235 Gigatonnes carbon dioxide equivalent (GtCO2e) in 2015 and global carbon dioxide emissions from fossil fuel combustion, cement production and other industrial processes account for about 68% of total global greenhouse gas emissions, and were estimated to be 36.2 GtCO2e. The global per capita GHG emissions (in terms of tonnes of CO2e per person) for the year 2015 was about 7.235 tonnes of CO2equivalent per person per year (tCO2e/Person/Year) (Considering Global population for 2015 was 7.35 billion persons).

The per capita GHG emissions for Vanuatu come out approximately 2.302 tonnes of CO2equivalent per person for year 2015 (Population of 0.265 Million persons); which is around 32% of the world average during that period. In absolute terms Vanuatu's total CO2equivalen emissions was around 0.0011% of the Global GHG emissions for year 2015.

Total GHG Emissions: 2007 – 2015

The following graph and table present the Vanuatu's total GHG emissions in Gg CO2e (excl. Removals) for the inventory year 2007 to 2015:

Figure 2.3: Vanuatu's Total GHG Emission (excluding removals), Gg CO2eq : 2007 -2015

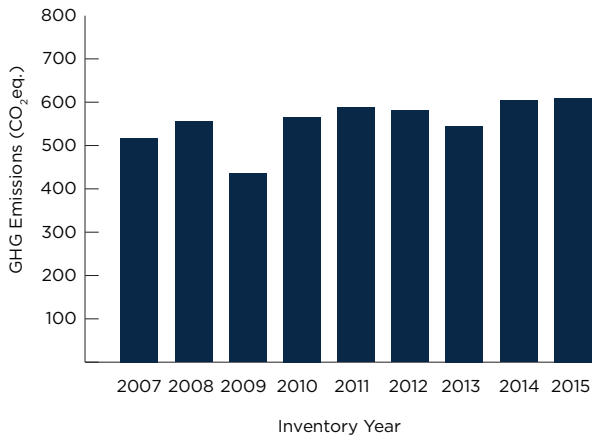


Figure 2.4: Vanuatu's Total GHG Emissions by Gas (Gg): Average 2007-2015

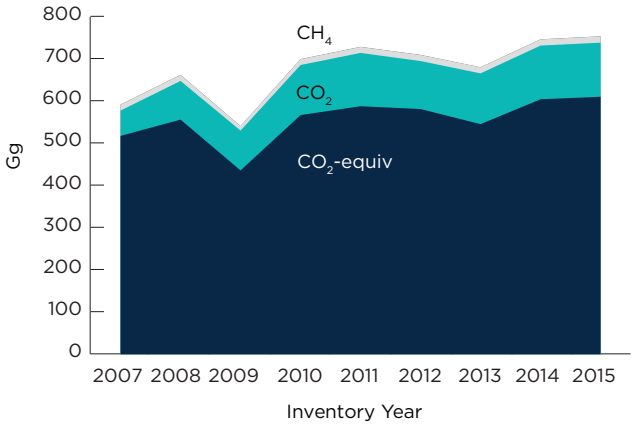


Table 2.10: Vanuatu's Total GHG Emission (excluding removals), Gg CO2eq : 2007 -2015

Year	Vanuatu's Total GHG emissions excl. removals in Gg (2007-2015)			
	CO_2-equiv	CO_2	CH_4	N_2O
2007	517.412	59.959	14.057	0.241
2008	556.059	91.603	14.272	0.245
2009	435.648	94.324	10.531	0.175
2010	566.818	118.590	13.776	0.236
2011	587.786	126.320	14.180	0.243
2012	581.133	113.719	14.366	0.246
2013	545.299	120.290	14.492	0.073
2014	604.257	127.251	14.663	0.251
2015	610.204	128.206	14.818	0.253
Average	**556.068**	**108.918**	**13.906**	**0.218**

As can be seen the total GHG emissions from Vanuatu is increasing over the years and indicative increase in CO2 emission followed by CH4 and N2O emissions. Evidently the main GHG emissions from Vanuatu comprises of mainly Carbon Dioxide (CO2) as major contributor from combustion of fossil fuel for generation of electricity, transportation and other sectors; Methane (CH4) and Nitrous Oxide (N2O) emissions from agriculture-livestock (Enteric fermentation and Manure management), Waste Sector (Solid waste and waste water) and Land. Livestock is a major source of Methane emission in Vanuatu.

As discussed above the republic of Vanuatu is net carbon negative, since the land-use change and forestry sector is a net sink of CO2 in Vanuatu. The CO2 removals from the forestry sector were estimated -1.1534 Gg of CO2e for the year 1994 and -7,913.14 Gg of CO2e for the year 2000. The total GHG emissions for the year 2007-2015 including the removals form LULUC and Forestry Sector summarized in the table below:

Figure 2.5: Vanuatu's Total GHG Emissions by Gas (Gg): Average 2007-2015

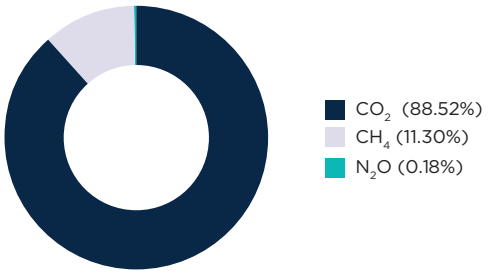


Table 2.11: Vanuatu's Total GHG Emission (including removals), Gg CO2eq : 2007 -2015

CO2 Emissions (CO2 equivalents Gg)									
Inventory Year Categories	2007	2008	2009	2010	2011	2012	2013	2014	2015
1 - Energy									
1.A - Fuel Combustion Activities	60.4	92.3	95.1	119.7	127.5	114.9	121.5	128.6	129.6
2 - Industrial Processes and Product Use									
3 - Agriculture, Forestry, and Other Land Use									
3.A - Livestock	412.6	418.3	298.4	400.6	412.3	417.2	373.6	424.3	428.1
3.B - Land (Forestry)	-7021.2	-7021.2	-7021.2	-6973.7	-6973.7	-6973.7	-6973.7	-6973.7	-6973.7
3.C - Aggregate sources and non-CO2 emissions sources on land	14.8	15.0	10.9	14.3	14.8	14.9	15.0	15.2	15.3
4 - Waste									
4.A - Solid Waste Disposal	22.4	23.3	24.1	24.9	25.8	26.7	27.7	28.6	29.6
4.D - Wastewater Treatment and Discharge	7.1	7.2	7.2	7.3	7.4	7.4	7.5	7.6	7.7
Total GHG Emissions, excl. Removals	**517.4**	**556.1**	**435.6**	**566.8**	**587.8**	**581.1**	**545.3**	**604.3**	**610.2**
Total GHG Emissions, incl. Removals	**-6503.7**	**-6465.1**	**-6585.5**	**-6406.9**	**-6385.9**	**-6392.6**	**-6428.4**	**-6369.4**	**-6363.5**

Vanuatu's forest (all types of forests) covers about 75% of the total land area i.e. approximately 4380 square kilometers, and include dense tropical rainforests and exotic plantation forests. Much of the natural forest is on steep inaccessible sites and contains few species for commercial use. Over the period of time there is no change in forest land area due to difficult terrain and low commercial utilization. These forest cover provides natural source for carbon sink (removals). In the current inventory, under Land Use Change and Forestry sector, CO2 emissions/removals are estimated for changes in forest and other woody biomass stock including wood fuel and commercial logging. Due to lack of data, emissions/removals from forest and grassland conversion, abandonment of managed lands and CO2 emissions from soil have not been estimated.

GHG Emissions by Sector: 2007–2015

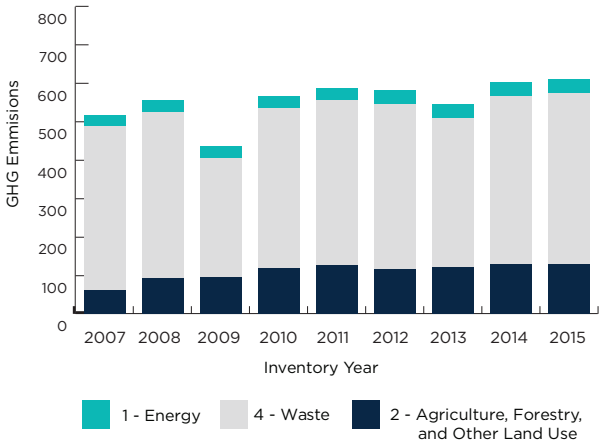
As discussed above the main GHG emission sectors and sub-sectors in Vanuatu includes:

- Energy Sector
  - Energy Industries
  - Manufacturing Industries and Construction
  - Transportation
    - Road Transportation
    - Aviation (Domestic)
    - Water-borne Navigation (Domestic)
  - Other Sectors – Commercial, Institutional and Residential
- Agriculture, Forestry, and Other Land Use (AFOLU)
  - Livestock
  - Forest Land
  - Land use
- Waste Sector
  - Solid Waste
    - Municipal Solid Waste (MSW)
  - Wastewater Treatment and Discharge
    - Domestic Waste Water

Note: GHG emissions form international aviation and international water borne navigation has been calculated as memo item and not included in the total GHG emissions form Vanuatu.

The sectoral GHG emissions and contribution of different sub-sectors in Vanuatu's total GHG emission are presented as follows:

Figure 2.6: Vanuatu's Total GHG Emission (excluding removals), Gg CO2eq : 2007 -2015



As discussed above the total GHG emissions in Vanuatu contributed by three main sectors viz Agriculture (livestock and land), Energy and Waste Sectors. The average contribution of these sector for the year 2007-2015 were Agriculture (74.2%), Energy Sector (19.2%), and Waste Sector (6%), there is no contribution from industrial process and solvent &other product use (IPPU).

The sectoral contribution of GHG emissions in Vanuatu during year 2007-2015 presented in table below:

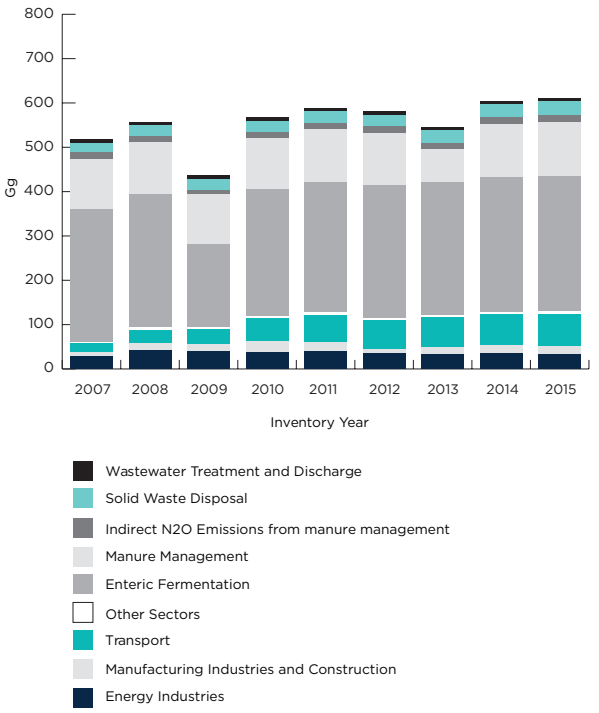
Table 2.12: Vanuatu's Sectoral GHG Emission (excluding removals), Gg CO2eq : 2007 -2015

Total CO_2 Emissions, (CO2 Equivalents Gg)									
Categories	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
1 - Energy	60.42	92.31	95.10	119.66	127.53	114.87	121.54	128.55	129.55
2 - Industrial Processes and Product Use									
3 - Agriculture, Forestry, and Other Land Use	427.45	433.32	309.22	414.91	427.07	432.11	388.60	439.51	443.38
4 - Waste	29.55	30.43	31.33	32.24	33.18	34.15	35.16	36.20	37.28
Total GHG Emissions, excl. Removals	**517.41**	**556.06**	**435.65**	**566.82**	**587.79**	**581.13**	**545.30**	**604.26**	**610.20**

GHG Emissions by Sector: 2007–2015

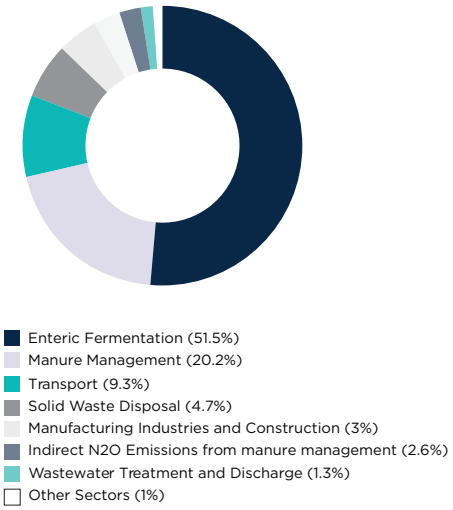
The sub-sectoral GHG emissions in Vanuatu's total GHG emission are presented as follows.

Figure 2.7: Vanuatu's Sub-Sector-wise GHG Emissions-excluding removals (Gg)



The above sub-sectoral GHG emission of Vanuatu for the years 2007-2015 shows that the Livestock Enteric Fermentation and Manure Management is the major source of GHG emissions, the average emissions form these sub-sectors are 51.46% and 20.18% respectively; followed by the transport sector 9.35%; Energy Generation 6.43%; Solid Waste Disposal 4.66%; Manufacturing Industries and Construction 3.02%; Land Management 2.6%; Waste Water Treatment and Discharge 1.33%; and Other Sectors including Commercial, Institutional and residential 0.98%. The following graph present the average emissions from the each of subsector discussed here; the following sector of the report includes the detailed analysis of each sub-sector.

Figure 2.8: Vanuatu's Sub-Sector-wise Average GHG Emissions (excluding removals): 2007-2015



The sub-sectoral contribution of GHG emissions in Vanuatu during year 2007-2014 presented in table below.

Table 2.13: Vanuatu's Sub-Sectoral GHG Emission (excluding removals), Gg CO2eq : 2007 -2015

Total CO2 Emissions, (CO2 Equivalents Gg)									
Sub-Sectors	2007	2008	2009	2010	2011	2012	2013	2014	2015
1.A.1 - Energy Industries	27.73	42.05	39.47	38.02	38.81	35.88	31.68	35.74	32.19
1.A.2 - Manufacturing Industries and Construction	9.85	16.26	16.21	23.67	20.91	8.96	17.40	17.92	19.94
1.A.3 - Transport	18.93	29.28	33.08	52.09	62.04	63.95	66.72	69.56	72.14
1.A.4 - Other Sectors	3.92	4.72	6.34	5.88	5.77	6.08	5.74	5.33	5.28
3.A.1 - Enteric Fermentation	298.25	301.49	187.09	285.82	294.56	298.09	299.90	303.55	306.62
3.A.2 - Manure Management	114.37	116.85	111.27	114.75	117.76	119.09	73.68	120.79	121.47
3.C.6 - Indirect N2O Emissions from manure management	14.83	14.99	10.86	14.34	14.75	14.93	15.03	15.17	15.29
4.A - Solid Waste Disposal	22.44	23.25	24.09	24.94	25.81	26.72	27.65	28.62	29.62
4.D - Wastewater Treatment and Discharge	7.11	7.17	7.24	7.30	7.37	7.44	7.51	7.58	7.65
Total GHG Emissions, excl. Removals	**517.41**	**556.06**	**435.65**	**566.82**	**587.79**	**581.13**	**545.30**	**604.26**	**610.20**

Gas by Gas Emission Inventory: 2007–2015

The gas by gas GHG emission inventory for Vanuatu for the inventory years 2007-2015 discussed in this section. The GHG emissions mainly contributed from Energy, AFOLU and Waste sector. Greenhouse gases covered in this analysis include Carbon di-oxide (CO2), Methane (CH4) and Nitrous-oxide (N2O), the estimated quantum of these main GHGs presented in prior section.

The emission from other direct GHGs i.e. hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and Sulphur hexafluoride (SF6) have not been included here since HFCs, PFCs, SF6 are not directly imported or sold in Vanuatu; hence direct emission of these gases does not occur; however negligible amount of these gases present in equipment like ACs, Refrigerators, switch-boards and Circuit-breakers etc. further non-of the activity listed under Tier-1 approach to estimate emissions from these gases applicable for Vanuatu.

The national GHG inventory also doesn't include the emission of precursor gases like Carbon Monoxide (CO), Nitrogen Oxides (NOx) and non-Methane Volatile Organic Compounds (NMVOC) and other gases not controlled by the Montreal Protocol, such as Sulphur Oxides (SOx); 'due to lack of detailed activity data and due to high uncertainty involved in estimation of emissions from indirect gases. Hence, the TNC Team decided to improve the quality of data and shall estimate emission from these gases during future national GHG Inventory.

The data analysis confirms that CO2 is the most potent GHG in Vanuatu. This is primarily due to emissions from energy industries mainly electricity generation; transportation-road transport, domestic aviation and water borne transportation; manufacturing industries & construction and other commercial, institutional and residentials.

Next most prominent GHG in Vanuatu is CH4 mainly from the livestock, land management, solid waste and waste water sub- sectors; followed by N2O mainly from livestock, land management and waste water sub-sector.

Gas wise GHG emissions form Vanuatu for the year 2007-2015 presented here:

Table 2.14: Vanuatu's Sub-Sectoral GHG Emission (excluding removals), Gg CO2eq : 2007 -2015

Inventory Year	CO2 (Gg)	CH4 (Gg)	N2O (Gg)
2007	59.959	14.057	0.241
2008	91.603	14.272	0.245
2009	94.324	10.531	0.175
2010	118.590	13.776	0.236
2011	126.320	14.180	0.243
2012	113.719	14.366	0.246
2013	120.290	14.492	0.073
2014	127.251	14.663	0.251
2015	128.206	14.818	0.253
Average	**108.918**	**13.906**	**0.218**
% Share	**88.52%**	**11.30%**	**0.18%**

The detailed analysis of all three potent GHGs are discussed in the following section.

Carbon dioxide (CO2)

Net CO2 emissions in Vanuatu was estimated for the period 2007-2015 presented in the graph below. The energy sector and sub-sectors are the main source of CO2 emissions, accounting for approximately 100% of emissions. The CO2 emissions from Vanuatu has shown the increasing trend historically and under the inventory period 2007-2015, the net CO2 emissions in year 2007 was 59.959 Gg and increase to 128.206 Gg (114% increased) in 2015; the marginal dip in 2009 and 2012 is due to less petroleum consumption and economic slowdown in those years; further the combustion of fossil fuels remain the main contributor of CO2 emissions in Vanuatu.

Figure 2.9: Vanuatu's Total CO2 emissions in Gg: 2007-2015

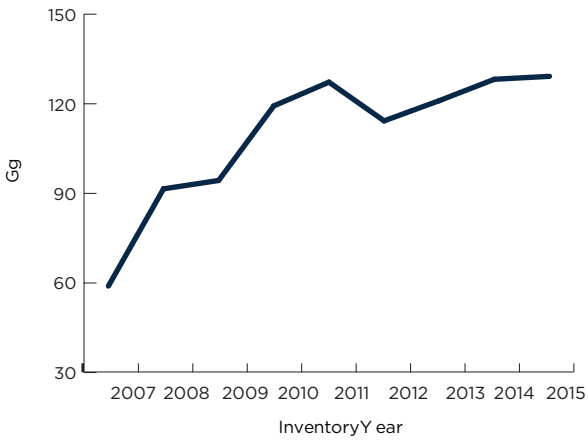
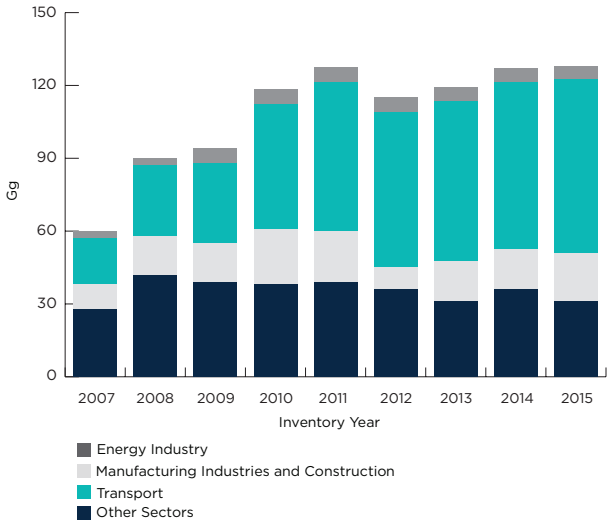


Figure 2.10: Sector-wise CO2 emissions in Gg: 2007-2015



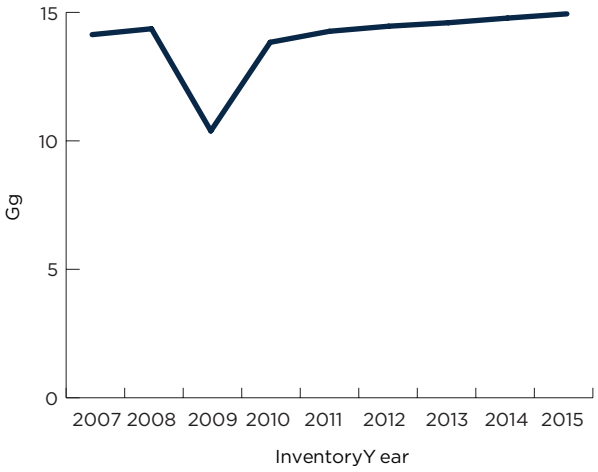
The sub-sector wise analysis of the total CO2 emission present that the Transportation sub-sector (47.27%) i.e. Road Transport (80%), Domestic Aviation (12%) and Domestic Water Borne Navigation (8%) are the main source of CO2 emission in Vanuatu; followed by the Energy Industry (32.5%) i.e. Electricity Generation, Manufacturing Industries and Construction (15.27%) and remaining from Other sectors (4.96%) i.e. commercial, institutional and residential sub-sectors.

Methane (CH_4)

Net Methane (CH4) emissions in Vanuatu were estimated for the period 2007-2015 presented in the graph below. Over 92% of Methane emission in Vanuatu comes from the agriculture sector i.e. from Livestock- Cattle, Swine, Horses, Goat and Chicken; enteric fermentation and manure management, the waste (Solid waste -MSW, Waste water) sector is the second largest source of CH4 emissions, accounting about 7.78% of emissions. Minor fraction of methane comes from the energy sector; mainly as the emissions from combustion of fossil fuel (0.03%).

The CH4 emissions from Vanuatu has shown linear increasing trend over the years 2007-2015, the net CH4 emissions in year 2007 was 14.057 Gg and increase to 14.818 Gg (5% increase) in 2015; the increase in methane emission is due to increase in livestock and waste generation also unscientific and unorganized waste management practices during the years; the open dumping and decay of waste increased the net methane emissions in Vanuatu. The decrease in 2009 is due to livestock population reduction during the year.

Figure 2.11: Total Methane (CH4) emissions in Gg – 2007-2015



The contribution of Methane emissions in Vanuatu's net GHG emission is increasing rapidly and calls for serious action on improving the livestock manure management and municipal solid and waste water management practices. The following table presents methane emission in Vanuatu from different sub-sectors.

Table 2.15: Subsector wise CH4 Emission Gg : 2007 -2015

Categories	2007	2008	2009	2010	2011	2012	2013	2014	2015
1.A.1 - Energy Industries	0.001	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001
1.A.2 - Manufacturing Indus-tries and Construc-tion	0.000	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001
1.A.3 - Transport	0.001	0.002	0.002	0.003	0.003	0.003	0.003	0.003	0.003
1.A.4 - Other Sectors	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3.A.1 - Enteric Fermentation	10.652	10.768	6.682	10.208	10.520	10.646	10.711	10.841	10.951
3.A.2 - Manure Management	2.444	2.513	2.828	2.516	2.576	2.604	2.631	2.637	2.647
3.C.6 - Indirect N2O Emis-sions from manure manage-ment	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4.A - Solid Waste Disposal	0.801	0.830	0.860	0.891	0.922	0.954	0.988	1.022	1.058
4.D - Wastewater Treatment and Dis-charge	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157
Total CH4 Emissions	14.057	14.272	10.531	13.776	14.180	14.366	14.492	14.663	14.818

Nitrous Oxide (N2O)

The net Nitrous oxide (N2O) emissions in Vanuatu is estimated to be 0.241 Gg in 2007 and there is about 5% increase over the period till 2015 (0.253 Gg); However, the average contribution on Net N2O in Va-nuatu's total GHG emission is very minimal about 0.18% of to-tal GHG emissions for the years 2007-2015. The main source of N2O emissions in Vanuatu is from livestock manure management (68.3%), Land man-agement (25%), Waste water (5.2%) and energy sector (1.5%). The fol-lowing table presents N2O emission in Vanuatu for the year 2007-2015.

Table 2.16: Subsector wise N2O Emission Gg : 2007 -2015

Categories	2007	2008	2009	2010	2011	2012	2013	2014	2015
1.A.1 - Energy Industries	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.A.2 - Manufacturing Indus-tries and Construction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1.A.3 - Transport	0.001	0.002	0.002	0.003	0.003	0.003	0.004	0.004	0.004
3.A.2 - Manure Management	0.173	0.175	0.121	0.167	0.172	0.174	0.000	0.177	0.179
3.C.6 - Indi-rect N2O Emis-sions from ma-nure man-agement	0.056	0.057	0.041	0.054	0.056	0.056	0.057	0.057	0.058
4.D - Wastewater Treatment and Discharge	0.010	0.010	0.011	0.011	0.011	0.011	0.012	0.012	0.012
Total N2O Emissions	0.241	0.245	0.175	0.236	0.243	0.246	0.073	0.251	0.253

Other GHGs (PFCs, HFCs and SF6)

Emissions from per-fluorocarbons (PFCs), hydro-flu-orocarbons (HFCs) and Sulphur hexafluoride (SF6) in Vanuatu is negligible; as the products containing these gases are not produced in the country. Emissions from the consumption of Halocarbons and SF6 were not es-timated due to lack of activity data.

Indirect Greenhouse Gases (NOx, CO, NMVOC)

Apart from the direct GHG emissions in Vanuatu; the other indirect emissions of NOx, CO, NMVOC and SO2 takes place; however, they are not main source of the GHGs and have very negligible quantum. Due to lack of data and due to high uncertainty involved estimation of emissions from indirect gases in Vanuatu e.g. NOx, CO,

NMVOC, SO2 not accounted under this GHG inventory for year 2007-2015.

Carbon Dioxide Emissions from the Energy Sector - Reference Approach

The GHG Emissions from the energy sector were estimated using reference and sectoral approaches using IPCC Tier 1 analytical framework. Under the reference approach, GHG emissions were estimated using only the fuel consumption data for each type of fuel. The results of estimated CO2 emissions for the GHG inventory year 2007-2015 using reference approach has been estimated and compared with the CO2 emissions estimated using sectoral approach. The difference between the outputs from the two approaches are presented in the table below, the results are very close within ±1% for most of the years; however difference is substantial for the year 2012.

Table below presents the calculation results using reference and sectoral approach.

Table 2.17: Energy Sector CO2 Emissions using Reference and Sectoral Approach, 2007-2015

Inventory Year	Reference Approach				Sectoral Approach		Difference	
	Apparent Consumption (TJ)	Excluded Consumption (TJ)	Apparent Consumption -Excluding Non-energy uses (TJ)	CO2 Emission (Gg)	Energy Consumption (TJ)	CO2 emission (Gg)	Energy Consumption (%)	CO2 emission %
2007	823.077	8.828	814.248	59.576	820.309	59.959	-1%	-1%
2008	1272.523	28.061	1244.462	90.992	1254.144	91.603	-1%	-1%
2009	1305.337	26.770	1278.567	93.147	1297.223	94.324	-1%	-1%
2010	1780.061	147.613	1632.448	118.590	1632.448	118.590	0%	0%
2011	1965.532	146.494	1819.038	129.852	1838.778	126.320	-1%	3%
2012	1934.882	224.471	1710.411	124.146	1569.688	113.719	8%	8%
2013	1989.620	331.487	1658.134	120.290	1658.134	120.290	0%	0%
2014	2093.339	341.530	1751.809	127.251	1775.004	127.251	-1%	0%
2015	2132.400	367.824	1764.576	128.206	1764.576	128.206	0%	0%

Memo Items

In accordance with 2006 IPCC guidelines, CO2 emissions from International Bunkers and burning of biomass are not included under the national items, only International Bunkers i.e. international aviation and international water borne navigation have been estimated and reported separately as memo items in the inventory.

International Bunkers

International bunkers include international aviation and international water borne navigation. Total CO2 emissions from international aviation and international water borne navigation for the year 2007-2015 were estimated and presented in the following table, while emissions from other gases were insignificant. These emissions are not counted under national total GHG emissions.

Figure 2.12: International Bunker GHG emissions Gg CO2e: 2007-2015

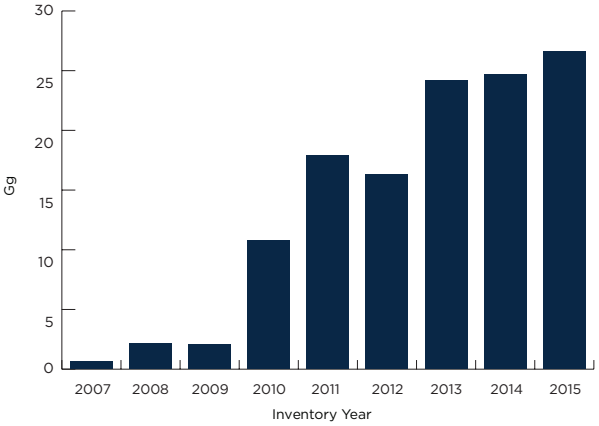


Table 2.18: International Bunkers (Aviation) GHG emissions Gg CO2e trend, 1994-2014

Memo Items (5)	2007	2008	2009	2010	2011	2012	2013	2014	2015
International Bunkers	0.654	2.111	2.013	10.781	17.910	16.274	24.158	24.681	26.658
1.A.3.a.i - International Aviation (International Bunkers)	-	-	-	7.328	13.601	13.829	17.642	22.898	22.915
1.A.3.d.i - International water-borne navigation (International bunkers)	0.654	2.111	2.013	3.454	4.309	2.445	6.517	1.783	3.743
1.A.5.c - Multilateral Operations	NO (Not Occurring)								

Biomass

Vanuatu has a rich bio-diversity and abundance of biomass availability; Biomass has been a major source of energy for Vanuatu with 70% of the population living in rural areas that do not have access to grid connected electricity. Biomass was extensively used by the rural population for cooking, crop drying and other household tasks, rather than diesel powered electricity. A 2004 SPREP analysis estimated the biomass proportion to be around 50% of energy supply; however as the access to modern energy and energy efficiency appliances (solar PV, cookstove etc.) and grid electricity expansion in many regions of Vanuatu as well as population growth suggest that the biomass share has reduced – a broad estimate suggest that biomass now makes up around 30% -40% of gross energy production and further limiting the biomass application in rural Vanuatu.

It is important to note that mostly the rural and some of the urban households use biomass as primary source of energy; Biomass remains the main source of energy for cooking with ~85% of households using wood and coconut shells. However, there is little accurate information available on biomass produced and utilized in Vanuatu, the data collection and QA/QC procedure will be implemented for future inventory report. .

Bio-fuels (Coconut Oil)

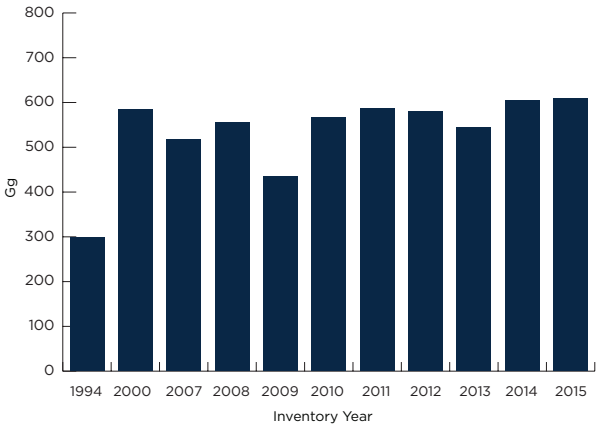
Coconut gardening is one of the major agricultural activities of households in Vanuatu; hence large quantity of coconut oil produced and used as a biofuel. Biofuels (coconut oil) have been used for electricity generation in Vanuatu for a number of years. Diesel generators in the Efate and Malekula grids have been converted by the operator (UNELCO) to be able to both use coconut oil and conventional diesel. The use of coconut oil had its peak in 2013, however, the utilization of the coconut oil as a biofuel is subject to the export of copra and international market prices and demand in the international market. The volatile market price and demand of coconut oil makes it non-competitive to diesel at times. In the year 2015, 5% of the total electricity generated i.e. about 3.23 GWh was from using the coconut oil (963,220 liters of coconut oil). There is a scope to conduct a Life Cycle Analysis (LCA) on Biofuels to determine the net GHG reduction per unit fuel consumed by comparing GHG emissions related to biofuels production and utilization with conventional diesel and gasoline production.

Vanuatu's GHG Emission Trend Analysis

Total GHG Emission Trend: 1994–2015

This section of the report presents an analysis of Vanuatu's Greenhouse Gas (GHG) emission estimates across key emission intensive sectors namely Energy, Agriculture (Livestock, Forestry, and Land-use) and Waste, for the years 1994 to 2015. The total GHG emissions (excluding removals) from Vanuatu presented in the graph below.

Figure 2.13: Vanuatu's Total GHG emissions Gg CO2e: 1994-2015

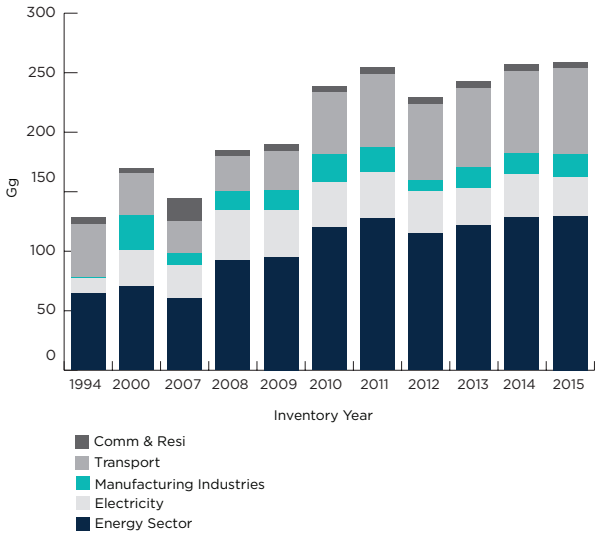


The total GHG emissions of Vanuatu increased from 299.387 Gg in 1994 to 610.214 Gg in 2015 over 20 years; the increase in total GHG emissions depicted due to increase in economic activity and inclusion of additional sectors in GHG inventory over the GHG inventory years. The 1994 GHG inventory year only included the energy and livestock sectors; however following years also included the emission from land use and waste sector. There is minor variation in total GHG emissions, the marginal dip in year 2009 is mainly due to lower economic growth during the period.

Sectoral GHG Emission Trend: 1994–2015

The following section presents the GHG emission trends in major economic and GHG emission sector of Vanuatu i.e. Energy and Livestock for more categoric review and analysis of GHG emission trends in Vanuatu.

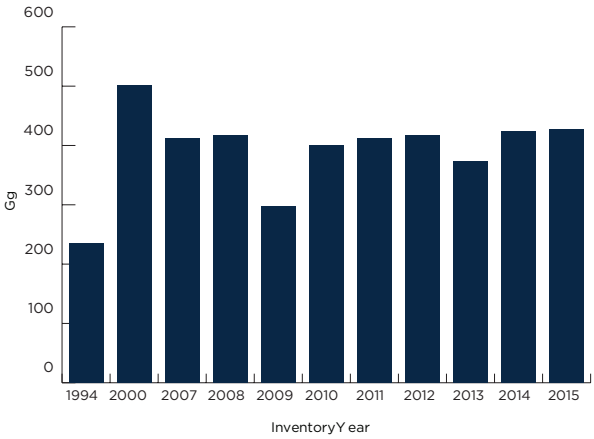
Figure 2.14: Vanuatu's Energy Sector Total GHG emissions Gg CO2e: 1994-2015



Vanuatu's energy sector has seen major increase in total GHG emission during the period 1994-2015.The total energy sector emission in 1994 was about 64.227 Gg CO2e; which is almost doubled (increased 102%) to 129.55 Gg CO2e in the year 2015.

The GHG emission from energy sector is analogues to increase in petroleum consumption in Vanuatu during the period; the consumption of petrol, LPG and diesel has doubled; with the transport sector generating most of the increase (land transport consumes just over 50% of all petroleum products imported for domestic consumption). Diesel used in electricity generation has grown more slowly (dropping a little in the last couple of years) with the introduction of more renewables into the generation mix.

Figure 2.15: Vanuatu's Livestock Sub-sector Total GHG emissions Gg CO2e: 1994-2015



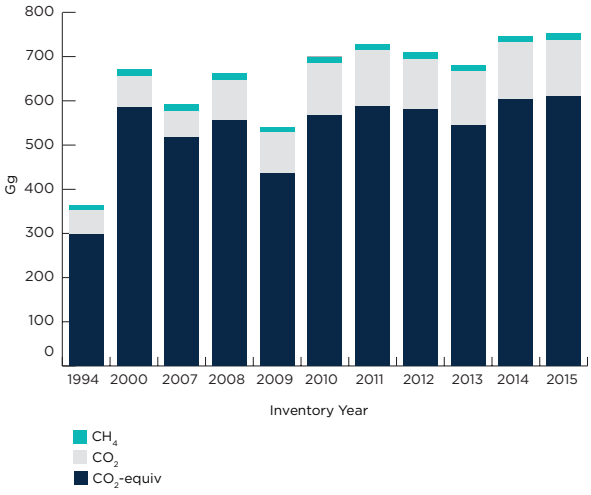
The livestock sector emission in Vanuatu increased from 235.160 Gg CO2e in the year 1994 to 428.09 Gg in 2015. Livestock farming is an important economic activity in Vanuatu, Cattle and Beef export is a source of major revenue for economy. Although cattle are the most important livestock in Vanuatu in terms of their contribution to the economy, the animals such as pigs and chickens are of considerable importance within the context of subsistence agriculture or household activities, both as a source of food and the role these play in the country's culture and customs (especially pigs). However, there is a lack of manure management; hence the emissions form the livestock sector both the enteric fermentation and manure management have the higher share in the total GHG emissions from Vanuatu.

Gas–wise Emission Trend: 1994–2015

The gas wise GHG emissions trend 1994-2015 (Gg CO2 eq.) in Vanuatu presented below; as discussed above the major share of GHG emissions includes CO2, CH4 and N2O respectively. As discuss above, the CO2 emission is mainly forming the energy sector i.e. combustion of the fossil fuel; and CH4 and N2O emissions are mainly attributed from the Agriculture (Livestock and land use) and Waste sector (Municipal Solid waste and waste water).

Likewise, the total GHG emissions the CO2 emission in Vanuatu almost doubled in 2015 comparison to the 1994 emissions i.e. from 54 Gg to 128.21 Gg in 2015. Methane emissions has also seen significant increase from 11.2 Gg in 1994 to 14.82 Gg in 2015; the increase of 32% over the inventory period observed due to poor waste management practices. Further, significant increase over 700% observed in the N2O emission during this period; which is attributed due to livestock and poor land management.

Figure 2.16: Vanuatu's Gas-wise GHG emissions Gg: 1994-2015



The Gas-wise emission trend is expected to follow in future as well considering the increase in fossil fuel consumption in Vanuatu. However, methane and N_2O emissions may also increase significantly, if efficient manure and waste management practices not implemented in near future.

The detailed sectoral and sub-sectoral analysis discussed in the following section of the report.

Vanuatu's GHG Emission Sector Analysis

The previous section of the GHG inventory presents the Vanuatu's GHG Inventory for year 2007-2015 and GHG emission trends from 1994-2015. The emission data suggest three major sectors contributing Vanuatu's 100% GHG emissions i.e. Energy, Agriculture-Livestock and Land Use, and Waste Sector; however, the Forests are the net sink or removal. The following section gives analysis of each of these GHG emission sector and sub-sector analysis.

Energy Sector

As discussed above the energy sector is the predominant emitter of GHGs in Vanuatu. The Energy sector GHG emissions includes emissions from the fuel (fossil fuel or petroleum) combustion activity from Energy Industry (electricity generation), Manufacturing Industries and Construction, Transportation (Road and Domestic aviation and water borne navigation), and Other sectors (Commercial, Institutional and residential); in the nutshell the energy sector emissions are mainly attributed from the combustion of fossil fuel or petroleum.

Vanuatu is net importer of the petroleum product; hence the GHG emission calculation of overall emissions in this sector was relatively straightforward once the imported quantity of fossil fuel was known (activity data). The difficulty for Vanuatu has been in terms of the sectoral breakdown of emissions, given that there were no energy balances for the country available; further the sectoral fuel sales forthcoming from the fuel suppliers/retailers are not available. An attempt was made using some available data from stakeholders and proxy data to estimate the sectoral emissions.

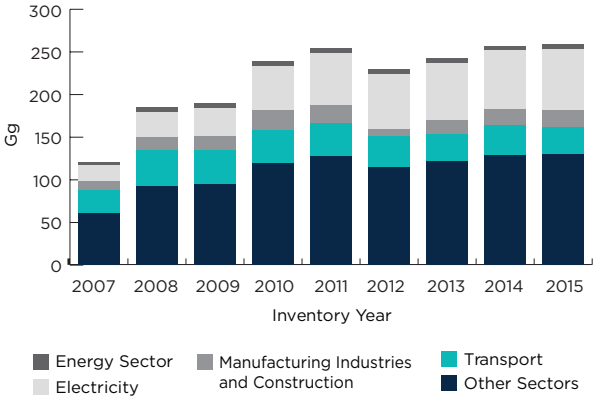
The sectoral data was entered into IPCC Inventory Software (Version 2.54- June 2017) as per the requirement of standard IPCC sectoral model, the IPCC tool was customized for specific requirement of GHG emissions calculation for Vanuatu i.e. by using the default emission factors for energy conversion and IPCC AR5 GHG emission factors.

The result gives a sectoral breakdown of Vanuatu's energy sector CO2 emissions for the period 2007 to 2015. The IPCC inventory software calculates direct CO2 emissions and nonCO2 emissions (CH4 and N2O) for this sector; further other gases like SOx, NOx and NMVOC were negligible and outside the estimated accuracy of the main CO2, CH4 and N2O emissions.

Table 2.19: Energy Sector Emissions (in Gg CO2-equiv): 2007-2015

Categories	Net CO2 Emissions, (CO2 Equivalents Gg)								
	2007	2008	2009	2010	2011	2012	2013	2014	2015
1 - Energy	60.42	92.31	95.10	119.66	127.53	114.87	121.54	128.55	129.55
1.A - Fuel Combustion Activities	60.42	92.31	95.10	119.66	127.53	114.87	121.54	128.55	129.55
1.A.1 - Energy In-dustries	27.73	42.05	39.47	38.02	38.81	35.88	31.68	35.74	32.19
1.A.2 - Manufactur-ing Industries and Con-struction	9.85	16.26	16.21	23.67	20.91	8.96	17.40	17.92	19.94
1.A.3 - Transport	18.93	29.28	33.08	52.09	62.04	63.95	66.72	69.56	72.14
1.A.4 - Other Sec-tors	3.92	4.72	6.34	5.88	5.77	6.08	5.74	5.33	5.28
1.B - Fugitive emis-sions from fuels	NO (Not-Occurring)								
1.C - Carbon dioxide Transport and Storage	NO (Not-Occurring)								
Total GHG Emissions, excl. Removals	517.41	556.06	435.65	566.82	587.79	581.13	545.30	604.26	610.20
% Share of Energy Sec-tor in Total GHG emis-sions	12%	17%	22%	21%	22%	20%	22%	21%	21%

Figure 2.17: Vanuatu's Energy Sector GHG emissions Gg: 1994-2015

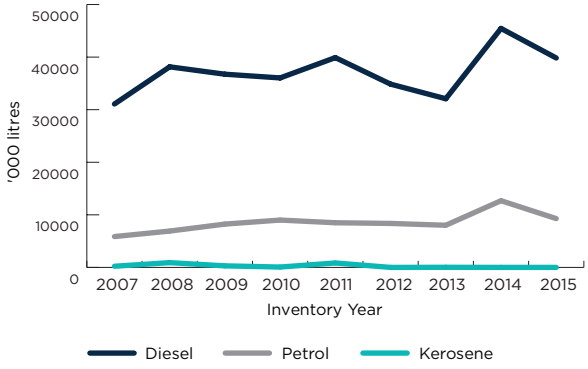


Vanuatu's energy supply comes principally from biomass and imported petroleum product. Biomass is mainly used for residential purposes for cooking and crop drying; however, petroleum products are important inputs into major sectors of the economy – electricity, industry, tourism, transportation, fishing and agriculture. Petroleum consumption has increased rapidly over the years, at an annual average rate of 6%.

Petroleum products (Diesel, Petrol, Kerosene, Avgas and jet fuel) supplied to Vanuatu by Pacific Petroleum Company (PPC) from Singapore; however, LPG is solely imported and supplied by the Origin Energy (Origin) from Brisbane as part of a supply schedule covering a number of island countries in the region. Distribution of fuel within Vanuatu is done in two ways: Port Vila and Santo use tanker trucks for bulk deliveries; the outer islands are shipped fuel in 200-liter drums and LPG bottles filled from the bulk terminals in Port Vila and Santo.

The Vanuatu market for petroleum and LPG is small by regional standards, with annual domestic demand of around 56 million liters (including 3 million liters of LPG) or about 10% of the size of Fiji's market. The petroleum import for the period 2007-2015 (excluding avgas, jet fuel, LPG and storage) presented in Figure 18:

Figure 2.18: Vanuatu's Fuel Import ('000 Litres, Source QSI Reports): 2007-2015



Once diesel use for electricity is excluded, consumption of petrol, LPG and diesel has doubled; with the transport sector generating most of the increase (land transport consumes just over 50% of all petroleum products imported for domestic consumption).

Diesel used in electricity generation has grown more slowly (dropping a little in the last couple of years) with the introduction of more renewables into the generation mix.

Based on current trends and projected growth rates (GDP growth assumed at 4%), petroleum demand is expected to nearly double by 2022 (approximately 100 million liters). Increases are expected to be highest for land transport fuels (petrol and diesel) based on correlation with historical growth rates. Kerosene (for aviation use) will be influenced by operating efficiencies achieved by airlines and may not see substantial increases in demand, despite increases in tourist numbers. Electricity demand for diesel will be subject to development plans for renewables - continued support for renewables, diesel demand for electricity generation to grow at less than forecast GDP.

The Government of Vanuatu (GoV) has identified addressing the cost of energy and security of supply as two of Vanuatu's development priorities. Vanuatu's National Energy Roadmap (NERM) 2013-2020, identified a number of priorities for petroleum including; Reduced reliance on imported petroleum; Strengthening of the legislative and regulatory framework and; Risk management (including physical storage and financial hedging) to reduce exposure to high and volatile petroleum prices.

Following table presents a summary of total fuel consumption in energy sector during the inventory year 2007-2015.

Table 2.20: Energy Sector Emissions (in Gg CO2-equiv): 2007-2015

	Aviation Gasoline (AVG)	Gasoline/Petrol	Gas / Die-sel Oil	Jet Kero-sene (DPK)	Kerosene	Liquefied Petroleum Gas (LPG)
	Litres	Litres	Litres	Litres	Litres	Ton
2007		3283011	19190627		237740	430
2008		5323700	29442795		337480	687
2009		5835901	29251597		202400	1271
2010	170268	7924825	35079519	4798261	163499	1750
2011	310414	8683772	37055031	7805206	123500	1321
2012	374912	8745602	35197911	8171266	92450	1737
2013	578495	8715936	35306983	9526270	76400	1684
2014	467224	8804065	36070471	11828233	41000	1610
2015	523164	8990919	37321545	11490630	28800	1584

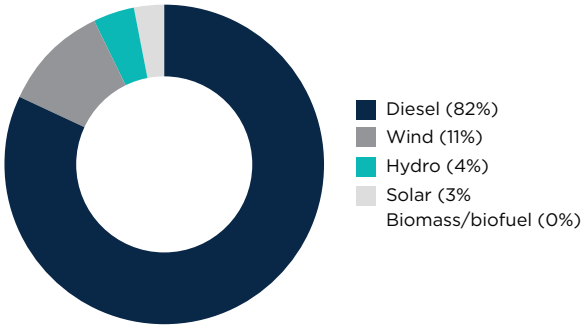
Energy Industries – Electricity Generation

Vanuatu has a total installed capacity of approximately 37 GW; however, the rate of electrification is very limited, about 33% mainly due to remoteness of islands and terrain difficulties for grid expansion and high cost of renewable energy. Out of 50,740 number of total households in Vanuatu, only 16,571 number of households having access to grid/mini-grid electricity or renewable energy based own generation. However, the overall peak demand in Vanuatu has been constantly increasing from 2007 to 2015 and reached to 14.2 MW.

The grid electricity generation is operated by two electricity generation entities i.e. the Vanuatu Utilities and Infrastructure Limited (VUI) and UNELCO; and supply electricity in four concession areas of Port Vila, Luganville , Malekula (Lakatoro) and Tanna (Lenakel). The Utilities Regulatory Authority (URA) of Vanuatu regulates the electricity sector in Vanuatu.

The following figure depicts the total installed capacity and break-up of installed capacity based on source of electricity generation Diesel and Bio-fuel (82%) followed by, Wind Power (11%), Hydro Power (4%), and Solar Power (0.2%).

Figure 2.19: Vanuatu's Existing Installed Capacity 2015



As shown in the figure, Diesel based generation is the main source of electricity, having the total installed capacity of about 30 MW. The electricity generation sector is the second largest end user of petroleum products; as diesel is the largest volume imported (over 80% of total import or on an average 37 million liters) as it is mainly used in transportation sector and electricity generation (18 million liters including use for outer islands generation). The grid connected power plants in Port Vila, Santo and Malekula and Tanna are estimated to use 76% of this fuel, leaving 24% for outer islands use.

The total Diesel consumption for electricity generation during the inventory period presented in the table be-

low; notably the Diesel used in electricity generation has grown more slowly (dropping a little in the last couple of years) with the introduction of more renewables into the generation mix. In near future the diesel consumption and emission due to electricity generation is expected to increase considering the new capacity addition and increased target of electrification in Vanuatu as per NERM-2016-2030.

Table 2.21: Fuel Consumption for Electricity Generation: 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
	Litres	Litres	Litres	Litres	Litres	Ton	Litres	Litres	Ton
Gas / Diesel Oil	10426117	15808980	14840500	14295306	14590904	13489193	11910108	13438140	12103880
Gasoline / Petrol	-	-	-	-	800	400	400	600	800

The generation efficiency of the Diesel Generation Plants is also an important aspect of higher diesel consumption in energy sector. In the year 2012, the specific consumption of diesel was 216.1 grams per kWh of electricity generated; however, during 2015 the average specific diesel consumption reached to on average, 218.0 g/kWh, which is a deterioration of 0.9% compared to the 2012.

Government of Vanuatu has identified this is an important aspect for energy security and affordable energy; further an indicator on diesel generation efficiency (Indicator 4: Improve the efficiency of diesel) has been included in the Vanuatu's National Energy Road Map (NERM 2016 – 2030).

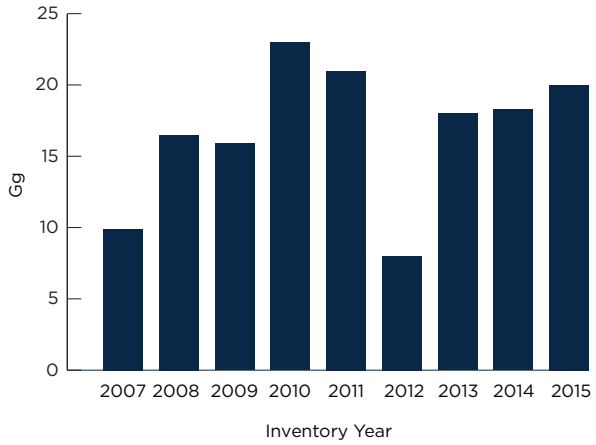
Manufacturing Industries and Construction

Manufacturing Industries and Construction sub-sector of energy sector is the 3rd largest GHG emitter and fossil fuel consumer in Vanuatu. The emission from this sector is mainly CO2 emission from the consumption of fossil fuel. Following table and graph present the total fuel consumption and total GHG emissions from the manufacturing and construction sector during the inventory year 2007-2015.

Table 2.22: Fuel Consumption in Manufacturing and Construction Sector : 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gas / Diesel Oil (litres)	2895365	4808785	4715083	6749177	6110188	1530830	4903411	5114873	5802046
Gaso-line/Petrol (litres)	681400	1144900	1028200	1528000	1456424	1530830	1321900	1351663	1427919
Kerosene (litres)	81700	97260	56200	52000	33600	62700	59000	29000	23400
Aviation Gasoline (AVG) (li-tres)	-	-	-	800	-	200	1034	-	200
Jet Kero-sene (DPK) (litres)	-	-	-	329500	-	200	-	-	-
Liquefied Petroleum Gas (LPG) (Ton)	128	204.691	394.421	420.552	417.3458	413	396	388	399

Figure 2.20: GHG Emission from Manufacturing Industries and Construction Sub-sector: 2007- 2015



Vanuatu has a small light-industry sector mainly catering to the local market. The Manufacturing, Industry and Construction sub-sector comprises the manufacturing, construction, quarry, wholesale and retail sectors, although currently making a minor contribution to Vanuatu GDP. Manufacturing value added, at around 4% of GDP in 2015; however Vanuatu has untapped potential to move up the industrial value chain. Organic beef from Vanuatu is well-known throughout the Pacific and exported as far as Japan and Norway, wood processing and coffee industry have good potential and under-exploited as of now.

The manufacturing sector in Vanuatu is primarily related to fish processing, copra and various coconut products as well as growing beef industry. The primary manufacturing industries includes:

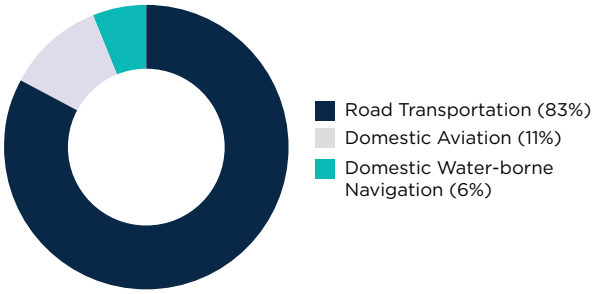
- Agriculture Industries
- Livestock Industries
- Forestry Industry
- Fisheries Industry

As shown in the above graph the manufacturing industries and construction sub-sector has shown un-even distribution of fuel consumption and respective overall GHG emission, this is largely due to critical nature of the industries and multiple international and domestic issues. This sub-sector is largely depending on the international export and market prices, the volatility of both affects the overall performance of the sub-sector. The construction sub-sector in Vanuatu has also seen negative growth during the inventory years. The construction activity is being driven by private-sector retail, residential and a number of donor-funded government construction projects mostly on the island of Efate, particularly in Port Vila. The slow construction activity and scrapping of some key projects hampered the growth. The manufacturing, industries and construction sector in Vanuatu has shown considerable potentials for growth despite alleged high costs of production and low utility rates on production facilities given low supply of raw materials for certain products. Given the manufacturing, industry and construction favoring policies and support of the government, domestic and international organization; the emission from this sub-sector will steadily increase in future.

Transport Sub–sector

Transport sub-sector is the largest GHG emitter and fossil fuel consumer of energy sector in Vanuatu. The transport sector includes the inland road transport, domestic aviation and domestic water borne navigation; the international aviation and international water borne navigation includes as the memo item and not part of this GHG inventory. The land transport consumes just over 50% of all petroleum products imported for domestic consumption. The total fuel consumption during the inventory years 2007-2015 and GHG emissions from the transport sector are depicted in the following charts:

Figure 2.21: Transport Sector Fuel Consumption and GHG Emission Share: 2007-2015



As shown in the graph, among the transport sector; road transport's share in total fuel consumption (83%) and GHG emissions is higher than the domestic aviation (11%) and domestic water borne navigation (6%). The road transport emission is mainly due to higher number of land transport vehicle registered, no specific regulations governing the fuel efficiency in transport sector (vehicle standards). The price of transport services such as buses, taxis, airfares and shipping are not regulated or are regulated in part. The public transport system in Vanuatu consists of privately-owned minibuses that run unspecified routes through Port Vila and Santo. However, detailed assessment for this is difficult because of the lack of good data on Vanuatu's current vehicle fleet and systems for monitoring continued improvement in the fuel economy of vehicles.

Table 2.23: Fuel Consumption in Transportation Sector : 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
1.A.3.a.ii - Domestic Aviation									
Aviation Gasoline (AVG)				169264	306690	371585	575943	463824	514444
Jet Kerosene (DPK)				1610965	2503728	2780085	2646973	2889757	2559194
1.A.3.a.ii - Domestic Aviation									
Gas / Diesel Oil	3836151	6084040	7081077	11049674	12903742	13009717	13719336	14260344	15068310
Gasoline/Petrol	2342811	3788200	4474361	6088825	6895348	6913071	7109236	7108202	7208200
Kerosene	78000	125600	80200	89499	64300	7350	3800	2400	1400
1.A.3.a.ii - Domestic Aviation									
Gas / Diesel Oil	1044609	1317388	1189329	1203177	1414006	1781039	1868095	2213760	2518565
Gasoline/Petrol	55600	91200	81200	75600	65800	29201	34600	61400	109900
Kerosene	1840	3220	2000	1800	400	600	200	600	0
Jet Kerosene (DPK)								10800	200

Figure 2.22: Private Motor Vehicle Registrations: 2007-2015

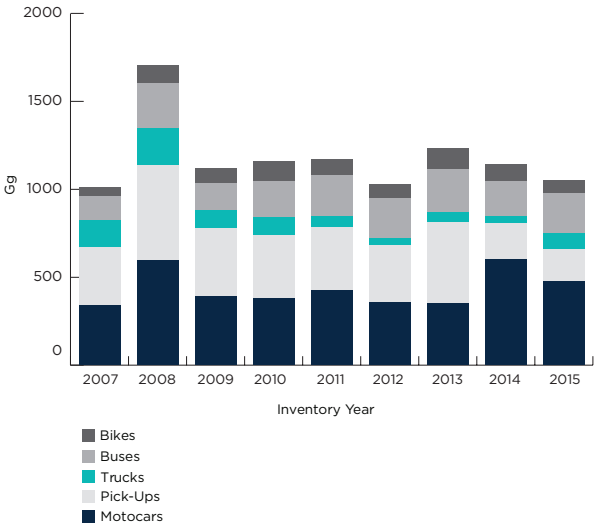


Figure 22 presents the private vehicle registered during the inventory year 2007-2015; however, no records are available for the vehicles de-registered or gone off road during the period.

Given the transport sector accounts for over half of Vanuatu's domestic petroleum demand (which excludes bunkering and international aviation), improvements in the efficiency of usage of fuels in the transport sector are a key area for Vanuatu's energy strategy. In the near future Increases in consumption are expected to be highest for land transport fuels (petrol and diesel) based on correlation with historical growth rates. Kerosene (for aviation use) will be influenced by operating efficiencies achieved by airlines and may not see substantial increases in demand, despite increases in tourist numbers.

Figure 2.23: Private Motor Vehicle Registrations: 2007-2015

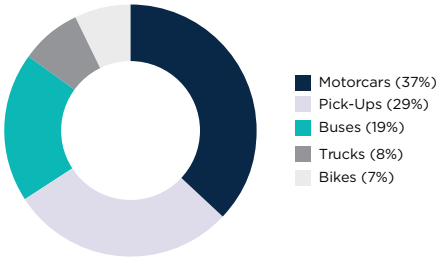


Table 2.24: Actual and projected number of land vehicles in use (registered and non-registered)

Vehicle Type	2010	2015	2020	2025	2031
Registered = Port Vila & Luganville	4,956	6618	7737	8742	9744
Estimated Growth		4%	3%	2%	2%
Non-Registered = Rural Areas [Estimated]	552	645	781	905	1021
Estimated Growth		4%	3%	3%	2%

Improvements in data collection regarding land vehicles by the GoV would enable an improved analysis of land transportation trends, for example, data collection by category of end-user (residential, public, commercial/ industrial). Data collection by fuel type (diesel, gasoline or other) and engine sizes/cylinder capacity sizes would also enable further and more in-depth analysis of transport sector energy usage.

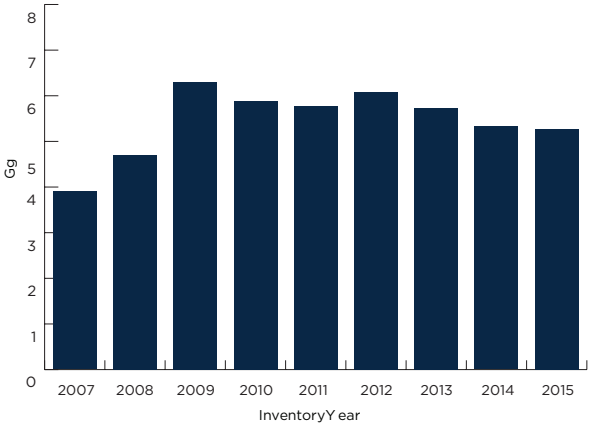
Other Sector – Commercial, Institutional and Residential

The others sub-sector of energy sector includes direct fuel consumption mainly in commercial, institutional, Residential and any other uncategorized and unorganized sector or purposes; this includes Hotels, tourism bungalow, guest houses, restaurants, retail, shopping complexes etc. The total fuel consumption in these other sector during the inventory year is as follows:

Table 2.25: Fuel Consumption in Other Sectors : 2007-2015

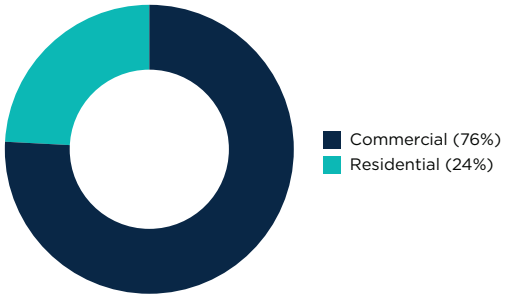
	2007	2008	2009	2010	2011	2012	2013	2014	2015
Gas / Diesel Oil	742900	640351	687370	499900	435650	552597	486562	382900	
Gaso-line/Petrol	201800	298200	241200	231600	265000	263800	248200	279600	
Kerosene	76200	111400	64000	20200	25000	21800	13400	9000	
Commercial/Institutional									
Gaso-line/Petrol					200			600	242000
Kerosene					200				4000
Gas / Diesel Oil									441100
Gaso-line/Petrol									600
Liquefied Petroleum Gas (LPG)	309	493.208	907.096	936.735	928.983	945	940	919	900
Residential	14.057	14.272	10.531	13.776	14.180	14.366	14.492	14.663	14.818
Liquefied Petroleum Gas (LPG)	121	193.72	363.662	392.845	392	379	348	303	285

Figure 2.24: GHG Emissions in Gg from Other Sub-sector : 2007-2015



The overall fuel consumption in these sub-sectors is mainly used for the electricity generation and lighting (Diesel and Petrol Generation Sets), since the grid connectivity is limited in outer islands and reliability of the grid availability is also a concern within the grid connected area. Government of Vanuatu has an ambitious plan to expand the grid connectivity and promoting the off-grid renewable electricity generation via renewable sources (solar PV etc.), hence the direct fuel consumption for lighting and electricity generation is expected to reduce over the period of time.

Figure 2.25: LPG Consumption in Residential and Commercial Sub-sector :2007-2015



The penetration of modern cooking technology and fuels is limited in Vanuatu. The annual domestic demand of LPG is around 3 million liters; Origin is the sole importer and marketer of LPG; Origin operates bulk storage receiving facilities in Port Vila and Santo, and supply is made to the market via a mix of road tanker and bottles ranging from 4, 9, 11 and 45 kg.

The Residential and Commercial sub-sector is main consumer of the Liquefied Petroleum Gas (LPG) for cooking purposes. Kerosene is also used for cooking in some of the households. The major challenge in use of LPG is two-prong i.e. availability in the outer island and affordability. Further, the easy and cheap access of the biomass also discourage people to opt for the cleaner fuel.

In near future the stability and expansion of the electricity grid would reduce the direct fuel consumption in this sector; however, the LPG consumption is expected to marginally increase due to awareness, affordability and access to modern cooking fuel for residential sector.

Industrial Processes and Product Use (IPPU)

This sector covers GHG emissions from industrial processes as an output of non-energy related activities. As per the IPPC guidelines; the IPPU sector major emissions source categories includes : Cement production, lime production, iron and steel industry, adipic acid and nitric acid production, aluminium production, magnesium production, sulfur hexafluoride (SF6) emissions from electrical equipment, and from other sources, perfluorocarbons (PFC), hydrofluorocarbons (HFC) and SF6 emissions from semiconductor manufacturing, emissions of substitutes for ozone depleting substances (ODS substitutes) including seven sub-source categories, and HCFC-22 manufacture.

Table 2.26: IPPU Sectoral GHG Inventory of Anthropogenic Emissions

Categories	Remarks
2 - Industrial Processes and Product Use	Not Occurring (NO)
2.A - Mineral Industry	
2.B - Chemical Industry	
2.C - Metal Industry	
2.D - Non-Energy Products from Fuels and Solvent Use	
2.E - Electronics Industry	
2.F - Product Uses as Substitutes for Ozone Depleting Substances	Not Estimated (NE)
2.F.1 - Refrigeration and Air Conditioning	Not Estimated (NE)
2.F.2 - Foam Blowing Agents	Not Occurring (NO)
2.F.3 - Fire Protection	
2.F.4 - Aerosols	
2.F.5 - Solvents	
2.F.6 - Other Applications (please specify)	
2.G - Other Product Manufacture and Use	Not Estimated (NE)
2.G.1 - Electrical Equipment	Not Estimated (NE)
2.G.2 - SF6 and PFCs from Other Product Uses	
2.G.3 - N2O from Product Uses	Not Occurring (NO)
2.G.4 - Other (Please specify)	
2.H - Other	Not Occurring (NO)

In Vanuatu this sector is non-existence in the absence of any major industry or industrial process emissions. This sector also comprises emissions from solvent and other product use containing volatile compounds (primarily Non-Methane Volatile Organic Compounds). Vanuatu doesn't import any solvents or refrigerants and ODS directly, small amount of refrigerant and ODS used in equipment (AC&R) only.

Hence, GHG emissions from this sector considered as not occurred for the inventory years 2007-2015.

Agriculture, Forestry, and Other Land Use (AFOLU)

The agriculture sector is the major contributor of methane emissions in Vanuatu and is also the top contributor of GHG emissions in Vanuatu. However, the forestry sector is the net carbon sink and makes the Vanuatu net carbon emissions negative.

Table 2.27: AFOLU Sector GHG Inventory of Anthropogenic Emissions

Categories	Remarks
3 - Agriculture, Forestry, and Other Land Use	
3.A - Livestock	Estimated
3.A.1 - Enteric Fermentation	Estimated
3.A.2 - Manure Management	Estimated
3.B - Land	
3.B.1 - Forest land	Estimated
3.B.2 - Cropland	Not Estimated
3.B.3 - Grassland	Not Estimated
3.B.4 - Wetlands	Not Estimated
3.B.5 - Settlements	Not Estimated

3.B.6 - Other Land	Not Estimated
3.C - Aggregate sources and non-CO2 emissions sources on land	
3.C.1 - Emissions from biomass burning	Not Estimated
3.C.2 - Liming	Not Estimated
3.C.3 - Urea application	Not Estimated
3.C.4 - Direct N2O Emissions from managed soils	Not Estimated
3.C.5 - Indirect N2O Emissions from managed soils	Not Estimated
3.C.6 - Indirect N2O Emissions from manure management	Estimated
3.C.7 - Rice cultivations	Not Occurring
3.C.8 - Other (please specify)	Not Occurring
3.D - Other	Not Occurring
3.D.1 - Harvested Wood Products	Not Occurring
3.D.2 - Other (please specify)	Not Occurring

Emissions in this sector are estimated for following categories:

- Livestock Farming
  - Enteric Fermentation
  - Manure Management
- N2O Emissions from managed soils
- Forestry Sector (net removal)

Emissions due to rice cultivation and burning of Savannas do not occur in Vanuatu while emissions from field burning of agricultural residues have not been estimated due to lack of data. Data used for estimating GHG emissions from agriculture sector were from national livestock statistics and Department of Agriculture. These were also crosschecked and confirmed with FAO data. Since use of fertilizers in Vanuatu is very limited and records are not available for GHG Inventory years 2007-2015, emissions from use of fertilizer are not estimated under the agriculture sector.

The emissions from agriculture sector in Vanuatu is the largest contributor and account for average about 74% of Vanuatu's total GHG emissions for the year 2007-2015. It can be observed from Table below, that GHG emissions from agriculture sector have increased since 2007. This increase is primarily due to increase in livestock farming and N2O emissions from managed soils were not estimated under the Initial National Communication.

Table 2.28: AFOLU Sector GHG Emission in Gg (excluding Removal): 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
3 - Agriculture, Forestry, and Other Land Use (AFOLU)									
3.A - Livestock	412.6	418.3	298.4	400.6	412.3	417.2	373.6	424.3	428.1
3.A.1 - Enteric Fermentation	298.3	301.5	187.1	285.8	294.6	298.1	299.9	303.5	306.6
3.A.2 - Manure Management	114.4	116.8	111.3	114.8	117.8	119.1	73.7	120.8	121.5
3.B - Land	-7021.2	-7021.2	-7021.2	-6973.7	-6973.7	-6973.7	-6973.7	-6973.7	-6973.7
3.B.1 - Forest land	-7021.2	-7021.2	-7021.2	-6973.7	-6973.7	-6973.7	-6973.7	-6973.7	-6973.7
3.C - Aggregate sources and non-CO2 emissions sources on land	14.8	15.0	10.9	14.3	14.8	14.9	15.0	15.2	15.3
3.C.6 - Indirect N2O Emis-sions from manure management	14.8	15.0	10.9	14.3	14.8	14.9	15.0	15.2	15.3
AFOLU Sector Total (Excl. Re-movals)	427.4	433.3	309.2	414.9	427.1	432.1	388.6	439.5	443.4
AFOLU Sector (Incl. Removals)	-6593.7	-6587.8	-6711.9	-6558.8	-6546.6	-6541.6	-6585.1	-6534.2	-6530.3

Figure 2.26: AFOLU Sector GHG Emission in Gg (excluding Removal) : 2007-2015

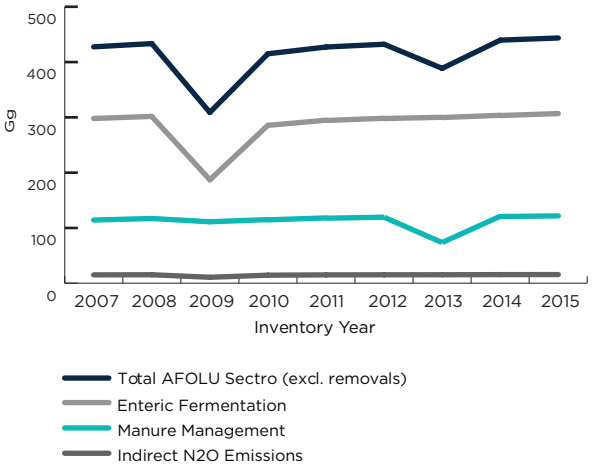
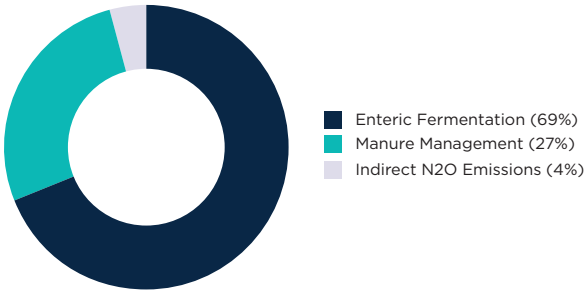


Figure 2.27: AFOLU Sector GHG Emission Share (excluding Removal) : 2007-2015



Emissions from the agriculture sector are primarily composed of methane and nitrous oxide. However, emissions of indirect GHGs such as CO and NOx are considered negligible and are not estimated. As shown in the graph the major share of the GHG emission of AFOLU sector is from the Livestock farming – enteric fermentation (69%) and manure management (27%) and rest comes from the indirect N2O emission from manure/land management (4%). This is due to large livestock farming practice in Vanuatu and animal gazing practices. The sub-sector analysis in following section gives details information on these GHG contributor sub-sectors.

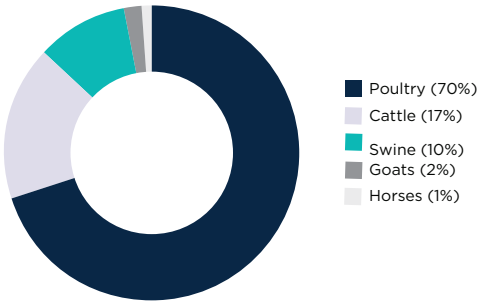
Livestock

The livestock sector is a major contributor to food security and an is essential component of livelihood for a vast majority of the people of the Republic of Vanuatu. The sector plays an important role in local cultures and the economic development of Vanuatu. Vanuatu has large livestock population; however, yet to realize its full potential in the livestock sector. The data and information on the total livestock population and livestock farming practices are very limited in Vanuatu. The major information available on the livestock and beef export. The data used for the inventory year 2007-2015 is based on the national agriculture census-2007, Census of Population and Housing 2009, and FAO published data. The following table present the data used for estimation of GHG emissions from the livestock sector.

Table 2.29: Livestock Population: 2007-2015

Livestock Population	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cattle	1,74,152	1,75,000	1,05,051	1,65,000	1,70,000	1,72,000	1,73,000	1,75,000	1,76,674
Goats	8,792	19,500	34,086	22,000	24,000	25,000	25,000	26,000	26,803
Horses	4,000	4,500	5,559	6,000	6,000	6,000	6,200	6,500	6,778
Swine	86,698	89,000	1,08,056	90,000	92,000	93,000	94,000	94,000	94,216
Poultry	3,68,251	8,04,000	4,68,779	6,00,000	7,00,000	7,00,000	7,50,000	8,00,000	8,19,000
Total	**6,41,893**	**10,92,000**	**7,21,531**	**8,83,000**	**9,92,000**	**9,96,000**	**10,48,200**	**11,01,500**	**11,23,471**

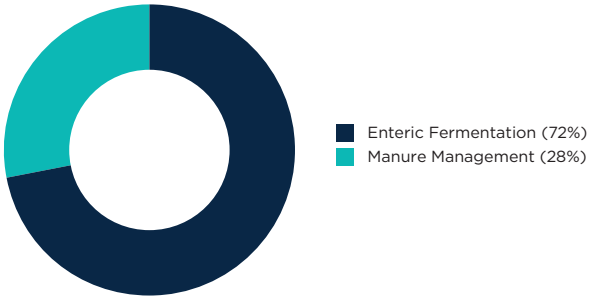
Figure 2.28: Livestock Category wise Population : 2007-2015



The livestock farming in Vanuatu has diverse structure including the unorganized small household farmers to Commercial Livestock Production Farms. The smallholder livestock production is the main provider of meat protein to the informal sector for cultural, religious and other community-based activities; however, the commercial livestock production has been the mainstay of meat protein provider to Vanuatu and export markets. The lack of detailed data and information of the livestock sector leads to certain assumption like the bifurcation of the total cattle population not possible hence considered as other cattle. Further, no information in animal grazing and pasture and manure management system; which leads to using the standard IPCC values.

The livestock sub-sector GHG emission for the inventory year summarized below:

Figure 2.29: Livestock GHG Emissions Share



Enteric Fermentation: Enteric Fermentation is the fermentation that takes place in the digestive system of animals. In particular in ruminant animals (cattle, buffalo, sheep, goats) methane is produced in the rumen by the bacteria as a by-product of fermentation process. This methane when released adds to GHG emission in the atmosphere. Enteric fermentation accounts for 72% of GHG emissions from Livestock farming in Vanuatu. Cattle account for the majority of methane emissions in this category. The subtropical environment of Vanuatu is well suited for cattle farming. This provides a conducive environment for cattle farming in Vanuatu, which has increased significantly since 1994 and hence is a significant source of GHG emissions in the country.

Manure Management: Systematic management of manure from livestock is not practiced in Vanuatu. There is limited data available on management of manure from cattle, swine, poultry, horses and goats excretion. Hence, GHG emission for manure management is estimated based on default values provided in IPPC-2006 guidelines. In Vanuatu, GHG emissions from manure management amount to 28% of GHG emissions from livestock farming sector. This can be reduced by introducing animal waste management systems.

N2O Emissions from managed soils: Emissions of N2O from managed soils are primarily due to the microbial processes of nitrification and de-nitrification. Emissions from this category constitute 4% of total CO2 emissions from agriculture sector. Due to limited data available on usage of fertilizers in Vanuatu for the inventory years 2007-2015, only emissions due to animal waste are taken into account.

Forest

Vanuatu's total land area is about 12,336km2 with more than 36.1% (440,000 hectares) covered by tropical forest. About 4,800 hectares were covered with planted forests; about 3% of the mid-to high forest (about 6,000 hectares) and 0.7% of the low forest (about1,400 hectares) are in protected areas. Though limited information available on the forest conversion or change in forest, but the discussion with the forest department and data published by FAO shows there is no significant change in forest cover area since year 2000 including the current GHG inventory year 2007-2015. However, this situation is changing now. Vanuatu is utilizing more forests than is being planted and some of the customary landowners are developing their logged forest areas for other activities, like rearing of cattle, or in coastland lowland areas of Efate and east Santo for real estate development.

The forest of Vanuatu are also home for some 108 known species of amphibians, birds, mammals and reptiles and also home to at least 870 species of vascular

plants. The coastal region is also rich in sea life, with more than 4,000 species of marine molluscs. Coral reef systems fringe most islands in Vanuatu; the Reef Islands are a cluster of coral cays between Mota Lave and Ureparapara, in northern Vanuatu. Mangroves are also an important part of the ecosystem of Vanuatu, including sea grass beds and other near-shore marine ecosystems. However, no data or detailed information available on mangrove plantation or covered area.

Table 2.30: Vanuatu: Land Area and Forest Cover: 2007-2015

Total Land Area (Hectare)	1219,000	100%
Forest Cover Area (Hectare)	440,000	36.3%
Other Wooded Land (Hectare)	475,000	39.3%
Other Land (Hectare)	297,000	24.4%

For the GHG inventory year 2007-2015, under Land Use Change and Forestry sector, CO2 emissions/removals are estimated for changes in forest and other woody biomass stock including commercial logging. Due to lack of data, emissions/removals from forest and grassland conversion, abandonment of managed lands and CO2 emissions from soil have not been estimated. The data for estimation of CO2 removals from forests is based on discussions and reports from Department of Forests which were also crosschecked and confirmed with FAO published data for Vanuatu.

Table 2.31: Forests Land: Loss of carbon from wood removals

Wood Removal	Unit	2007-2015
Wood fuel, non-coniferous	m^3/year	91,000
Saw logs and veneer logs, non-coniferous	m^3/year	28,000
Sawn wood, non-coniferous all	m^3/year	14,000
Other industrial roundwood, coniferous (2010-2015)	m^3/year	10,000*

The land-use change and forestry sector since forest land remaining forest land and considering the average annual above-ground biomass growth; however there is loss of carbon from wood removals (as listed above). The Forestry sector remains the net sink of CO2 in Vanuatu. Notably the first national communication (INC), emissions from Land Use Change and Forestry were estimated only for commercial forestry and commercial plantations. The current inventory also considers biomass growth for GHG estimation.

The CO_2 removals from the forestry sector are estimated for the GHG inventory year 2007-2015 presented in the table below:

Table 2.32: Forestry Sector: CO2 removals: 2007-2015

	Annual increase in biomass carbon stocks due to biomass growth	Annual carbon loss due to biomass removals	Net Annual Carbon Uptake (+) or Release (-)	Convert to CO2 Annual Emission (-) or Removal (+)
	(tonnes C yr^{-1})	(tonnes C yr^{-1})	(tonnes C yr^{-1})	(Gg CO_2)
2007 - 2009	2109800	194938.45	1914861.55	(+) 7021.15
2010 - 2015	2109800	207884.95	1901915.05	(+) 6973.68

The prominence of carbon sequestration in the national GHG inventory reflects national forest policy that regards forests as crucial for the wellbeing of the ni-Vanuatu population to furnish essential needs such as wood, food, fodder and traditional remedies.

Waste Sector

The waste sector of Vanuatu comprises mainly solid waste and waste water. This section present the estimated emissions of methane from the waste sector for the national Greenhouse Gas Inventory 2007-2015.

Categories	Remarks
4 - Waste	
4.A - Solid Waste Disposal	Estimated
4.B - Biological Treatment of Solid Waste	Not Occurring
4.C - Incineration and Open Burning of Waste	Not Estimated
4.D - Wastewater Treatment and Discharge	Estimated
4.E - Other (please specify)	Not Occurring

This sector contains mostly methane (CH4) and Nitrous oxide (N2O) emission estimate from the following key categories:

- Solid Waste Management and Disposal (excluding biological waste)
- Domestic and Commercial wastewater handling (there is no industrial waste water generation)

Methane emissions from waste sector for 2007 – 2015, presented following graph and table below. The total GHG emissions increased from 29.548 Gg CO2e in 2007 to 37.275 Gg CO2e in 2015, showing a net increase of 26.15% during the GHG inventory years 2007-2015. However, share of waste sector in total GHG emissions from Vanuatu remains constant i.e. about 6% during the inventory period of 2007-2015.

Figure 2.30: Waste Sector Emissions Gg CO2e: 2007-2015

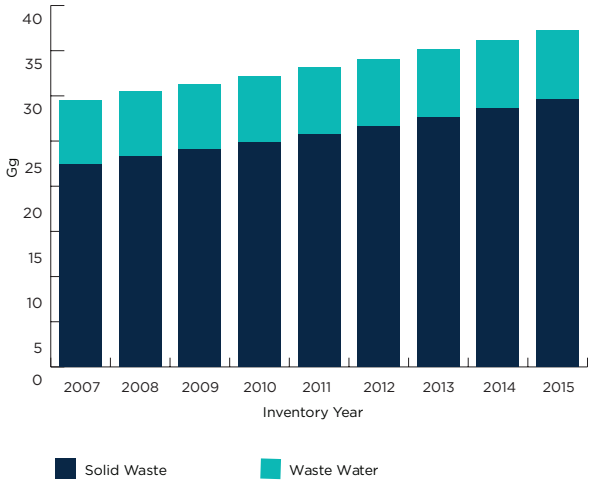


Table 2.33: Waste Sector GHG Emissions (Gg CO_{2e}): 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
4 - Waste	29.5	30.4	31.3	32.2	33.2	34.2	35.2	36.2	37.3
4.A - Solid Waste Disposal (MSW)	22.4	23.3	24.1	24.9	25.8	26.7	27.7	28.6	29.6
4.D - Wastewater Treatment and Dis-charge (WW)	7.1	7.2	7.2	7.3	7.4	7.4	7.5	7.6	7.7

Table 2.34: Waste Sector GHG Emissions (Gg): 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total CH4 emissions (MSW)	0.8	0.83	0.86	0.89	0.92	0.95	0.99	1.02	1.06
Total CH4 emissions (WW)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Total CH4 emissions (Waste Sector)	0.96	0.99	1.02	1.05	1.08	1.11	1.14	1.18	1.22
Total N2O emissions	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total CO2 eq	29.55	30.43	31.33	32.24	33.18	34.15	35.16	36.20	37.28

* For display purposes, the data has been rounded off to 2 decimal places

Figure 2.31: Waste Sector Emissions Gg CH_4 and N_2O: 2007-2015

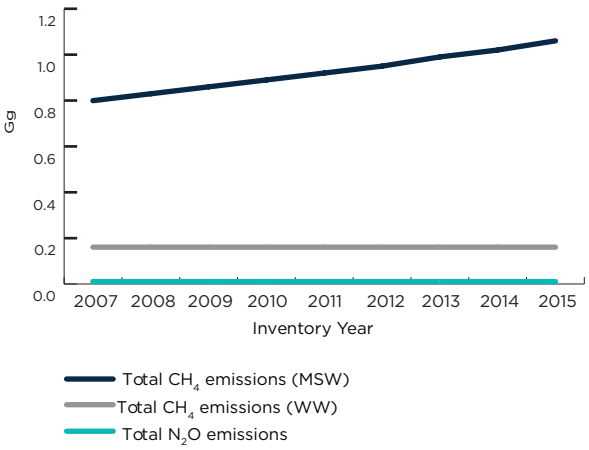


Figure 2.32: Waste Sector Emissions Gg CH_4: 2007-2015

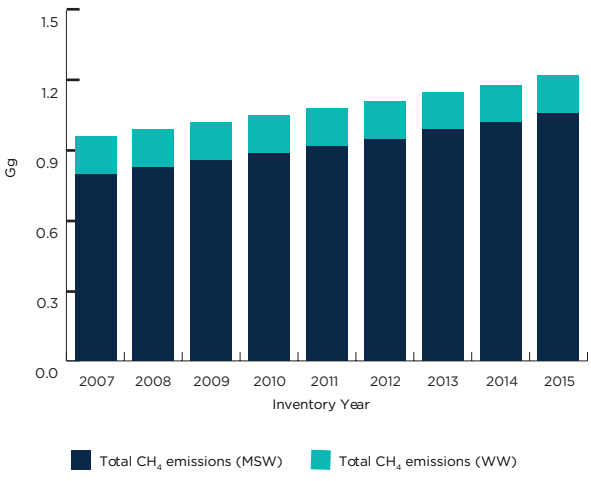
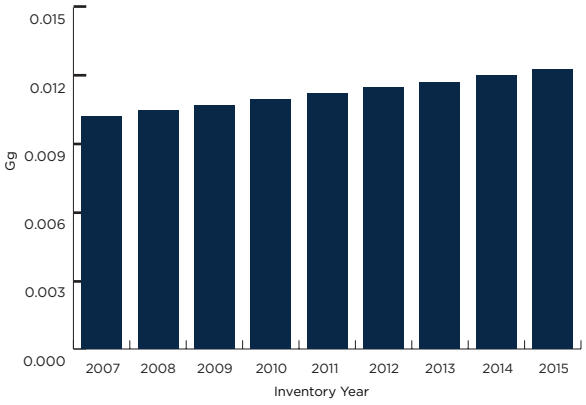


Figure 2.33: Waste Sector Emissions Gg N2O: 2007-2015



Year	Total N2O emissions
2007	0.01023
2008	0.01047
2009	0.01071
2010	0.01096
2011	0.01121
2012	0.01147
2013	0.01173
2014	0.012
2015	0.01228

The following section discuss in detail on emission form the solid waste disposal and waste water treatment and discharge during the inventory years 2007-2015 (No biological waste treatment or burning of municipal solid waste considered).

Solid Waste Disposal – Municipal Solid Waste (MSW)

The key source of methane emissions from solid waste management and disposal include emissions from anaerobic decomposition of waste disposed at Bouffa landfill site, Port Villa, Luganville and Lenakel solid waste disposal site. Solid waste disposal constitutes 5% of total GHG emissions from Vanuatu and 78% of total GHG emission from waste sector in Vanuatu and is one of the major concerns for the country. In Vanuatu, common methods of municipal solid waste disposal (MSW) include open backyard dumpsites, disposal at sea or on unused land, and burning. The management and control of the landfill has been and continue to be a challenge. Solid waste disposal is pronounced in the urban areas as the waste from rural areas is generally scattered and does not pose many hazard. GoV is currently working with JICA to improve the solid waste management situation in the country.

The GHG emissions have been calculated as per the Tier 1 method: Based on the IPCC First Order Decomposition (FOD) method, using mainly default activity data and default parameters. In the absence of actual monitored data, the MSW generation in Vanuatu estimated from the urban population of Port Vila, Luganville and Lenakel and using average 1-1.5 kg/person/day and waste composition was taken from the study conducted by the JPRISM Team in the year 2015 as the Weight of waste component (wt%) in pacific island countries. The MSW generation and waste composition considered for the currently inventory calculation is provided in following table and figure.

Table 2.35: Solid Waste (MSW) Generation in Vanuatu (Ton): 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Urban Population	53261	55193	57,195	59196	61267	63411	65630	67927	70304
Rural Population	170172	173468	1,76,828	180187	183610	187098	190652	194274	197965
Total Population	223433	228661	234023	239383	244877	250509	256282	262201	268269
Households	46548	47637	48754	49871	51016	52189	53392	54625	55889
Average Household size	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Total Solid Waste (MSW) generated-Ton	31099	32226	33394	34564	35774	37027	38324	39666	41055
Waste disposed at man-aged sites (land-fill) -Ton	0	0	0	0	0	0	0	0	0

Waste disposed at un-managed sites (landfill, open dumping) -Ton	31099	32226	33394	34564	35774	37027	38324	39666	41055
No of landfill	3	3	3	3	3	3	3	3	3
Uncontrolled waste dumps	3	3	3	3	3	3	3	3	3

Figure 2.34: Solid Waste (MSW) Generation in Vanuatu (Ton): 2007-2015

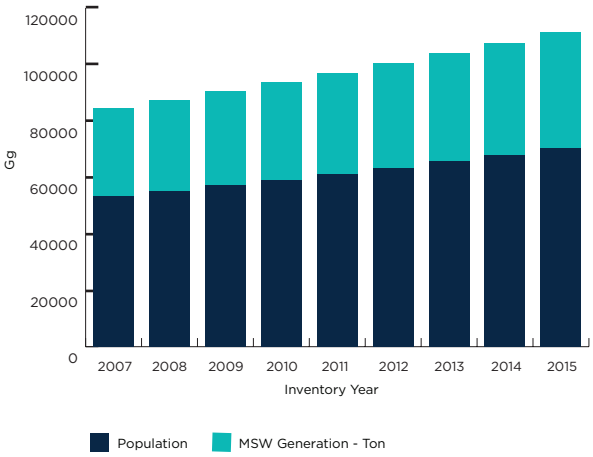
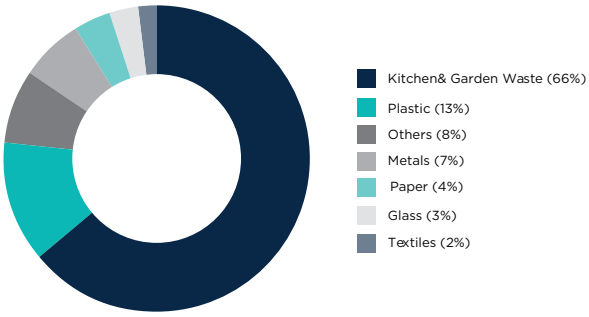


Figure 2.35: MSW Characterization (wt%) - JPRISM Team Study Report



The municipal solid waste composition considered for this GHG inventory presented in the following figure.

Wastewater Treatment and Discharge Sub–Sector

Domestic and Commercial Wastewater Handling: The sanitation system in Vanuatu is largely decentralized, consisting of privately managed household and commercial septic tanks for the collection of human waste. These allow the decomposition of the waste but the process leaves sludge as a by-product. Periodically the residual sludge is removed by private service providers through tankers and disposed of at a designated site.

GHG emission from waste water treatment and discharge sub-sector constitute 22.16% of GHG emissions from the waste sector and <1% of total GHG emissions from Vanuatu. Government of Vanuatu, with support from ADB is currently considering developing a sludge treatment facility at Port Vila.

There is not appropriate information available for waste water generation, sewerage treatment and sanitation system in Vanuatu, however common practice would be decentralized system, consisting of privately managed household and commercial septic tanks for the collection of human waste. These allow the decomposition of the waste, but the process leaves waste water and sludge as a by-product. The waste water is generally discharged at landfill site or to the sea.

The GHG emissions from waste water includes Methane and N2O emissions, in the absence of the monitored data; waste water generation estimated from the population and IPCC default parameter for Oceania region. The Tier1 method has been applied to estimate GHG emissions form the sub-sector, that uses the default values for the emission factor and activity parameters and is considered good practice for countries with limited data. The per capita waste water generation was calculated as per the fresh water consumption i.e. 60% of fresh water consumption (Per capita fresh water consumption in Vanuatu was 130 Liters/Day). The parameter used for estimation of GHG emissions presented in the following table.

Table 2.36: Waste Water (Domestic) Generation in Vanuatu (MLD) : 2007-2015

Data/Parameters	Unit	2007	2008	2009	2010	2011	2012	2013	2014	2015
Population	Num-ber	223433	228661	234023	239383	244877	250509	256282	262201	268269
Total Waste Water gen-erated	MLD	17.43	17.84	18.25	18.67	19.10	19.54	19.99	20.45	20.92
Wastewater and sewage treatment (Septic sys-tem)	MLD	7.55	7.73	7.91	8.09	8.28	8.47	8.66	8.86	9.07
Wastewater's source					Domestic					
Domestic	Avg. House-hold size	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8
Wastewater's organic content (Domestic Efflu-ent) -mg/litre	BOD/ COD	52	52	52	52	52	52	52	52	52
Wastewater's organic content (Septic System) -mg/litre		150	150	150	150	150	150	150	150	150
Wastewater treated	MLD	0	0	0	0	0	0	0	0	0

The waste water emissions CH4 and N2O estimated using the IPCC methodology and default value for Oceania region. The methane and N2O emissions from the waste water during the period 2007-2015 presented in the table below:

Table 2.37: Waste Water GHG Emissions (Gg): 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
CH4 Emissions (Gg)	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157	0.157
N2O Emissions (Gg)	0.0102	0.0105	0.0107	0.0110	0.0112	0.0115	0.0117	0.0120	0.0123
CO2e Emission (Gg)	7.110	7.174	7.239	7.304	7.371	7.439	7.509	7.581	7.654

The data uncertainty and default values used for the waste sector emission shall be overcome by the proper data monitoring and reporting, though the waste water GHG emission are not significant in Vanuatu but the emissions are increasing and posing other environmental hazards. Further, the economy of Vanuatu is highly depended on the tourism sector, hence waste sector may negatively impact the tourism and overall images of Vanuatu as preferred tourist destination in pacific.

Conclusion

This GHG inventory serves as a baseline for the country to measure its progress towards reduction of greenhouse gases. It also serves as an integral tool in designing the countries climate change policies and to measure the success of such policies. The current GHG inventory provides comprehensive information about GHG emissions and removals in Vanuatu for the year 2007 to 2015 and also reflects the GHG emission trend since 1994. The inventory for the year 2007 and subsequent years till 2015 indicates that Vanuatu is a net sink for CO2 emissions. The 2007 to 2015 GHG emissions results revealed a reasonably constant trend over the reporting period with the annual variation dominated by fuel consumption in energy sector.

The compilation of the GHG inventory continues to be a challenge, especially in the availability of activity data for computation of GHG emissions. The key findings and recommendations of this inventory development exercise have been identified during and highlighted in previous sections of the report; however data collection, monitoring and verification for GHG emission sector is key takeaway of this exercise. For the future GHG inventory Vanuatu shall minimise the data gaps and uncertainty specifically Livestock, Forestry, Energy and Waste sector.

Notes for Future National GHG Inventory of Vanuatu (Inventory Improvement Plan)

- Precursor gases: The estimation and reporting of the precursors for national inventories emissions i.e. carbon monoxide (CO), oxides of nitrogen (NOx), non-methane volatile organic compounds (NMVOCs), and sulphur dioxide (SO2) may be considered to the extent possible and based on national circumstances and possibilities.

- Key Category Analysis: The activity data collection and review process will be improved and higher tier (tier-2) analysis of GHG from the key categories and sub-categories identified for Vanuatu proposed for the next inventory. The activity data collection, review process and QA/QC procedure will be developed and implemented for all the key categories and sub-categories.

- Trend Analysis: The GHG emissions from the previous year will be recalculated for trend analysis, if there is change in the methodologies used during the reporting period.

- Procedural arrangements: (a) Data Collection: The activity data collection from the industry, public and private sector as well as institutions and department shall be formalized via suitable instrument e.g. legal contracts, MoUs, MoAs, or other legal documents. (b) The newly formed Department of Climate Change will initiate the regulation to formalize the database management, archives and institutional setup for the above.

- Procedural arrangements: Department of Climate Change will establish arrangements for implementing improved QA/QC procedures, manage and operate the inventory database, and document and archive inventory information and the operation of the inventory

- Implementation Integrated Monitoring, Reporting and Verification (MRV Tool) for National GHG Inventory: The department of Climate Change will implement and operationalise the web based integrated monitoring, reporting and verification system for national GHG inventory (energy sector).

- Biomass and Biofuel Consumption: The Biomass and Biofuel (coconut oil) consumption data collection and QA/QC procedure will be implement to include these fuels in the future inventory reports.

- Livestock Data: The livestock emission both enteric fermentation and manure management are key category; hence more frequent and granular data will be obtained from the Animal husbandry department. In the future inventory the applicability of higher tier method (Tier 2- method) will be adopted for this subcategory if subjective to the data availability.

- Forestry and Other Land Use: Limited data and information available from this sub-sector hence tier-1 method used in this report. However; Vanuatu is implementing REDD+ programme and more qualitative data and information will be available in near future. Higher tier method will be used in future GHG inventory.

- Waste Sector Data: The waste (Solid waste and waste water) sector activity data monitoring and reporting has been initiated in urban centres; higher tier method (Tier-2) will be applied for the future inventory period.

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National Waste Management, Pollution Control Strategy and Implementation Plan 2016-2020

Annexes

Annex 1: Vanuatu's National GHG Inventory Summary : 2007–2015

Inventory Year: 2007-2015	Net CO_2 Emissions, (CO_2 Equivalents Gg)								
Categories	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Total National Emissions and Removals									
1 - Energy	**60.42**	**92.31**	**95.10**	**119.66**	**127.53**	**114.87**	**121.54**	**128.55**	**129.55**
1.A - Fuel Combustion Activities	**60.42**	**92.31**	**95.10**	**119.66**	**127.53**	**114.87**	**121.54**	**128.55**	**129.55**
1.A.1 - Energy Industries	27.73	42.05	39.47	38.02	38.81	35.88	31.68	35.74	32.19
1.A.2 - Manufacturing Industries and Construction	9.85	16.26	16.21	23.67	20.91	8.96	17.40	17.92	19.94
1.A.3 - Transport	18.93	29.28	33.08	52.09	62.04	63.95	66.72	69.56	72.14
1.A.4 - Other Sectors	3.92	4.72	6.34	5.88	5.77	6.08	5.74	5.33	5.28
2 - Industrial Processes and Product Use	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO***	**NO***	**NO***
3 - Agriculture, Forestry, and Other Land Use	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
3.A - Livestock	**412.62**	**418.34**	**298.36**	**400.58**	**412.32**	**417.18**	**373.58**	**424.34**	**428.09**
3.A.1 - Enteric Fermentation	298.25	301.49	187.09	285.82	294.56	298.09	299.90	303.55	306.62
3.A.2 - Manure Management	114.37	116.85	111.27	114.75	117.76	119.09	73.68	120.79	121.47
3.B - Land	**-7021.16**	**-7021.16**	**-7021.16**	**-6973.69**	**-6973.69**	**-6973.69**	**-6973.69**	**-6973.69**	**-6973.69**
3.B.1 - Forest land	-7021.16	-7021.16	-7021.16	-6973.69	-6973.69	-6973.69	-6973.69	-6973.69	-6973.69
3.C - Aggregate sources and non-CO2 emis-sions sources on land	**14.83**	**14.99**	**10.86**	**14.34**	**14.75**	**14.93**	**15.03**	**15.17**	**15.29**

3.C.6 - Indirect N2O Emissions from manure manage-ment	14.83	14.99	10.86	14.34	14.75	14.93	15.03	15.17	15.29
3.D - Other	**NO***	**NO***	**NO***	**NO***	**NO***	**NO***	**NO***	**NO***	**NO***
4 - Waste	**29.55**	**30.43**	**31.33**	**32.24**	**33.18**	**34.15**	**35.16**	**36.20**	**37.28**
4.A - Solid Waste Disposal	**22.44**	**23.25**	**24.09**	**24.94**	**25.81**	**26.72**	**27.65**	**28.62**	**29.62**
4.D - Wastewater Treatment and Discharge	**7.11**	**7.17**	**7.24**	**7.30**	**7.37**	**7.44**	**7.51**	**7.58**	**7.65**
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Memo Items (5)	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
International Bunkers	**0.66**	**2.11**	**2.01**	**10.78**	**17.91**	**16.27**	**24.16**	**24.68**	**26.66**
1.A.3.a.i - Inter-national Aviation (International Bunkers)	NE*	NE*	NE*	7.33	13.60	13.83	17.64	22.90	22.92
1.A.3.d.i - Inter-national water-borne navigation (Interna-tional bunkers)	0.66	2.11	2.01	3.45	4.31	2.45	6.52	1.78	3.74
Total GHG Emissions, excl. Removals	**517.41**	**556.06**	**435.65**	**566.82**	**587.79**	**581.13**	**545.30**	**604.26**	**610.20**
Total GHG Emissions, incl. Removals	**-6503.75**	**-6465.10**	**-6585.51**	**-6406.87**	**-6385.90**	**-6392.56**	**-6428.39**	**-6369.43**	**-6363.48**

* NO - Not Occurring, NE - Not Estimated

Annex 2: Vanuatu's National GHG Inventory Summary : 2007

Inventory Year: 2007	Emissions (Gg)			Emissions (Gg)
Categories	CO_2	CH_4	N_2O	CO2 Equivalents
Total National Emissions and Removals				
1 - Energy	**59.959**	**0.003**	**0.001**	**60.419**
1.A - Fuel Combustion Activities	**59.959**	**0.003**	**0.001**	**60.419**
1.A.1 - Energy Industries	27.640	0.001	0.000	27.730
1.A.2 - Manufacturing Industries and Construction	9.816	0.000	0.000	9.847
1.A.3 - Transport	18.598	0.001	0.001	18.925
1.A.4 - Other Sectors	3.906	0.000	0.000	3.915
2 - Industrial Processes and Product Use	**NO***	**NO***	**NO***	**NO***
3 - Agriculture, Forestry, and Other Land Use				
3.A - Livestock	**0.000**	**13.096**	**0.173**	**412.620**
3.A.1 - Enteric Fermentation	0.000	10.652	0.000	298.250
3.A.2 - Manure Management	0.000	2.444	0.173	114.370
3.B - Land	**-7021.159**	**0.000**	**0.000**	
3.B.1 - Forest land	-7021.159	0.000	0.000	-7021.159
3.C - Aggregate sources and non-CO2 emissions sources on land	**0.000**	**0.000**	**0.056**	**14.826**
3.C.6 - Indirect N2O Emissions from manure management	0.000	0.000	0.056	14.826
3.D - Other	**NO***	**NO***	**NO***	**NO***
4 - Waste	**0.000**	**0.959**	**0.010**	**29.548**
4.A - Solid Waste Disposal	**0.000**	**0.801**	**0.000**	**22.438**
4.D - Wastewater Treatment and Discharge	**0.000**	**0.157**	**0.010**	**7.110**
Memo Items (5)				
International Bunkers	**0.654**	**0.000**	**0.000**	**0.664**
1.A.3.a.i - International Aviation (International Bunkers)	0.000	0.000	0.000	0.000
1.A.3.d.i - International water-borne navigation (International bunkers)	0.654	0.000	0.000	0.664
Total GHG Emissions, excl. Removals	**59.959**	**14.057**	**0.241**	**517.412**
Total GHG Emissions, incl. Removals	**-6961.200**	**14.057**	**0.241**	**-6503.747**

* NO - Not Occurring

Annex 3: Vanuatu's National GHG Inventory Summary : 2008

Inventory Year: 2008	Emissions (Gg)			Emissions (Gg)
Categories	CO_2	CH_4	N_2O	CO2 Equivalents
Total National Emissions and Removals				
1 - Energy	**91.603**	**0.004**	**0.002**	**92.313**
1.A - Fuel Combustion Activities	**91.603**	**0.004**	**0.002**	**92.313**
1.A.1 - Energy Industries	41.910	0.002	0.000	42.047
1.A.2 - Manufacturing Industries and Construction	16.211	0.001	0.000	16.263
1.A.3 - Transport	28.774	0.002	0.002	29.283
1.A.4 - Other Sectors	4.709	0.000	0.000	4.720
2 - Industrial Processes and Product Use	**NO***	**NO***	**NO***	**NO***
3 - Agriculture, Forestry, and Other Land Use				
3.A - Livestock	**0.000**	**13.280**	**0.175**	**418.335**
3.A.1 - Enteric Fermentation	0.000	10.768	0.000	301.490
3.A.2 - Manure Management	0.000	2.513	0.175	116.845
3.B - Land				
3.B.1 - Forest land	-7021.159			-7021.159
3.C - Aggregate sources and non-CO2 emissions sources on land	**0.000**	**0.000**	**0.057**	**14.985**
3.C.6 - Indirect N2O Emissions from manure management	0.000	0.000	0.057	14.985
3.D - Other	**NO***	**NO***	**NO***	**NO***
4 - Waste	**0.000**	**0.988**	**0.010**	**30.425**
4.A - Solid Waste Disposal	**0.000**	**0.830**	**0.000**	**23.251**
4.D - Wastewater Treatment and Discharge	**0.000**	**0.157**	**0.010**	**7.174**
Memo Items (5)				
International Bunkers	**2.079**	**0.000**	**0.000**	**2.111**
1.A.3.a.i - International Aviation (International Bunkers)	0.000	0.000	0.000	0.000
1.A.3.d.i - International water-borne navigation (International bunkers)	2.079	0.000	0.000	2.111
Total GHG Emissions, excl. Removals	**91.603**	**14.272**	**0.245**	**556.059**
Total GHG Emissions, incl. Removals	**-6929.556**	**14.272**	**0.245**	**-6465.100**

* NO - Not Occurring

Annex 4: Vanuatu's National GHG Inventory Summary : 2009

Inventory Year: 2009	Emissions (Gg)			Emissions (Gg)
Categories	CO_2	CH_4	N_2O	CO2 Equivalents
Total National Emissions and Removals				
1 - Energy	**94.324**	**0.004**	**0.002**	**95.096**
1.A - Fuel Combustion Activities	**94.324**	**0.004**	**0.002**	**95.096**
1.A.1 - Energy Industries	39.342	0.002	0.000	39.471
1.A.2 - Manufacturing Industries and Construction	16.159	0.001	0.000	16.209
1.A.3 - Transport	32.497	0.002	0.002	33.078
1.A.4 - Other Sectors	6.326	0.000	0.000	6.338
2 - Industrial Processes and Product Use	**NO***	**NO***	**NO***	**NO***
3 - Agriculture, Forestry, and Other Land Use				
3.A - Livestock	**0.000**	**9.509**	**0.121**	**298.359**
3.A.1 - Enteric Fermentation	0.000	6.682	0.000	187.085
3.A.2 - Manure Management	0.000	2.828	0.121	111.274
3.B - Land	**-7,021.159**	**0.000**	**0.000**	**-7,021.159**
3.B.1 - Forest land	-7,021.159	0.000	0.000	-7,021.159
3.C - Aggregate sources and non-CO2 emissions sources on land	**0.000**	**0.000**	**0.041**	**10.860**
3.C.6 - Indirect N2O Emissions from manure management	0.000	0.000	0.041	10.860
3.D - Other	**NO***	**NO***	**NO***	**NO***
4 - Waste	**0.000**	**1.018**	**0.011**	**31.333**
4.A - Solid Waste Disposal	**0.000**	**0.860**	**0.000**	**24.094**
4.D - Wastewater Treatment and Discharge	**0.000**	**0.157**	**0.011**	**7.239**
Memo Items (5)				
International Bunkers	**1.982**	**0.000**	**0.000**	**2.013**
1.A.3.a.i - International Aviation (International Bunkers)	0.000	0.000	0.000	0.000
1.A.3.d.i - International water-borne navigation (International bunkers)	1.982	0.000	0.000	2.013
Total GHG Emissions, excl. Removals	**94.324**	**10.531**	**0.175**	**435.648**
Total GHG Emissions, incl. Removals	**-6,926.835**	**10.531**	**0.175**	**-6,585.511**

* NO - Not Occurring

Annex 5: Vanuatu's National GHG Inventory Summary : 2010

Inventory Year: 2010	Emissions (Gg)			Emissions (Gg)
Categories	CO_2	CH_4	N_2O	CO2 Equivalents
Total National Emissions and Removals				
1 - Energy	**118.590**	**0.005**	**0.004**	**119.662**
1.A - Fuel Combustion Activities	**118.590**	**0.005**	**0.004**	**119.662**
1.A.1 - Energy Industries	37.897	0.002	0.000	38.021
1.A.2 - Manufacturing Industries and Construction	23.596	0.001	0.000	23.671
1.A.3 - Transport	51.226	0.003	0.003	52.089
1.A.4 - Other Sectors	5.872	0.000	0.000	5.882
2 - Industrial Processes and Product Use	**NO***	**NO***	**NO***	**NO***
3 - Agriculture, Forestry, and Other Land Use				
3.A - Livestock	**0.000**	**12.724**	**0.167**	**400.576**
3.A.1 - Enteric Fermentation	0.000	10.208	0.000	285.824
3.A.2 - Manure Management	0.000	2.516	0.167	114.752
3.B - Land	**-6,973.689**	**0.000**	**0.000**	**-6,973.689**
3.B.1 - Forest land	-6,973.689	0.000	0.000	-6,973.689
3.C - Aggregate sources and non-CO2 emissions sources on land	**0.000**	**0.000**	**0.054**	**14.339**
3.C.6 - Indirect N2O Emissions from manure management	0.000	0.000	0.054	14.339
3.D - Other	**NO***	**NO***	**NO***	**NO***
4 - Waste	**0.000**	**1.048**	**0.011**	**32.241**
4.A - Solid Waste Disposal	**0.000**	**0.891**	**0.000**	**24.937**
4.D - Wastewater Treatment and Discharge	**0.000**	**0.157**	**0.011**	**7.304**
Memo Items (5)				
International Bunkers	**10.674**	**0.000**	**0.000**	**10.781**
1.A.3.a.i - International Aviation (International Bunkers)	7.272	0.000	0.000	7.328
1.A.3.d.i - International water-borne navigation (International bunkers)	3.401	0.000	0.000	3.454
Total GHG Emissions, excl. Removals	**118.590**	**13.776**	**0.236**	**566.818**
Total GHG Emissions, incl. Removals	**-6,855.098**	**13.776**	**0.236**	**-6,406.870**

* NO - Not Occurring

Annex 6: Vanuatu's National GHG Inventory Summary : 2011

Inventory Year: 2011	Emissions (Gg)			Emissions (Gg)
Categories	CO_2	CH_4	N_2O	CO2 Equivalents
Total National Emissions and Removals				
1 - Energy	**126.320**	**0.005**	**0.004**	**127.532**
1.A - Fuel Combustion Activities	**126.320**	**0.005**	**0.004**	**127.532**
1.A.1 - Energy Industries	38.682	0.002	0.000	38.809
1.A.2 - Manufacturing Industries and Construction	20.842	0.001	0.000	20.908
1.A.3 - Transport	61.032	0.003	0.003	62.041
1.A.4 - Other Sectors	5.764	0.000	0.000	5.773
2 - Industrial Processes and Product Use	**Not Occurring**	**Not Occurring**	**Not Occurring**	**Not Occurring**
3 - Agriculture, Forestry, and Other Land Use				
3.A - Livestock	**0.000**	**13.096**	**0.172**	**412.320**
3.A.1 - Enteric Fermentation	0.000	10.520	0.000	294.560
3.A.2 - Manure Management	0.000	2.576	0.172	117.760
3.B - Land	**-6973.689**	**0.000**	**0.000**	**-6973.689**
3.B.1 - Forest land	-6973.689	0.000	0.000	-6973.689
3.C - Aggregate sources and non-CO2 emissions sources on land	**0.000**	**0.000**	**0.056**	**14.752**
3.C.6 - Indirect N2O Emissions from manure management	0.000	0.000	0.056	14.752
3.D - Other	**Not Occurring**	**Not Occurring**	**Not Occurring**	**Not Occurring**
4 - Waste	**0.000**	**1.079**	**0.011**	**33.181**
4.A - Solid Waste Disposal	**0.000**	**0.922**	**0.000**	**25.811**
4.D - Wastewater Treatment and Discharge	**0.000**	**0.157**	**0.011**	**7.371**
Memo Items (5)				
International Bunkers	**17.742**	**0.000**	**0.001**	**17.910**
1.A.3.a.i - International Aviation (International Bunkers)	13.499	0.000	0.000	13.601
1.A.3.d.i - International water-borne navigation (International bunkers)	4.243	0.000	0.000	4.309
Total GHG Emissions, excl. Removals	**126.320**	**14.180**	**0.243**	**587.786**
Total GHG Emissions, incl. Removals	**-6847.368**	**14.180**	**0.243**	**-6385.902**

* NO - Not Occurring

Annex 7: Vanuatu's National GHG Inventory Summary : 2012

Inventory Year: 2012	Emissions (Gg)			Emissions (Gg)
Categories	CO_2	CH_4	N_2O	CO2 Equivalents
Total National Emissions and Removals				
1 - Energy	**113.719**	**0.005**	**0.004**	**114.874**
1.A - Fuel Combustion Activities	**113.719**	**0.005**	**0.004**	**114.874**
1.A.1 - Energy Industries	35.761	0.001	0.000	35.878
1.A.2 - Manufacturing Industries and Construction	8.935	0.000	0.000	8.962
1.A.3 - Transport	62.951	0.003	0.003	63.951
1.A.4 - Other Sectors	6.072	0.000	0.000	6.083
2 - Industrial Processes and Product Use	**NO***	**NO***	**NO***	**NO***
3 - Agriculture, Forestry, and Other Land Use				
3.A - Livestock	**0.000**	**13.250**	**0.174**	**417.181**
3.A.1 - Enteric Fermentation	0.000	10.646	0.000	298.088
3.A.2 - Manure Management	0.000	2.604	0.174	119.093
3.B - Land	**-6,973.689**	**0.000**	**0.000**	**-6,973.689**
3.B.1 - Forest land	-6,973.689	0.000	0.000	-6,973.689
3.C - Aggregate sources and non-CO2 emissions sources on land	**0.000**	**0.000**	**0.056**	**14.925**
3.C.6 - Indirect N2O Emissions from manure management	0.000	0.000	0.056	14.925
3.D - Other	**NO***	**NO***	**NO***	**NO***
4 - Waste	**0.000**	**1.111**	**0.011**	**34.154**
4.A - Solid Waste Disposal	**0.000**	**0.954**	**0.000**	**26.715**
4.D - Wastewater Treatment and Discharge	**0.000**	**0.157**	**0.011**	**7.439**
Memo Items (5)				
International Bunkers	**16.133**	**0.000**	**0.001**	**16.274**
1.A.3.a.i - International Aviation (International Bunkers)	13.725	0.000	0.000	13.829
1.A.3.d.i - International water-borne navigation (International bunkers)	2.408	0.000	0.000	2.445
Total GHG Emissions, excl. Removals	**113.719**	**14.366**	**0.246**	**581.133**
Total GHG Emissions, incl. Removals	**-6,859.970**	**14.366**	**0.246**	**-6,392.556**

* NO - Not Occurring

Annex 8: Vanuatu's National GHG Inventory Summary : 2013

Inventory Year: 2013	Emissions (Gg)			Emissions (Gg)
Categories	CO_2	CH_4	N_2O	CO2 Equivalents
Total National Emissions and Removals				
1 - Energy	**120.290**	**0.005**	**0.004**	**121.536**
1.A - Fuel Combustion Activities	**120.290**	**0.005**	**0.004**	**121.536**
1.A.1 - Energy Industries	31.575	0.001	0.000	31.678
1.A.2 - Manufacturing Industries and Construction	17.340	0.001	0.000	17.395
1.A.3 - Transport	65.643	0.003	0.004	66.721
1.A.4 - Other Sectors	5.732	0.000	0.000	5.742
2 - Industrial Processes and Product Use	**NO***	**NO***	**NO***	**NO***
3 - Agriculture, Forestry, and Other Land Use				
3.A - Livestock	**0.000**	**13.342**	**0.000**	**373.577**
3.A.1 - Enteric Fermentation	0.000	10.711	0.000	299.897
3.A.2 - Manure Management	0.000	2.631	0.000	73.680
3.B - Land	**-6,973.689**	**0.000**	**0.000**	**-6,973.689**
3.B.1 - Forest land	-6,973.689	0.000	0.000	-6,973.689
3.C - Aggregate sources and non-CO2 emissions sources on land	**0.000**	**0.000**	**0.057**	**15.027**
3.C.6 - Indirect N2O Emissions from manure management	0.000	0.000	0.057	15.027
3.D - Other	**NO***	**NO***	**NO***	**NO***
4 - Waste	**0.000**	**1.145**	**0.012**	**35.160**
4.A - Solid Waste Disposal	**0.000**	**0.988**	**0.000**	**27.651**
4.D - Wastewater Treatment and Discharge	**0.000**	**0.157**	**0.012**	**7.509**
Memo Items (5)				
International Bunkers	**23.926**	**0.000**	**0.001**	**24.158**
1.A.3.a.i - International Aviation (International Bunkers)	17.508	0.000	0.000	17.642
1.A.3.d.i - International water-borne navigation (International bunkers)	6.418	0.000	0.000	6.517
Total GHG Emissions, excl. Removals	**120.290**	**14.492**	**0.073**	**545.299**
Total GHG Emissions, incl. Removals	**-6,853.399**	**14.492**	**0.073**	**-6,428.390**

* NO - Not Occurring

Annex 9: Vanuatu's National GHG Inventory Summary : 2014

Inventory Year: 2014	Emissions (Gg)			Emissions (Gg)
Categories	CO_2	CH_4	N_2O	CO2 Equivalents
Total National Emissions and Removals				
1 - Energy	**127.251**	**0.006**	**0.004**	**128.551**
1.A - Fuel Combustion Activities	**127.251**	**0.006**	**0.004**	**128.551**
1.A.1 - Energy Industries	35.626	0.001	0.000	35.743
1.A.2 - Manufacturing Industries and Construction	17.865	0.001	0.000	17.921
1.A.3 - Transport	68.437	0.003	0.004	69.555
1.A.4 - Other Sectors	5.323	0.000	0.000	5.332
2 - Industrial Processes and Product Use	**NO***	**NO***	**NO***	**NO***
3 - Agriculture, Forestry, and Other Land Use				
3.A - Livestock	**0.000**	**13.478**	**0.177**	**424.341**
3.A.1 - Enteric Fermentation	0.000	10.841	0.000	303.548
3.A.2 - Manure Management	0.000	2.637	0.177	120.793
3.B - Land	**-6,973.689**	**0.000**	**0.000**	**-6,973.689**
3.B.1 - Forest land	-6,973.689	0.000	0.000	-6,973.689
3.C - Aggregate sources and non-CO2 emissions sources on land	**0.000**	**0.000**	**0.057**	**15.166**
3.C.6 - Indirect N2O Emissions from manure management	0.000	0.000	0.057	15.166
3.D - Other	**NO***	**NO***	**NO***	**NO***
4 - Waste	**0.000**	**1.179**	**0.012**	**36.200**
4.A - Solid Waste Disposal	**0.000**	**1.022**	**0.000**	**28.619**
4.D - Wastewater Treatment and Discharge	**0.000**	**0.157**	**0.012**	**7.581**
Memo Items (5)				
International Bunkers	**24.481**	**0.000**	**0.001**	**24.681**
1.A.3.a.i - International Aviation (International Bunkers)	22.725	0.000	0.001	22.898
1.A.3.d.i - International water-borne navigation (International bunkers)	1.755	0.000	0.000	1.783
Total GHG Emissions, excl. Removals	**127.251**	**14.663**	**0.251**	**604.257**
Total GHG Emissions, incl. Removals	**-6,846.438**	**14.663**	**0.251**	**-6,369.431**

* NO - Not Occurring

Annex 10: Vanuatu's National GHG Inventory Summary : 2015

Inventory Year: 2015	Emissions (Gg)			Emissions (Gg)
Categories	CO_2	CH_4	N_2O	CO2 Equivalents
Total National Emissions and Removals				
1 - Energy	**128.206**	**0.006**	**0.004**	**129.550**
1.A - Fuel Combustion Activities	**128.206**	**0.006**	**0.004**	**129.550**
1.A.1 - Energy Industries	32.089	0.001	0.000	32.194
1.A.2 - Manufacturing Industries and Construction	19.880	0.001	0.000	19.943
1.A.3 - Transport	70.969	0.003	0.004	72.135
1.A.4 - Other Sectors	5.269	0.000	0.000	5.277
2 - Industrial Processes and Product Use	**NO***	**NO***	**NO***	**NO***
3 - Agriculture, Forestry, and Other Land Use				
3.A - Livestock	**0.000**	**13.597**	**0.179**	**428.090**
3.A.1 - Enteric Fermentation	0.000	10.951	0.000	306.619
3.A.2 - Manure Management	0.000	2.647	0.179	121.471
3.B - Land	**-6,973.689**	**0.000**	**0.000**	**-6,973.689**
3.B.1 - Forest land	-6,973.689	0.000	0.000	-6,973.689
3.C - Aggregate sources and non-CO2 emissions sources on land	**0.000**	**0.000**	**0.058**	**15.290**
3.C.6 - Indirect N2O Emissions from manure management	0.000	0.000	0.058	15.290
3.D - Other	**NO***	**NO***	**NO***	**NO***
4 - Waste	**0.000**	**1.215**	**0.012**	**37.275**
4.A - Solid Waste Disposal	**0.000**	**1.058**	**0.000**	**29.621**
4.D - Wastewater Treatment and Discharge	**0.000**	**0.157**	**0.012**	**7.654**
Memo Items (5)				
International Bunkers	**26.428**	**0.000**	**0.001**	**26.658**
1.A.3.a.i - International Aviation (International Bunkers)	22.742	0.000	0.001	22.915
1.A.3.d.i - International water-borne navigation (International bunkers)	3.686	0.000	0.000	3.743
Total GHG Emissions, excl. Removals	**128.206**	**14.818**	**0.253**	**610.204**
Total GHG Emissions, incl. Removals	**-6,845.482**	**14.818**	**0.253**	**-6,363.484**

* NO - Not Occurring

Annex 11: Key Category Analysis : 2013

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	Greenhouse gas	2013 Ex,t (Gg CO2 Eq)	|Ex,t| (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.A.1	Enteric Fermentation	METHANE (CH4)	299.897	299.897	0.50677	**0.51**
3.A.2	Manure Management	METHANE (CH4)	73.680	73.680	0.12451	**0.63**
1.A.3.b	Road Transportation	CARBON DIOXIDE (CO2)	52.552	52.552	0.08880	**0.72**
3.A.2	Manure Management	NITROUS OXIDE (N2O)	46.478	46.478	0.07854	**0.80**
1.A.1	Energy Industries	CARBON DIOXIDE (CO2)	31.575	31.575	0.05336	**0.85**
4.A	Solid Waste Disposal	METHANE (CH4)	27.651	27.651	0.04673	**0.90**
1.A.2	Manufacturing Industries and Construction	CARBON DIOXIDE (CO2)	17.340	17.340	0.02930	**0.93**
3.C.6	Indirect N2O Emissions from manure management	NITROUS OXIDE (N2O)	15.027	15.027	0.02539	**0.95**
1.A.3.a	Civil Aviation	CARBON DIOXIDE (CO2)	8.059	8.059	0.01362	**0.97**
1.A.4	Other Sectors	CARBON DIOXIDE (CO2)	5.732	5.732	0.00969	0.98
1.A.3.d	Water-borne Navigation	CARBON DIOXIDE (CO2)	5.032	5.032	0.00850	0.99
4.D	Wastewater Treatment and Discharge	METHANE (CH4)	4.400	4.400	0.00744	0.99
4.D	Wastewater Treatment and Discharge	NITROUS OXIDE (N2O)	3.109	3.109	0.00525	1.00
1.A.3.b	Road Transportation	NITROUS OXIDE (N2O)	0.860	0.860	0.00145	1.00
1.A.3.b	Road Transportation	METHANE (CH4)	0.078	0.078	0.00013	1.00
1.A.3.d	Water-borne Navigation	NITROUS OXIDE (N2O)	0.071	0.071	0.00012	1.00
1.A.1	Energy Industries	NITROUS OXIDE (N2O)	0.068	0.068	0.00011	1.00
1.A.3.a	Civil Aviation	NITROUS OXIDE (N2O)	0.060	0.060	0.00010	1.00
1.A.2	Manufacturing Industries and Construction	NITROUS OXIDE (N2O)	0.036	0.036	0.00006	1.00
1.A.1	Energy Industries	METHANE (CH4)	0.036	0.036	0.00006	1.00
1.A.2	Manufacturing Industries and Construction	METHANE (CH4)	0.019	0.019	0.00003	1.00
1.A.3.d	Water-borne Navigation	METHANE (CH4)	0.007	0.007	0.00001	1.00
1.A.4	Other Sectors	NITROUS OXIDE (N2O)	0.006	0.006	0.00001	1.00
1.A.4	Other Sectors	METHANE (CH4)	0.004	0.004	0.00001	1.00
1.A.3.a	Civil Aviation	METHANE (CH4)	0.002	0.002	0.00000	1.00
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-6973.689	0.000	0.00000	1.00
Total			**-6381.912**	**591.776**	**1.0000**	

Annex 12: Key Category Analysis : 2014

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	Greenhouse gas	2013 Ex,t (Gg CO2 Eq)	|Ex,t| (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.A.1	Enteric Fermentation	METHANE (CH4)	303.548	303.548	0.50235	**0.50**
3.A.2	Manure Management	METHANE (CH4)	73.838	73.838	0.12220	**0.62**
1.A.3.b	Road Transportation	CARBON DIOXIDE (CO2)	53.980	53.980	0.08933	**0.71**
3.A.2	Manure Management	NITROUS OXIDE (N2O)	46.954	46.954	0.07771	**0.79**
1.A.1	Energy Industries	CARBON DIOXIDE (CO2)	35.626	35.626	0.05896	**0.85**
4.A	Solid Waste Disposal	METHANE (CH4)	28.619	28.619	0.04736	**0.90**
1.A.2	Manufacturing Industries and Construction	CARBON DIOXIDE (CO2)	17.865	17.865	0.02957	**0.93**
3.C.6	Indirect N2O Emissions from manure management	NITROUS OXIDE (N2O)	15.166	15.166	0.02510	**0.95**
1.A.3.a	Civil Aviation	CARBON DIOXIDE (CO2)	8.419	8.419	0.01393	**0.97**
1.A.3.d	Water-borne Navigation	CARBON DIOXIDE (CO2)	6.037	6.037	0.00999	0.98
1.A.4	Other Sectors	CARBON DIOXIDE (CO2)	5.323	5.323	0.00881	0.99
4.D	Wastewater Treatment and Discharge	METHANE (CH4)	4.400	4.400	0.00728	0.99
4.D	Wastewater Treatment and Discharge	NITROUS OXIDE (N2O)	3.180	3.180	0.00526	1.00
1.A.3.b	Road Transportation	NITROUS OXIDE (N2O)	0.880	0.880	0.00146	1.00
1.A.3.d	Water-borne Navigation	NITROUS OXIDE (N2O)	0.085	0.085	0.00014	1.00
1.A.3.b	Road Transportation	METHANE (CH4)	0.081	0.081	0.00013	1.00
1.A.1	Energy Industries	NITROUS OXIDE (N2O)	0.076	0.076	0.00013	1.00
1.A.3.a	Civil Aviation	NITROUS OXIDE (N2O)	0.063	0.063	0.00010	1.00
1.A.2	Manufacturing Industries and Construction	NITROUS OXIDE (N2O)	0.037	0.037	0.00006	1.00
1.A.1	Energy Industries	METHANE (CH4)	0.040	0.040	0.00007	1.00
1.A.2	Manufacturing Industries and Construction	METHANE (CH4)	0.020	0.020	0.00003	1.00
1.A.3.d	Water-borne Navigation	METHANE (CH4)	0.009	0.009	0.00001	1.00
1.A.4	Other Sectors	NITROUS OXIDE (N2O)	0.005	0.005	0.00001	1.00
1.A.4	Other Sectors	METHANE (CH4)	0.004	0.004	0.00001	1.00
1.A.3.a	Civil Aviation	METHANE (CH4)	0.002	0.002	0.00000	1.00
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-6973.689	0.000	0.00000	1.00
Total			**-6369.431**	**604.257**	**1.0000**	

Annex 13: Key Category Analysis : 2015

A	B	C	D	E	F	G
IPCC Category code	IPCC Category	Greenhouse gas	2013 Ex,t (Gg CO2 Eq)	|Ex,t| (Gg CO2 Eq)	Lx,t	Cumulative Total of Column F
3.A.1	Enteric Fermentation	METHANE (CH4)	306.619	306.619	0.50249	**0.50**
3.A.2	Manure Management	METHANE (CH4)	74.104	74.104	0.12144	**0.62**
1.A.3.b	Road Transportation	CARBON DIOXIDE (CO2)	56.347	56.347	0.09234	**0.72**
3.A.2	Manure Management	NITROUS OXIDE (N2O)	47.367	47.367	0.07762	**0.79**
1.A.1	Energy Industries	CARBON DIOXIDE (CO2)	32.089	32.089	0.05259	**0.85**
4.A	Solid Waste Disposal	METHANE (CH4)	29.621	29.621	0.04854	**0.90**
1.A.2	Manufacturing Industries and Construction	CARBON DIOXIDE (CO2)	19.880	19.880	0.03258	**0.93**
3.C.6	Indirect N2O Emissions from manure management	NITROUS OXIDE (N2O)	15.290	15.290	0.02506	**0.95**
1.A.3.a	Civil Aviation	CARBON DIOXIDE (CO2)	7.694	7.694	0.01261	**0.97**
1.A.3.d	Water-borne Navigation	CARBON DIOXIDE (CO2)	6.927	6.927	0.01135	0.98
1.A.4	Other Sectors	CARBON DIOXIDE (CO2)	5.269	5.269	0.00863	0.99
4.D	Wastewater Treatment and Discharge	METHANE (CH4)	4.400	4.400	0.00721	0.99
4.D	Wastewater Treatment and Discharge	NITROUS OXIDE (N2O)	3.254	3.254	0.00533	1.00
1.A.3.b	Road Transportation	NITROUS OXIDE (N2O)	0.915	0.915	0.00150	1.00
1.A.3.d	Water-borne Navigation	NITROUS OXIDE (N2O)	0.099	0.099	0.00016	1.00
1.A.3.b	Road Transportation	METHANE (CH4)	0.084	0.084	0.00014	1.00
1.A.1	Energy Industries	NITROUS OXIDE (N2O)	0.069	0.069	0.00011	1.00
1.A.3.a	Civil Aviation	NITROUS OXIDE (N2O)	0.057	0.057	0.00009	1.00
1.A.2	Manufacturing Industries and Construction	NITROUS OXIDE (N2O)	0.041	0.041	0.00007	1.00
1.A.1	Energy Industries	METHANE (CH4)	0.036	0.036	0.00006	1.00
1.A.2	Manufacturing Industries and Construction	METHANE (CH4)	0.022	0.022	0.00004	1.00
1.A.3.d	Water-borne Navigation	METHANE (CH4)	0.010	0.010	0.00002	1.00
1.A.4	Other Sectors	NITROUS OXIDE (N2O)	0.005	0.005	0.00001	1.00
1.A.4	Other Sectors	METHANE (CH4)	0.004	0.004	0.00001	1.00
1.A.3.a	Civil Aviation	METHANE (CH4)	0.002	0.002	0.00000	1.00
3.B.1.a	Forest land Remaining Forest land	CARBON DIOXIDE (CO2)	-6973.689	0.000	0.00000	1.00
Total			**-6363.484**	**610.204**	**1.0000**	

Annex 14: Uncertainty Analysis (Approach–1) for Gas CO_2

IPCC Categories	A	B	C	D	E	F	G	H	I	J	K
	Input data										
	Gg CO2 equivalent		%								
1 - Energy											
1.A - Fuel Combustion Activities											
1.A.1 - Energy Industries	12.695	32.194	0.95	0.00	0.95	0.00	0.02	32.19	0.00	0.02	0.00
1.A.2 - Manufacturing Indus-tries and Con-struction	0.930	19.943	0.95	0.00	0.95	0.00	0.06	19.94	0.00	0.06	0.00
1.A.3 - Transport	45.292	72.135	0.95	0.00	0.95	0.01	0.07	72.13	0.00	0.06	0.00
1.A.4 - Other Sectors	5.309	5.277	0.95	0.00	0.95	0.00	0.02	5.28	0.00	0.02	0.00
2 - Industrial Processes and Product Use	0.000	0.000	0.95	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00
3 - Agriculture, Forestry, and Other Land Use											
3.A - Livestock	235.160	428.090	0.30	0.00	0.25	0.03	0.17	128.70	0.00	0.05	0.00
3.B - Land	0.000	0.000	0.30	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00
3.C - Aggregate sources and non-CO2 emissions sources on land	0.000	15.290	0.30	0.00	0.40	0.00	0.05	15.29	0.00	0.02	0.00
4 - Waste	0.000	37.275	0.30	0.00	0.40	0.00	0.12	37.27	0.00	0.04	0.00
Total	299.387	610.204				0.05					0.01

Percentage uncertainty in total inventory: 22%

Trend uncertainty: 11%

Annex 15: Global Warming Potential Values

The following table includes the 100-year time horizon global warming potentials (GWP) relative to CO2 used for this NIR. This table is adapted from the IPCC Fifth Assessment Report, 2014 (AR5). The AR5 values are the most recent, but the second assessment report (1995) and fourth assessment report (2007) values are also listed here; however the use of the latest (AR5) values is recommended.

Industrial designation or common name	Chemical formula	GWP values for 100-year time horizon		
		Second Assessment Report (SAR)	Fourth Assessment Report (AR4)	Fifth Assessment Report (AR5)
Carbon dioxide	CO_4	1	1	1
Methane	CH_4	21	25	28
Nitrous oxide	N_4O	310	298	265

CHAPTER 3

Vulnerability and Adaptation Measures

Vulnerability and Adaptation

Background

This section aims to provide and update information about how projected climate change, climate variability and extreme events may affect Vanuatu's economic and social sectors. This chapter outlines Vanuatu's current climatic, socioeconomic and natural systems; current vulnerability and adaptation efforts; future risks and national/sectoral adaptation policies, strategies and measures including a summary of potential adaptation actions for priority sectors. In terms of adaptation projects, consideration has been given to those areas and/or sectors that are most critical and are of highest priority.

Vanuatu faces a range of natural hazards (geophysical and climatic), and is also subjected to climatic variability and extremes. Vanuatu's latitude places it in the warm pool of the SPCZ, making highly exposed to tropical cyclone activity and ENSO cycles which increase the risks of droughts and floods. Other main climate hazards include rising sea levels threatening coastal environments and property, sea temperature increases and ocean acidification putting pressure on highly valuable coastal ecosystems and resources

The country is also located in a seismically and volcanically active region and has high exposure to geologic hazards, including volcanic eruptions, earthquakes, tsunamis, and landslides. Earthquakes are frequent and often originate at considerable depth and are therefore not too destructive (large magnitude but low density). Nevertheless, some earthquakes have caused extended damages in the past. Destructive tidal waves (tsunami) occur occasionally as a result of earthquakes.

To address climate and disaster risks, Vanuatu has prioritized the development of institutional frameworks and structures. The establishment of the National Advisory Board for Climate and Disaster Risk Reduction (NAB) with its' Secretariat has enhanced governance of these two issues. Implementation of Vanuatu's obligations of the UFCCC has further benefited from strengthened engagement and implementation of actions by government agencies, civil society, academia, the private sector and development partners.

Assessments in this section are derived from considerable body of existing knowledge and information (e.g. recent sector policies, plans and strategies, BOM/CSIRO 2014 climate analysis) and used a riskbased approach based on up-to-date, factual and often quantitative information, wherever possible. Vulnerability and adaptation assessment methodologies whilst being inspired by IPCC, UNFCCC, UNDP and Pacific-community-based methodologies have been tailored to meet specific Vanuatu contexts.

Current Climatic Scenario

Brief descriptions of the climatic scenario for Vanuatu including its past and present climate as well as projections for the future are presented in this section. The generated data is derived from the collective work of ni-Vanuatu and Australian climatologists under the Pacific Climate Change Science Program. Observed trends and analysis of air temperature, rainfall, extreme events (including tropical cyclones), sea-surface temperature, wind waves, ocean acidification, mean and extreme sea levels are presented and projections for air and sea-surface temperature, rainfall, sea level, ocean acidification and extreme events are provided.

Climate trends and scenarios data are obtained from 47 operational meteorological stations in Vanuatu. Multiple observations within a 24-hour period are taken at Sola, Pekoa, Saratamata, Lamap, Bauerfield, Whitegrass and Analguahat (Aneityum). At three climate stations (Lambubu, Lamap and Aneityum) and at 39 rainfall stations across the country, a single observation is taken at 9.00 am local time. The primary climate stations are located at Port Vila and Bauerfield Airport on the island of Efate. Several stations, including Iririki (Port Vila), have rainfall data from the early 1900s. Iririki also has the earliest air temperature observations which began in the late 1940s. An Iririki-PortVila-Bauerfield composite has been created and named Bauerfield Airport. Bauerfield Airport monthly rainfall from 1907 (daily values from 1949) and air temperature from 1949, and Aneityum rainfall and air temperature from 1948 have been used in this report. The Bauerfield Airport composite and Aneityum records are homogeneous.

Wind-wave data from buoys are particularly sparse in the Pacific region, with very short records. Model and reanalysis data are therefore required to detail the wind-wave climate of the region. Reanalysis surface wind data have been used to drive a wave model over the period 1979–2009 to generate a hindcast of the historical wind-wave climate.

Vanuatu has a tropical climate, moderated by south-east trade winds from May to October; moderate rainfall from November to April often affected by cyclones from December to April. According to the Australian Bureau of Meteorology and CSIRO (2014) study the following climate trends were observed:

a. Maximum and minimum air temperatures increased at Bauerfield Airport (Port Vila) from 1948–2011 as did November– April and May–October maximum temperatures at Aneityum. This is consistent with global warming.

b. Annual and half-year rainfall trends show little change at Bauerfield Airport since 1907 and Aneityum since 1949. Extreme daily rainfall trends also show little change at Aneityum and Bauerfield Airport since 1945.

c. Tropical cyclones affect Vanuatu mainly between November and April. An average of 24 cyclones per decade developed within or crossed the Vanuatu Exclusive Economic Zone (EEZ) between the 1969/70 to 2010/11 seasons. Twenty-nine of the 71 tropical cyclones (41%) between the 1981/82 and 2010/11 seasons were severe events (Category 3 or stronger) in the Vanuatu EEZ. Available data are not suitable for assessing long-term trends.

d. Wind-waves around Vanuatu do not vary significantly throughout the year, having fairly constant wave heights and periods, and being typically directed from the south-east. Waves are influenced by the southern trade winds and movement of the South Pacific Convergence Zone (SPCZ), and display some variability on interannual time scales with the El Niño–Southern Oscillation (ENSO) and Southern Annular Mode (SAM). Available data are not suitable for assessing long-term trends.

Future Climate Projections

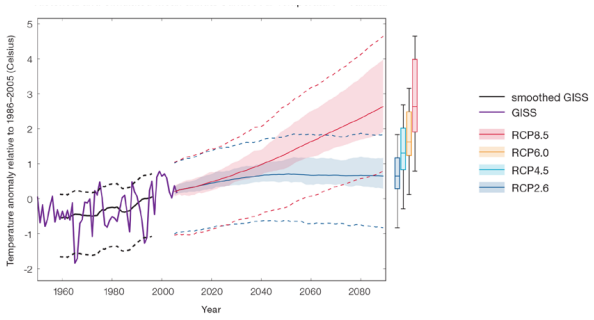
The simulation of the key processes and features for the Vanuatu region utilizes the Coupled Model Intercomparison Project (Phase 5) (CMIP5) similar to the previous generation of CMIP3 models, with all the same strengths and many of the same weaknesses. The best-performing CMIP5 models used in BOM/CSIRO 2014 study have lower biases (differences between the simulated and observed climate data) than the best CMIP3 models, and there are fewer poorly-performing models. For Vanuatu, the most important model bias is that the rainfall maximum of the SPCZ is too zonally (east-west) oriented and extends too far east in May–October. This lowers confidence in the model projections.

It is important to realize that the models used give different projections under the same scenario. This means there is not a single projected future for Vanuatu, but rather a range of possible futures for each emission scenario. This range is described below.

Temperature

Further warming is expected over Vanuatu (Figure 1, Table 2). Under all Representative Concentration Pathways (RCPs), the warming is up to 1.0°C by 2030, relative to 1995, but after 2030 there is a growing difference in warming between each RCP. For example, in Vanuatu by 2090, a warming of 1.9–4.0°C is projected for RCP8.5 while a warming of 0.3–1.2°C is projected for RCP2.6. This range is broader than that presented in Australian Bureau of Meteorology and CSIRO (2011) because a wider range of emissions scenarios is considered. While relatively warm and cool years and decades will still occur due to natural variability, there is projected to be more warm years and decades on average in a warmer climate. Dynamical downscaling of climate models suggests that temperature rises may be about 0.3°C greater over land than over ocean in this area.

Figure 3.1: Historical and simulated mean annual surface air temperature - Vanuatu



The graph shows the anomaly (from the base period 1986–2005) in surface air temperature from observations (the GISS dataset, in purple), and for the CMIP5 models under the very high (RCP8.5, in red) and very low (RCP2.6, in blue) emissions scenarios. The solid red and blue lines show the smoothed (20-year running average) multi-model mean anomaly in surface air temperature, while shading represents the spread of model values (5–95th percentile). The dashed lines show the 5–95th percentile of the observed interannual variability for the observed period (in black) and added to the projections as a visual guide (in red and blue). This indicates that future surface air temperature could be above or below the projected long-term averages due to interannual variability. The ranges of projections for a 20-year period centred on 2090 are shown by the bars on the right for RCP8.5, 6.0, 4.5 and 2.6. Source: BOM and CSIRO 2014

Rainfall

The CMIP5 models show a range of projected annual average rainfall change from an increase to a decrease, and the model average is near zero. The range is greater in the highest emissions scenarios (Figure 2, Table 2). There is a range of projections for May–October rainfall from an increase to a decrease, and a slight projected increase in November–April rainfall.

The result for mean annual rainfall is similar to that reported in Australian Bureau of Meteorology and CSIRO (2011), however there is less certainty about the seasonal rainfall projections here than in Australian Bureau of Meteorology and CSIRO (2011). The range of new model results and new research into the drivers of change suggest that there is less certainty in the direction of projected change than found previously.

The year-to-year rainfall variability over Vanuatu is generally larger than the projected change, except for the models with the largest projected change in the highest emission scenario by 2090. The effect of climate change on average rainfall may not be obvious in the short or medium term due to natural variability. Dynamical downscaling of climate models suggests that under a wet scenario, the rainfall increase may be enhanced on the southeast side of islands and reduced on the northwest side of islands in the May–October season.

Figure 3.2: Historical and simulated mean annual Precipitation - Vanuatu

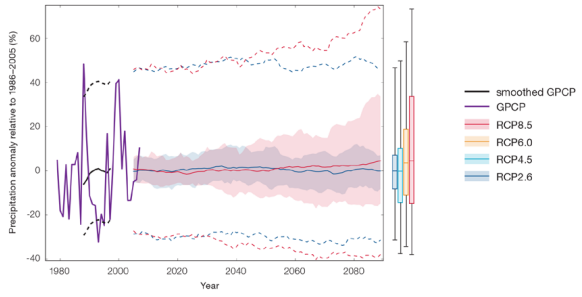


Figure 2: Historical and simulated annual average rainfall time series for the region surrounding Vanuatu. The graph shows the anomaly (from the base period 1986–2005) in rainfall from observations (the GPCP dataset, in purple), and for the CMIP5 models under the very high (RCP8.5, in red) and very low (RCP2.6, in blue) emissions scenarios. The solid red and blue lines show the smoothed (20- year running average) multi-model mean anomaly in rainfall, while shading represents the spread of model values (5–95th percentile). The dashed lines show the 5–95th percentile of the observed interannual variability for the observed period (in black) and added to the projections as a visual guide (in red and blue). This indicates that future rainfall could be above or below the projected long-term averages due to interannual variability. The ranges of projections for a 20-year period centred on 2090 are shown by the bars on the right for RCP8.5, 6.0, 4.5 and 2.6. Source: BOM and CSIRO 2014

Extremes

Extreme Temperature

The temperature on extremely hot days is projected to increase by about the same amount as average temperature. This conclusion is based on analysis of daily temperature data from a subset of CMIP5 models. The frequency of extremely hot days is also expected to increase.

The temperature of the 1-in-20-year hot day is projected to increase by approximately 0.6°C by 2030 under the RCP2.6 scenario and by 0.7°C under the RCP8.5 scenario. By 2090 the projected increase is 0.7°C for RCP2.6 and 3°C for RCP8.5.

Also, while all models project the same direction of change there is a wide range in the projected magnitude of change among the models.

Extreme Rainfall

The frequency and intensity of extreme rainfall events are projected to increase. This conclusion is based on analysis of daily rainfall data from a subset of CMIP5 models using a similar method to that in Australian Bureau of Meteorology and CSIRO (2011) with some improvements, so the results are slightly different to those in Australian Bureau of Meteorology and CSIRO (2011). The current 1-in-20-year daily rainfall amount is projected to increase by approximately 9 mm by 2030 for RCP2.6 and by 8 mm by 2030 for RCP8.5. By 2090, it is projected to increase by approximately 1 mm for RCP2.6 and by 40 mm for RCP8.5.The majority of models project the current 1-in-20-year daily rainfall event will become, on average, a 1-in-13-year event for RCP2.6 and a 1-in-5-year event for RCP8.5 by 2090. These results are different to those found in Australian Bureau of Meteorology and CSIRO (2011) because of different methods used.

Drought

For Vanuatu the overall proportion of time spent in drought is expected to decrease slightly under RCP8.5 and stay approximately the same under all other scenarios. Under RCP8.5 the frequency of drought events in all categories is expected to decrease while the duration of drought events in all categories is expected to

remain stable (Figure 3). Under RCP2.6 the frequency and duration of drought events in all categories is projected to remain stable.

Tropical Cyclones

The projection is for a decrease in cyclone genesis (formation) frequency for the south-west basin (see Table 2). However, the confidence level for this projection is medium. The GCMs show inconsistent results across models for changes in cyclone frequency for the south-west basin, using the direct detection methodologies, with a little over a half of projected changes being for a decrease in genesis frequency. About half of the projected changes, based on these methods, vary between a 15–35% decrease in genesis frequency.

The three empirical techniques assess changes in the main atmospheric ingredients known to be necessary for cyclone formation. About two-thirds of models suggest the conditions for cyclone formation will become less favourable in this region with about one third of projected changes being for a decrease in genesis frequency of between 5 and 30%.

Figure 3.3: Projections of drought in Vanuatu under RCP8.5

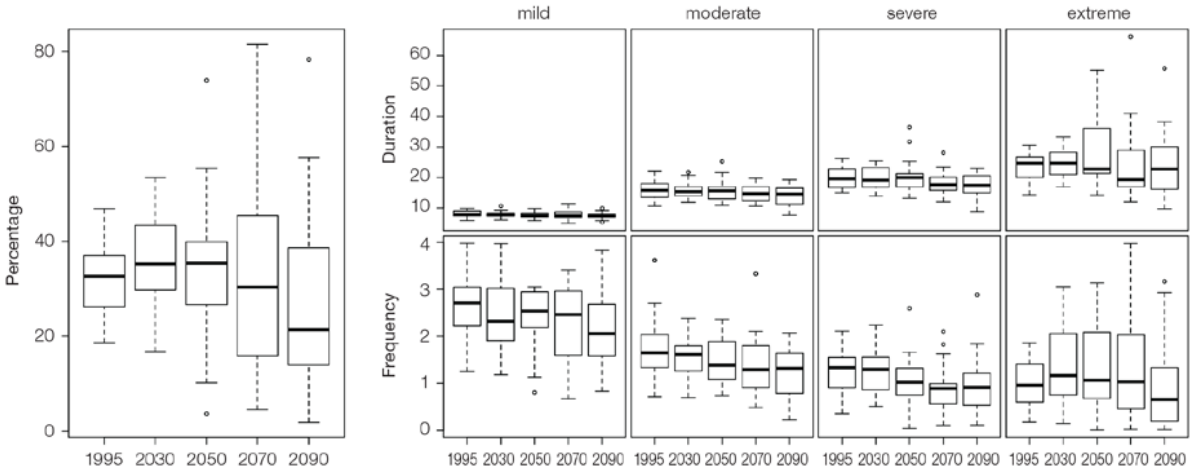


Figure 3: Box-plots showing percent of time in moderate, severe or extreme drought (left hand side), and average drought duration and frequency for the different categories of drought (mild, moderate, severe and extreme) for Vanuatu. These are shown for 20-year periods centred on 1995, 2030, 2050, 2070 and 2090 for the RCP8.5 (very high emissions) scenario. The thick dark lines show the median of all models, the box shows the interquartile (25–75%) range, the dashed lines show 1.5 times the interquartile range and circles show outlier results. Source: BOM and CSIRO 2014.

Ocean Acidification

In Vanuatu the aragonite saturation state has declined from about 4.5 in the late 18th century to an observed value of about 3.9±0.1 by 2000. All models show that the aragonite saturation state, a proxy for coral reef growth rate, will continue to decrease as atmospheric CO2 concentrations increase (very high confidence). Projections from CMIP5 models indicate that under RCPs 8.5 and 4.5 the median aragonite saturation state will transition to marginal conditions (3.5) around 2030. In RCP8.5 the aragonite saturation state continues to strongly decline thereafter to values where coral reefs have not historically been found (< 3.0). Under RCP4.5 the aragonite saturation plateaus around 3.2 i.e. marginal conditions for healthy coral reefs.

While under RCP2.6 the median aragonite saturation state never falls below 3.5, and increases slightly toward the end of the century (Figure 4) suggesting that the conditions remains adequate for healthy corals reefs. There is medium confidence in this range and distribution of possible futures because the projections are based on climate models that do not resolve the

reef scale that can play a role in modulating large-scale changes. The impacts of ocean acidification are also likely to affect the entire marine ecosystem impacting the key ecosystem services provided by reefs.

Figure 3.4: Projected decreases in aragonite saturation state in Vanuatu

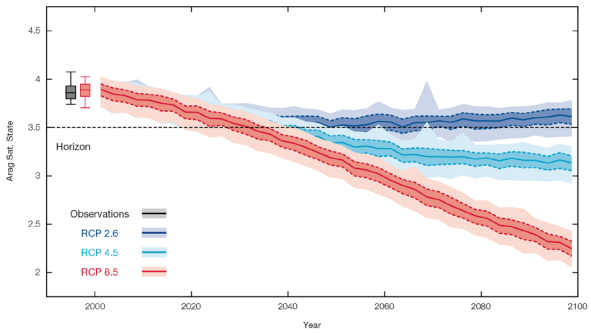


Figure 4: Projected decreases in aragonite saturation state in Vanuatu from CMIP5 models under RCP2.6, 4.5 and 8.5. Shown are the median values (solid lines), the interquartile range (dashed lines), and 5% and 95% percentiles (light shading). The horizontal line represents the transition to marginal conditions for coral reef health. Source: BOM and CSIRO 2014

Coral Bleaching Risk

As the ocean warms, the risk of coral bleaching increases (very high confidence). There is medium confidence in the projected rate of change for Vanuatu because there is medium confidence in the rate of change of SST, and the changes at the reef scale (which can play a role in modulating large-scale changes) are not adequately resolved. Importantly, the coral bleaching risk calculation does not account the impact of other potential stressors.

The changes in the frequency (or recurrence) and duration of severe bleaching risk are quantified for different projected sea-surface temperature (SST) changes (Table 1).

Overall there is a decrease in the time between two periods of elevated risk and an increase in the duration of the elevated risk. For example, under a long-term mean increase of 1°C (relative to 1982–1999 period), the average period of severe bleaching risk (referred to as a risk event) will last 8.0 weeks (with a minimum duration of 2.2 weeks and a maximum duration of 3.5 months) and the average time between two risks will be 3.1 years (with the minimum recurrence of 7.4 months and a maximum recurrence of 8.7 years). If severe bleaching events occur more often than once every five years, the long-term viability of coral reef ecosystems becomes threatened.

Table 3.1: Projected changes in severe coral bleaching risk for the Vanuatu EEZ for increases in SST relative to 1982–1999. Source: BOM and CSIRO 2014

Temperature change [1]	Recurrence interval [2]	Duration of the risk event [3]
Change in observed mean	30 years	4.1 weeks
+0.25°C	26.1 years (24.8 years – 27.4 years)	5.6 weeks (5.1 weeks – 6.0 weeks)
+0.5°C	20.3 years (15.8 years – 24.4 years)	5.3 weeks (4.2 weeks – 6.5 weeks)
+0.75°C	9.5 years (3.2 years – 18.0 years)	6.9 weeks (3.3 weeks – 2.3 months)
+1°C	3.1 years (7.4 months – 8.7 years)	8.0 weeks (2.2 weeks – 3.5 months)
+1.5°C	11.8 months (4.9 months – 3.2 years)	3.1 months (2.8 weeks – 5.3 months)
+2°C	8.0 months (5.0 months – 1.6 years)	4.8 months (1.7 months – 6.5 months)

[1] This refers to projected SST anomalies above the mean for 1982–1999.
[2] Recurrence is the mean time between severe coral bleaching risk events. Range (min – max) shown in brackets.
[3] Duration refers to the period of time where coral are exposed to the risk of severe bleaching. Range (min – max) shown in brackets.

Sea level

Mean sea level is projected to continue to rise over the course of the 21st century. There is very high confidence in the direction of change. The CMIP5 models simulate a rise of between approximately 8–19 cm by 2030 (very similar values for different RCPs), with increases of 42–89 cm by 2090 under the RCP8.5 (Figure 5 and Table 2). There is medium confidence in the range mainly because there is still uncertainty associated with projections of the Antarctic ice sheet contribution. Interannual variability of sea level will lead to periods of lower and higher regional sea levels. In the past, this interannual variability has been about 18 cm (5–95% range, after removal of the seasonal signal, see dashed lines in Figure 5 (a) and it is likely that a similar range will continue through the 21st century.

Wind–driven Waves

During December–March, a small decrease in wave height of up to 10 cm is projected (significant in December and March in 2090 under RCP8.5, and both emissions scenarios in 2035 in December), with a suggested but non-significant decrease in wave period, and no change in mean wave direction (low confidence) (Table 3). An anticlockwise rotation is projected in the larger storm waves, indicative of them being directed more frequently from the north than the south, with a suggested decrease in height (low confidence).

In June–September, there are no statistically significant projected changes in wave properties (low confidence) (Table 3). Non significant changes include a small increase in wave height in August and September.

Figure 3.5: (a) Observed and projected relative sea-level change near Vanuatu

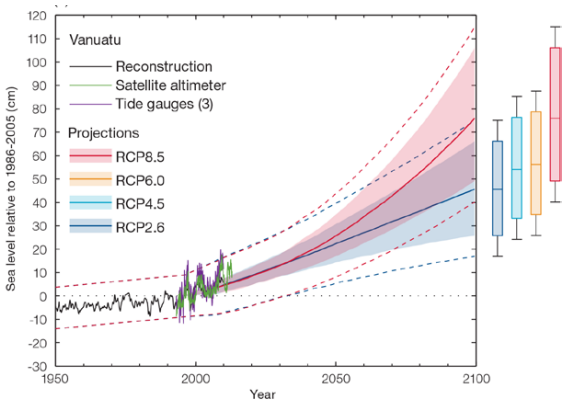


Figure 5: (a) The observed tide-gauge records of relative sea-level (since the late 1970s) are indicated in purple, and the satellite record (since 1993) in green. The gridded (reconstructed) sea level data at Vanuatu (since 1950) is shown in black. Multi-model mean projections from 1995–2100 are given for the RCP8.5 (red solid line) and RCP2.6 emissions scenarios (blue solid line), with the 5–95% uncertainty range shown by the red and blue shaded regions. The ranges of projections for four emission scenarios (RCPs 2.6, 4.5, 6.0 and 8.5) by 2100 are also shown by the bars on the right. The dashed lines are an estimate of interannual variability in sea level (5–95% uncertainty range about the projections) and indicate that individual monthly averages of sea level can be above or below longer-term averages. Source: BOM and CSIRO 2014.

Figure 3.6: (b) RCP4.5:2090

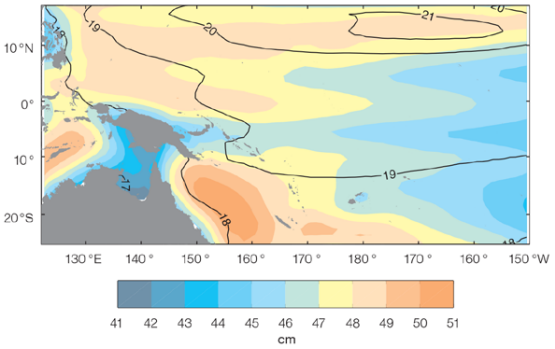


Figure 5: (b) The regional distribution of projected sea level rise under the RCP4.5 emissions scenario for 2081–2100 relative to 1986–2005. Mean projected changes are indicated by the shading, and the estimated uncertainty in the projections is indicated by the contours (in cm). Source: BOM and CSIRO 2014

Table 2: Projected changes in the annual and seasonal mean climate for Vanuatu under four emissions scenarios; RCP2.6 (very low emissions, in dark blue), RCP4.5 (low emissions, in light blue), RCP6 (medium emissions, in orange) and RCP8.5 (very high emissions, in red). Projected changes are given for four 20-year periods centred on 2030, 2050, 2070 and 2090, relative to a 20-year period centred on 1995. Values represent the multi-model mean change, with the 5–95% range of uncertainty in brackets. Confidence in the magnitude of change is expressed as high, medium or low. Surface air temperatures in the Pacific are closely related to sea-surface temperatures (SST), so the projected

changes to air temperature given in this table can be used as a guide to the expected changes to SST. 'NA' indicates where data are not available. Source: BOM and CSIRO 2014

Table 3.2: Projected changes in the annual and seasonal mean climate for Vanuatu under four emissions scenarios

Variable	Season	2030	2050	2070	2090	Confidence (magnitude of change)
Surface air temperature (°C)	Annual	0.6 (0.4–0.9)	0.7 (0.5–1.1)	0.7 (0.4–1.1)	0.7 (0.3–1.2)	*Medium*
		0.6 (0.3–1)	0.9 (0.6–1.5)	1.2 (0.7–1.8)	1.3 (0.8–2)	
		0.6 (0.4–1)	0.9 (0.6–1.3)	1.2 (1–1.9)	1.6 (1.2–2.5)	
		0.7 (0.5–1)	1.3 (0.8–2)	2 (1.5–2.9)	2.7 (1.9–4)	
Maximum temperature (°C)	1-in-20 year event	0.6 (0.4–0.9)	0.7 (0.2–0.9)	0.7 (0.3–1)	0.7 (0.3–0.9)	*Medium*
		0.6 (0.2–0.9)	0.9 (0.5–1.2)	1.2 (0.6–1.6)	1.3 (0.7–2)	
		NA (NA–NA)	NA (NA–NA)	NA (NA–NA)	NA (NA–NA)	
		0.7 (0.3–1.1)	1.4 (0.7–2)	2.1 (1.4–3.1)	2.9 (1.9–4.2)	
Minimum temperature (°C)	1-in-20 year event	0.5 (0.2–0.9)	0.6 (0.2–1)	0.7 (0.1–1)	0.6 (0.1–0.9)	*Medium*
		0.6 (0.1–0.8)	1 (0.3–1.2)	1.1 (0.5–1.6)	1.3 (0.7–1.8)	
		NA (NA–NA)	NA (NA–NA)	NA (NA–NA)	NA (NA–NA)	
		0.8 (0.3–1)	1.4 (0.9–1.8)	2.2 (1.6–2.7)	3 (2.1–3.9)	
Total rainfall (%)	Annual	1 (-7–9)	1 (-6–9)	0 (-10–9)	0 (-8–7)	*Low*
		0 (-9–13)	0 (-9–6)	1 (-9–9)	0 (-14–10)	
		2 (-4–13)	2 (-8–12)	3 (-6–16)	4 (-11–19)	
		0 (-6–8)	0 (-12–14)	2 (-16–15)	5 (-15–34)	
Total rainfall (%)	Nov-Apr	2 (-5–13)	2 (-6–9)	0 (-9–14)	1 (-7–13)	*Low*
		0 (-8–15)	1 (-9–9)	2 (-8–18)	1 (-13–13)	
		3 (-5–15)	2 (-7–11)	3 (-5–16)	3 (-11–22)	
		1 (-6–12)	1 (-9–13)	3 (-14–17)	5 (-13–30)	
Total rainfall (%)	May-Oct	0 (-11–12)	1 (-8–13)	-1 (-17–9)	-2 (-15–10)	*Low*
		0 (-12–15)	-1 (-13–11)	-2 (-14–12)	-1 (-25–14)	
		2 (-6–13)	2 (-11–16)	2 (-11–18)	5 (-9–21)	
		-2 (-10–8)	-1 (-19–16)	-1 (-21–17)	3 (-26–34)	
Aragonite saturation state (Ωar)	Annual	-0.3 (-0.7–0.0)	-0.4 (-0.7–-0.1)	-0.4 (-0.7–0.0)	-0.3 (-0.7–0.0)	*Medium*
		-0.4 (-0.7–0.0)	-0.6 (-0.9–-0.3)	-0.7 (-1.0–-0.4)	-0.8 (-1.1–-0.5)	
		NA (NA–NA)	NA (NA–NA)	NA (NA–NA)	NA (NA–NA)	
		-0.4 (-0.7–-0.1)	-0.8 (-1.1–-0.5)	-1.2 (-1.4–-0.9)	-1.5 (-1.8–-1.3)	
Mean sea level (cm)	Annual	13 (8–19)	23 (15–31)	32 (20–45)	42 (25–59)	*Medium*
		13 (8–18)	23 (15–32)	36 (23–49)	48 (30–67)	
		13 (8–18)	23 (15–31)	35 (23–48)	50 (32–69)	
		13 (8–18)	26 (17–35)	43 (29–59)	64 (42–89)	

Table 3: Projected average changes in wave height, period and direction in Vanuatu for December–March and June–September for RCP4.5 (low emissions, in blue) and RCP8.5 (very high emissions, in red), for two 20-year periods (2026–2045 and 2081–2100), relative to a 1986–2005 historical period. The values in brackets represent the 5th to 95th percentile range of uncertainty. Source: BOM and CSIRO 2014

Table 3.3: Projected average changes in wave height, period and direction in Vanuatu for December–March and June–September

Variable	Season	2035	2090	Confidence (range)
Wave height change (m)	December–March	-0.0 (-0.2–0.1) -0.0 (-0.2–0.1)	-0.1 (-0.2–0.1) -0 1 (-0.3–0.0)	*Low*
	June–September	+0.0 (-0.2–0.3) 0.0 (-0.2–0.3)	0.0 (-0.2–0.3) +0.0 (-0.2–0.3)	*Low*
Wave period change (s)	December–March	-0.1 (-0.6–0.4) -0.1 (-0.6–0.5)	-0.1 (-0.7–0.5) -0.2 (-0.8–0.5)	*Low*
	June–September	0.0 (-0.5–0.5) 0.0 (-0.5–0.5)	-0.0 (-0.6–0.6) -0.1 (-0.6–0.5)	*Low*
Wave direction change (° clockwise)	December–March	+0 (-10–10) 0 (-10–10)	+0 (-10–10) +0 (-10–10)	*Low*
	June–September	0 (-5–5) 0 (-5–5)	0 (-5–10) -0 (-10–5)	*Low*

Wind-wave variables parameters are calculated for a 20-year period centred on 2035.

Vulnerable Sectors

Vanuatu, like all Small Island Developing States (SIDS), is extremely vulnerable to the adverse impacts of climate change. The vulnerability of Vanuatu to climate change is predominantly shaped by its geographic and socio-economic situation. Geographically, the remoteness (long distance to other major land bodies) and dispersed archipelago and mountainous terrain that makes administration, communications, and operations costly and challenging. Its extensive coastline and dependence on marine biodiversity as protein source is, furthermore, prone to climate-induced coastal erosion, spring tides, and species loss/ coral bleaching. The remoteness of the island and small land area also constraints any development of scalable exporting economic sectors (apart from tourism, whereas the low standard of the infrastructure limits the growth and competitiveness of the tourism industry) and creates barriers to attract foreign investments. The small size of the nation, furthermore, can lead to the situation that one disaster (e.g. cyclone) can disproportionally affect an entire sector compared to larger countries where this risk can be spatially more diversified. Other factors that significantly shape the vulnerability of Vanuatu to climate change relate to the financial status of the nation – Vanuatu is a Least Developed Country (LDC) – and the high dependency of the local population on fisheries and agriculture (80% of the population engages in subsistence agriculture). Both sectors are particularly susceptible to climate change.

According to the World Risk Index 2018, Vanuatu ranked highest, out of 172 countries, in the subcategory for overall risk and exposure to natural hazards. Estimations of the report, indicate that over 50 percent of the country's population could potentially become victims of natural disasters. In addition to the climate change related risks, outlined above, Vanuatu is located along tropical cyclone tracks and on the Pacific Ring of Fire (tectonic plate boundaries with a chain of volcanoes), which frequently leads to earthquakes and tsunamis.

Particularly vulnerable to climate-induced impacts are Vanuatu's coastal areas where the majority of the country's population are residing, and a large share of infrastructure is being located. Sea level rise in combination with tectonic subsidence have led to extensive coastal erosion processes and increasingly frequent inundations in some islands. This led in some incidences to the forced relocation of entire communities, e.g. through the planned retreat in the northern island of Tegua, and communities on Aniwa and Torres islands . Sea level rise is also eroding important cultural sites, such as graveyards in Worasiviu village on Pele Island, Marou village on Emau Island and South Santo. These trends are being exacerbated through anthropogenic mangrove removal, sand extraction, and other unsustainable development patterns that increase the coastal vulnerability. Climate change is already exacerbating human displacement, often towards urban centers, as outlined in the National Climate Change & Disaster Induced Displacement Policy.

Sectoral Impacts

Almost all economics sectors in Vanuatu are likely to be impacted by climate change induced cyclones, temperature rise, changing precipitation, sea level rise, inundations, salinity, ocean acidification and other hazards. The most vulnerable sectors considered in the Second National Communication of Vanuatu to UNFCCC are: (i) agriculture (crops, cattle and sustenance); (ii) fisheries (freshwater, coastal, deep sea, aquaculture); (iii) forestry (including mangroves and production forest); (iv) tourism (cruise-ships, hotels); (v) transport (road, ferries, and air); (vi) infrastructure (utilities [energy, water, and sanitation], houses, offices, and industry); (vii) and Health. The climate change impacts on these sectors are outlined below, and are contributing to urbanization and internal displacement with the associated challenges of security, housing, waste management and social protection.

Agriculture

Due to the large amount of the population, around 80%, being dependent on subsistence agriculture the climate change impacts pose a tremendous risk to Vanuatu's agriculture sector and food security. Agricultural activities in Vanuatu are particularly susceptible climate change induced changes in precipitation patterns (as most cropping practices are rain-fed), extreme rain or drought events, salinization processes, increases in evapotranspiration, seasonal variations, and reduction in fresh-water availability. Prolonged and intense rainfall, for example, damage seedlings and encourage conditions that promote diseases and pests. Droughts, on the other hand, cause added thermal stress on plants. Projected temperature increases may reach the maximum heat tolerance thresholds of crops and induce heat stress and crop failure, especially in traditional crops like cassava, taro, and yam. Communities on Torres islands, South Santo, South Malekula, Central Pentecost, Epi, Erromango, Aniwa and Aneityum in particular reported impacts from increased temperatures and droughts on declining crop yields and lowered livestock productivity during the 2015 – 2016 El Nino period.

Inundations with saltwater and salinization of soils and freshwater lenses poses additional risks to coastal and low-lying farms. These climatic impacts are exacerbated by soil erosion and loss of soil fertility due to improperly managed deforestation and environmental degradation. Furthermore, anthropogenic and demographic pressures through migration/urbanization, loss of social cohesion and culture and over use of natural resources (poor land management practices) are exerting unsustainable pressures on the fragile resources with associated loss of ecosystem services.

This demands adaptive responses from the industry, the government, and local people to reach a paradigm shift in resilient livelihood choices and production patterns.

While specific economic impact studies from climate change on the agriculture sector are limited, the Cyclone Pam (Category Five) post disaster needs assessment indicated a total agriculture sector damage and losses caused estimated to be close to VT 6.1 billion (USD 51,000,000). The crop sub-sector was mostly affected especially with crops such as such as kava, banana, coconut, cocoa, and coffee, along with seasonal crops (vegetables) and annual crops (cassava, taro).

Figure 3.7: Crop damage caused by Tropical Cyclone Pam. Credit: Phys.org

Fisheries

The fisheries sector is of high importance for the country for income generation and as a food source, particularly for fisher communities. Climate change poses a significant threat towards Vanuatu's fisheries and marine life. The changing ocean temperature regime can lead to migration of fish populations and habitat impacts. Changes in ocean circulation patterns, furthermore, may affect the aquatic food web as species seek conditions suitable for their lifecycle. Climate-induced ocean acidification processes could impact the marine environment through deficiency in calcium carbonate, affecting shelled organisms and coral reef calcification. The reduction of coral reefs (e.g. due to acidification or temperature-driven coral bleaching) can lead to reduced fish and invertebrate populations which naturally seek shelter or raise their offspring in reef habitats. Naturally occurring extremes in sea surface temperatures (SSTs), exacerbated by climate change, have already been observed to have indirect and direct impacts on demersal fish and invertebrates. In 2015-2016, high SSTs resulted in mass fish mortality, likely due to the lowered oxygen concentration at higher sea temperatures. On the islands of Torres, Pentecost (particularly villages of Bwatnapni, Igi and Levetnabal), Epi, Aneityum and Erromango) there have been observed coral bleaching events with associated reductions in local fish stocks. Changing precipitation patterns, ocean temperatures, and habitats can, further, influence fish and invertebrate physiology i.e. metabolism, growth, reproduction. High temperatures may also induce growth of aquatic micro and macrophytes, which often lead to habitat degradation and oxygen depletion.

Coastal marine ecosystems can be impacted through enhanced sedimentation due to soil erosion from agricultural and forestry practices, intense cyclones or storms that cause physical damage, or extreme rainfall events leading to flash floods and landslides as in the case of Torres and Epi islands.

The projected alterations to habitats are expected to have the greatest effects on coastal fish and invertebrates given their high sensitivity to food and shelter quality changes they obtain from coral reefs, seagrasses, mangroves and intertidal flats. Potential impacts include reduced diversity and abundance of fish and invertebrates as their food resources decline, and mortality rates increase due to greater predation as structurally complex habitat is lost.

Specialist fish species that depend directly on live coral for food and shelter are likely to experience grater impacts than generalist species e.g. carnivorous snappers (Lutjanidae) and emperors (Lethrinidae). The proportions of herbivorous parrotfish (Scaridae), surgeonfish (Acanthuridae), and rabbitfish (Siganidae) are expected to increase as the percentage cover of live corals declines and the cover of macroalgae increases.

The vulnerability of bottom dwelling fish to the combined direct and indirect effects of climate change by 2035 is expected to be low, and any such effects will also be closely linked to local stressors such as fishing pressure and habitat loss. However, the vulnerability of bottom-dwelling fish is expected to increase to moderate by 2050 and to high by 2100. Invertebrates are estimated to have little or low vulnerability to climate change by 2035, increasing to low to moderate by 2050 and moderate to high by 2100.

Nearshore pelagic fisheries

There are large projected difference in tuna abundance between the western and eastern Pacific, and a greater projected decrease in zooplankton productivity in the western Pacific. When combined with the average proportions of tuna and non-tuna species in the catch, the result is a substantial difference in the projected abundance of nearshore pelagic fish in the two parts of the Pacific region. In the west, which includes Vanuatu, the overall catch is projected to decrease by 2100.
Although the availability of nearshore pelagic fish in the western Pacific is expected to decline, countries in that part of the region should be able to substantially increase catches of tuna by nearshore pelagic fisheries in coming years because there should still be ample numbers of tuna for the coastal fishery.

Aquaculture

Vanuatu's main aquaculture commodities for food security (Nile tilapia, giant clam, trochus, Penaeid prawn and Macrobrachium shrimp) are expected to be exposed to projected increases in water temperature and rainfall. Low lying ponds near the coast are also expected to be exposed to sea level rise and possibly more intense cyclones. Enterprises and households farming these species will be sensitive to these chang-

es because temperature regulates fish growth and reproduction and rainfall influences water temperature and water exchange (and its effect on dissolved oxygen levels) in ponds. Aquaculture operations however for tilapia are expected to benefit from the projected increases in temperature and rainfall as growth rates increase and more locations become suitable for pond aquaculture.

Other main aquaculture commodities such as shrimp, seaweed, giant clams, sea cucumbers and trochus are expected to be more vulnerable to climate change. These will be exposed to a variety of changes – increases in seas surface temperatures, ocean acidification, decreases in salinity due to changing rainfall patterns, sea level rise and possibly more intense cyclones – and are sensitive to such changes in various changes.

Shrimp farming may benefit from higher growth and improved yields due to increasing temperatures. However, potential longer term negative impacts include greater risk of temperature-related diseases and problems with ponds drying between production cycles as sea level rises.

Production of giant clams and cultures corals is likely to become more difficult as increasing sea surface temperatures and ocean acidification make conditions more hostile for their growth and survival. In some locations, sea level rise could reduce the potential impact on giant clams and coral by improving water exchange and nutrient supply to nutrient poor sites.

Higher temperatures, reduced salinity and ocean acidification and degraded seagrass habitats are likely to increase the mortality of hatchery – reared sea cucumber juveniles released in the wild. Sea cucumbers grown in ponds will be at greater risk from the increased likelihood of stratification caused by higher temperatures and rainfall.

Sea level rise and increased rainfall are likely to reduce the availability of habitat for juvenile trochus, limiting the areas suitable for trochus restocking programmes.

Economic impacts

According to Rosegrant et al (2016), Vanuatu will remain a net exporter of oceanic fish especially tuna. Conversely there is an anticipated decline in coastal fish production during the 2010 – 2050. Given that many of Vanuatu's poorer households rely on coastal fisheries for their consumption needs, this projected scenario has serious food security implications.

Figure 3.8: Local woman while fishing on shelf reef in Anelcauhat, aneityum island at low tide. Credit: VCAP

Forestry

With a total of 36% of Vanuatu's landmass the forest coverage is high and makes the country a net carbon sink. Forests, as fisheries, always been an integral part of lives of the people of Vanuatu and contribute to the welfare and economic development. There are limited assessments been done on the effects of climate change on the forestry in Vanuatu.

However, drawing on relevant impact projections it can be expected that climate-induced changing precipitation trends, temperature and seasonal variability, and intensified extreme weather events create significant additional stress to many tree species and biodiversity of Vanuatu's forests. This can lead to changed ecosystem composition and decline in plant density or migra-

tion of some species.

In its National Forest Policy (2013-2023) Vanuatu acknowledges the need to adapt to climate change and targets to "integrate climate change adaptation issues into forestry sector planning and activities". However, the enforcement of regulations is hindered by the fact that all forests are privately owned, whereas the constitution demands from landowners to manage their land in a way that "safeguards the national wealth, resources and environment in the interests of the present generation and of future generations".

Tourism

With a contribution of around 40% to Vanuatu's GDP (in 2014), tourism is one of the most important economic sectors with the highest growth potential for the nation. Climate change could, however, be a threat to the industry and its growth potential. This is acknowledged in Vanuatu's Strategic Tourism Action Plan 2014-2028.

The industry is likely being impacted through a reduced attractiveness as a tourist destination due to loss of destination habitats such as coral reefs (e.g. due to thermal bleaching) and reduced biodiversity. Further, tourism infrastructure that is located close to the shoreline is now under threat through coastal erosion and storm surges, both intensified and caused by cyclones and sea level rise (see above). For example, tourism was largely impacted by the passage of the Category Five Cyclone Pam which hit Vanuatu in 2015. The tourism sector was left with an estimated damage of around VT 5.9 billion (USD 50,000,000 approximately) and estimated losses of VT 3.6 billion (USD 30,000,000 approximately) for a six-month period. The majority of major hotels ceased their respective operations within that six-month period.

Increasing temperatures is further leading to increasing cooling costs and/or heat stress for tourists. And more variable rainfall can lead to drought and water shortages for tourists. It is inevitable to consider climate change in tourism development planning processes in order to enhance the sectors resilience and enable a sustainable sectoral growth.

Figure 3.9: Aerial view of damaged hotel. Credit: Vanuatu TC Pam PDNA

Transport & Infrastructure

Almost all major services, settlement and tourism infrastructure in Vanuatu are coastal. This focus on the coastal zone makes the populations extremely vulnerable to sea level rise, erosion and inundation. Transportation is pivotal for the country's prosperity and further development. Air and sea are the predominant modes of transportation in Vanuatu. There are 29 airports (5 paved and 24 unpaved) and two main ports and terminals across the different islands.

Developed road systems only exist on larger islands, whereas most roads are being located in proximity to the coasts. The existing road system comprises a total 1,894 km of roadways (111 km paved and 1,783 km unpaved). The inter-island transportation is already impacted by extreme climatic events frequently interrupting air and shipping services. Like the road systems most human settlements and man-made infrastructure is located in close proximity to the shoreline. The main commercial centres of Port Vila and Luganville, are located on the perimeter of the major islands. The location of existing infrastructure close to the coast enhances its susceptibility and vulnerability to climate change impacts, such as coastal erosion, storm surges, cyclones, sea level rise, extreme rainfall and landslides. Primary and secondary local roads on the islands of Santo (south), Malekula, Pentecost and Epi

are observed to generally experience flooding during episodes of heavy rain. Where bridge or river crossings exist, such structures undergo severe erosion and get washed away given from heavy flooding. Pavements or footpaths are furthermore likely to be impacted by temperature variations or precipitation. Heavy rainfall trends have contributed to the inaccessibility of footpaths on the islands of Aneityum and Erromango.

Community structures such as schools, churches and airports have been observed to be increasingly affected or threatened by sea level rise and coastal erosion e.g. on Torres, Santo, Pentecost, Epi, Aniwa, Aneityum and Erromango islands.

Economic impact

The transport infrastructure networks and facilities throughout Vanuatu suffered severe physical damage as a result of Tropical Cyclone Pam. Total damage and loss figures amounted to over VT 5 billion (USD 50,000,000).

Figure 3.10: Destroyed satellite dish on Tanna island. Credit: Vanuatu TC Pam PDN

Figure 3.11: Coastal erosion threatening church building and households on Ahamb Island, Malekula. Credit: VCAP

Health

Climate change effects on human health are both direct and indirect, and are expected to exacerbate existing health risks, especially in the most vulnerable communities, where the burden of disease is already high.

Extreme weather and climate events such as tropical cyclones, storm surges, flooding, and drought can have both short and long-term effects on human health, including drowning, injuries, increased disease transmission, and health problems associated with deterioration of water quality and quantity. Vanuatu's climate is conducive to the transmission of vector borne diseases such as malaria, dengue, filariasis, and schistosomiasis. A Commonwealth study revealed that during a period where Vanuatu experienced five cyclones, incidence of malaria preceded that of the previous year (Howes et al, 2018). In its' 2015 report, WHO classed a number of health risks that are likely from climate change impacts. This included health conditions such as respiratory illness (medium risk), mental health disorders, the aggravation of non-communicable diseases (high risk risk), water borne diseases (high risk) and food borne diseases (high risk).

Ciguatera fish poisoning (CFP) occurs in tropical regions and is the most common non-bacterial foodborne illness associated with consumption of fish. Distribution and abundance of the organisms that produce these toxins, chiefly dinoflagellates of the genus Gambierdiscus, are reported to correlate positively with water temperature. Vanuatu has been identified as one of the countries with high incidences of CFP, a trend closely associated with the enabling factor of increasing SSTs (Nurse et al, 2014).

Other direct climate change impacts related to intensified cyclones include those that could damage existing health infrastructure or hinder the transportation of injured or sick people, and damage critical water and energy supply infrastructure, affecting the people's health.

Water security

Freshwater supply in Vanuatu has always presented challenges. On high volcanic and granitic islands, small and steep river catchments respond rapidly to rainfall

events, and watersheds generally have restricted storage capacity. On porous limestone and low atoll islands, surface runoff is minimal, and water rapidly passes through the substrate into the groundwater lens. Rainwater harvesting is also an important contribution to freshwater access. Rapidly growing demand, land use change, urbanization, and tourism are already placing significant strain on the limited freshwater reserves.

These issues also occur on a background of decreasing rainfall and increasing temperature. Severe water shortages were particularly observed and reported in most islands of Vanuatu during the 2015 -2016 El Nino period. More specifically for the islands of Torres, Malekula, Santo, Pentecost, Epi, Erromango, Aniwa and Aneityum, gravity feed and rainwater harvesting systems encountered low flow rates or depleted water storage. Extreme events such as cyclones also aggravate Vanuatu's already delicate water resource situation. Tropical Cyclone Pam, one of the more intense cyclones to occur in the southern hemisphere, hit Vanuatu in 2015. The cyclone caused widespread damage including to community water infrastructure for example affected gravity feed systems in Central Pentecost. Total damage effects from Tropical Cyclone on water and sanitation systems amounted to VT 697,267,000 (USD 6,000,000 approx.).

Figure 3.12: Immediate solutions to destroyed housing and rainwater harvesting. Credit: Vanuatu TC Pam PDNA

Figure 3.13: Young mother carrying water on Toga Island. Credit: VCAP

Gender Impacts

Due to prevailing gender inequalities and social norms, women and girls are disproportionately affected by climate change and disaster impacts.

According to the Vanuatu National Statistics Office (2016), more women than men (49% and 41%, respectively) are involved in the subsistence economy, and there are more female headed single parent households with children, grandchildren or extended family members compared to men. Women consequentially are more vulnerable and face higher poverty risks as a result of climate change in areas of food security, energy access and water scarcity.

Women on the islands of Maskeylenes (Malekuka) and Torres particularly experience higher levels of vulnerability during drought periods given responsibilities relative to food preparation, bathing their children and general household cleaning chores. On Maskeylenes, it has been observed that climate driven impacts on water are triggering tensions between family groups where access rights are concerned. During heavy rain or flood periods, women (such as on Santo Santo) also experience a sense of isolation when there is limited access to particular critical health services due to the inaccessibility of connecting bridges or river crossings. There have also been reported cases where children, such as on Pentecost or Santo, being washed away by raging rivers or flood waters while attempting to attend school.

Climate related disasters impacts on women and children differently to men. In 2015 Tropical Cyclone Pam (Category Five) left extensive damage of pandanus trees and resulted in the loss of livelihoods for many ni-Vanuatu women who rely on the leaf for weaving and selling mats, as well as the female vendors which on sell the pandanus woven products to tourists (Government of Vanuatu, 2015).

Climate related disaster damages to health facilities and associated interruptions to medical services can also affect women.

Pregnant women may not be able to access timely obstetric care when a climate related disaster strikes. Reproductive health services will not be available, or reach those in need, if disaster response and plan are not attuned to gender issues. It was estimated that 900 pregnant women would require specialized medical assistance within the nine months immediately after Cyclone Pam (Government of Vanuatu, 2015).

Sexual and gender and gender based violence against women and girls has been shown to escalate in the aftermath of a climate derived disaster. It was reported that cases of domestic violence increased by 300 percent on the island of Tanna as a result of Cyclones Vania and Atu (UN Women, 2016).

Adaptation and Sustainable Development

Vanuatu recognizes the inextricable linkages between climate change and development. Climate change impacts can set back years of development gains and withhold people or communities into a vicious cycle of poverty. The category five (5) Tropical Cyclone Pam which hit Vanuatu in 2015 was an example of an extreme event which had far reaching impacts to the country's socio-economic development. The cyclone caused loss and damage costs amounting to over 64 percent of Vanuatu's GDP. Furthermore, ill planned development pathways can exacerbate underlying vulnerabilities or aggravate exposure to climate change impacts.

In 2016 Vanuatu launched its' National Sustainable Development (NSDP) Plan 2016 – 2030, the People's Plan. This plan serves as the country's highest-level policy framework. The NSDP acknowledges the importance of a balance the 'three pillars' of sustainable development, encompassing society, environment, and the economy. In line with the three pillars, the plan outlines 15 national sustainable development goals.

The third target of the environment pillar (ENV 3) addresses the climate change links stating that they seek to build "A strong and resilient nation in the face of climate change and disaster risks posed by natural and man-made hazards". Accordingly, the Vanuatu SDG Voluntary National Review report (GoV 2019), highlights steady progress made by the country in its' climate action development related goals especially in the areas of climate change governance, climate change monitoring and early warning systems, adaptive capacities and climate finance access.

In addition to the NDSP, the government of Vanuatu published a monitoring and evaluation framework in which they outline on how they want to measure progress towards reaching the development goals. The document provides information on the baseline situation of each indicator and the aspired measurable target by 2030. Some objectives for the ENV 3 goal are, for example a 100% mainstreaming of CC and disaster risks in public policies, budgets, and legislation by 2030, as well as a 100% coverage of all provinces by a multi-hazard warning system.

National and Sectoral Adaptation Programs

The following section provides an overview of the key climate change related national policies, plans regulatory frameworks and projects.

Climate change acts, plans, and national targets

The following section provides an overview of the key climate change related national plans and frameworks.

The Environmental Management and Conservation Act No. 12 as amended by The Environmental Management and Conservation (Amendment) Act No. 28 (2011): The initial 2002 Act, which was amended in 2011, is the most important environmental legislation in the country. It, particularly, addresses regulations in the four areas: (i) biodiversity; (ii) environmental impact assessments; (iii) administration; (iv) bio-prospecting laws and community conservation areas (CCAs). The initial act was revised in 2011 (into the Amendment Act No. 28). The revised act directly addresses the climate change related challenges and also provides a definition of the term, reflecting common IPCC terminology (p. 3): "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". It, furthermore, requests that climate change adaptation and mitigation issues need to be considered during decision-making and policy formulations associated to the terms of the Act. It moreover demands the inclusion of a

climate change database in the Environmental Registry. The Amendment Act also makes a direct reference to Vanuatu's obligations under the UNFCCC, for both adaptation and mitigation, and enables the Minister to enact regulations to meet the country's obligations.

Forestry Rights Registration and Timber Harvest Guarantee Act No. 28 (2000): This is another important act in perspective to climate change mitigation in Vanuatu. The Act regulates the classification, registration, transfer, and granting of forestry rights. The Act also defines a carbon sequestration right as: "a right conferred by agreement or otherwise to the legal, commercial or other benefit (whether present or future) of carbon sequestration by any existing or future tree or forest on the land".

The initial Act was amended in 2012 to include some regulations on sandalwood products and is now referred to as the Forestry Rights Registration and Timber Harvest Guarantee (Amendment) Act No. 8.

Nationally Determined Contributions: The NDC, lays out adaptation and mitigation strategies to increase climate resilience. The Government of Vanuatu highlights that it belongs to the Small Island Developing States, which recognised by the UNFCCC and IPCCC as most vulnerable countries towards climate change impacts, while having contributed marginally to global greenhouse gas emissions. Regardless, Vanuatu's NDC sets aims to achieve an ambitious mitigation contribution with a transitioning to close to 100% renewable energy in the electricity sector by 2030. This contribution would reduce emissions in the energy sector by 72Gg by 2030. Emissions in this sector were around 130 Gg in 2010 but are expected to rise to 240 Gg by 2030 (3% per annum). Furthermore, it aims to reduce emissions in all sectors, except agriculture and forestry, by 15%.

The forestry sector mitigation will be attended to as part of the existing REDD+ program and the mitigation in the agriculture sector will depend on cooperative programs with other nations. This contribution is based on using the best available data.

The outlined adaptation targets in the NDC resemble the adaptation priorities and related project ideas, outlined in Vanuatu's NAPA (2007) and Vanuatu Climate Change and Disaster Risk Reduction Policy 2016 – 2030

National Adaptation Programme of Action (NAPA) 2007: The objective of the NAPA was to develop a country-wide programme of immediate and urgent project-based adaptation activities in priority sectors, in order to address the current and anticipated adverse effects of climate change, including extreme events. Vanuatu's NAPA proposed five priority projects in the fields: (i) agriculture and food security (preservation/ processing/ marketing, modern & traditional practices, bartering); (ii) water management policies/ programmes (including rainwater harvesting); (iii) sustainable tourism; (iv) community based marine resource management programmes (modern & traditional, aqua-culture); and (v) sustainable forestry management. For the forestry sector, the NAPA highlights the importance of forests to local communities and for their significance to the country's cultural heritage.

National Adaptation Plan (NAP): A GCF proposal has been developed by UNEP to develop the NAP for Vanuatu for a grant funding of USD 3 million. This proposal aims to strengthen adaptation planning and governance particularly within central development mechanisms.

Vanuatu National Energy Roadmap (2013): The roadmap, developed by the Department of Energy proposes a long-term development plan for the energy sector to achieve the overall vision: "To energise Vanuatu's growth and development through the provision of secure, affordable, widely accessible, high quality, clean energy services for an Educated, Healthy, and Wealthy nation.

Vanuatu Strategic Tourism Action Plan 2014-2018: This strategic plan provides a high-level

analysis of and guidance to tourism in Vanuatu with the vision that "tourism celebrates Vanuatu's culture and environment, empowers its people and captivates its visitors throughout its islands". The plan identifies 5 key priorities and incorporates an action plan that outlines 44 actions categorized into 6 key areas. Climate change is acknowledged in the plan, but specific risks posed to tourism are not described in detail and climate change issues do not appear to be fully mainstreamed. Climate change is mentioned in one proposed activity, namely to "develop and implement a Sustainable Tourism Development Policy that includes Environmental Management, Climate Change, Eco-Tourism Cultural Tourism and managing social impacts".

Policy and Regulatory Framework

The following section provides an overview about key policies and regulatory frameworks of importance to climate change response in Vanuatu.

Vanuatu Climate Change and Disaster Risk Reduction Policy 2016 - 2030: This flagship policy document is the key strategy of Vanuatu to cope with and mitigate risks, including climate change induced risks. It was jointly developed by the government and the Secretariat of the Pacific Community in 2015.

The strategic Goal outlined in the document is to achieve 'resilient development', which is further described to incorporate "activities that enable and strengthen capacities to absorb and quickly bounce back from climate and/or disaster shocks and stresses". This overarching goal intents to drive planning, decision-making, programming and project delivery across government and its partners.

The document consists of a range of measures based on sustainability, accountability, collaboration, equity, community focus, and innovation. It addresses the six strategic priorities of: (i) governance; (ii) finance; (iii) knowledge and information; (iv) climate change adaptation and risk reduction; (v) low carbon development; and (iv) response and recovery.

The objectives of these strategic priorities, which are further specified by proposed actions in the document, are:

i. to enhance strategic frameworks and institutional structures to deliver effective climate change and disaster risk reduction initiatives in a coordinated, integrated and complementary manner;
ii. to ensure that adequate resourcing is available for climate change and disaster risk reduction activities, build financial capacity to manage resources, and enable access to increased international funding;
iii. to meet stakeholders' needs for climate change and disaster risk knowledge and information, and improve communication-related interventions that empower appropriate climate and disaster risk management actions;
iv. to integrate and strengthen climate change adaptation and disaster risk reduction initiatives across national, provincial and local levels, and across all sectors;
v. to expand sustainable development opportunities that reduce carbon emissions and simultaneously contribute to resilient livelihoods and wellbeing; and
vi. to strengthen and build capacity in the areas of disaster preparedness, planning, response and recovery.

The document, further, outlines options and pledges to enable a gender and socially inclusive process in delivering the outlined actions and reaching the objectives. Despite the long initial time-frame of the plan until 2030, it is perceived as being a living document with a periodic review every three to five years in order to reflect changing framework conditions and developments.

Vanuatu Framework for Climate Services (VFCS) (2016): The framework was developed by the Vanuatu Meteorology and Geo-Hazards Department, under the Ministry of Climate Change. The goal of the VFCS is to ensure that Vanuatu's climate services are of world-class standard, sustainable, are reach-

ing all end-users, and effectively help people manage and adapt to climate variability and change in Vanuatu. The framework is consistent with Vanuatu's NAPA, Vanuatu's Climate Change and Disaster Risk Reduction Policy 2016 to 2030, and the Pacific Islands Meteorological Strategy.

The VFCS maps out information requirements and users of climate services, and highlights gaps and needs that should addressed in the short- and medium term. To address these identified gaps, the framework proposes a list of recommended activities. It, further, proposes a roadmap on when each measures could be implemented, prioritises them, and provides an estimated required budget.

Vanuatu Forest Policy (2013-2023): Guided by Vanuatu's Department of Forestry, this Forest Policy 2013-2023 was developed building up on and updating the 1997 National Forestry Policy. The policy was developed in an integrative manner, involving a range of stakeholders in its development. The Forest Policy also draws clear linkages towards climate change mitigation and adaptation through presenting clear directives and implementation strategies. The policy, for example, targets to: "Integrate climate change adaptation issues into forestry sector planning and activities". The strategies outlined to achieve this directive include:

- Develop forestry-related climate change adaptation demonstration projects including concerns for food security, soil stabilization, water management, and coastal erosion.
- Raise awareness of stakeholders on forestry climate adaptation opportunities in Vanuatu and develop related materials.
- Liaise, collaborate and share expertise with relevant government and non-government organizations (national, regional and international) to assist local efforts to adapt to climate change.
- Introduce and promote climate change resilient tree species and varieties.
- Maintain and enhance food security through agro-forestry systems.
- Identify and seek financing for novel and promising forestry adaptation projects and programs.
- Rehabilitate watershed and water catchment areas to secure water supplies.
- Systematically assess and continuously monitor the impacts of climate change on forest systems.
- Zone development activities and undertake land use planning to minimize site-specific climate change impacts.
- Develop and regularly update a database of climate change adaptation information in the Vanuatu forest sector and
- Identify, prioritize and implement appropriate and effective strategies for the forestry sector to adapt to climate change.

REDD+: The SPC-GIZ Regional REDD+ Project has supported the Department of Forests to design and train its offices on a new forest inventory protocol, which includes climate adaptation assessments.
The program has also supported the finalization of the Vanuatu REDD+ Readiness proposal and worked to assess the climate adaptation and mitigation costs of several possible REDD+ sites on the island of Santo.

National Water Strategy 2008-2018: The National Water Strategy calls for sustainable and equitable access to safe water and sanitation for the people of Vanuatu to support improved health and promote social and economic development. It explicitly recognizes that climate related changes could be expected to limit the future availability of potable water, constrain its productive use and impact negatively on Vanuatu's pristine natural environment.

Vanuatu National Fisheries Sector Policy 2016-2031: This policy provides a high-level framework to fulfil the vision to promote a "healthy and sustainable fisheries sector for the long term economic, social and food security for the current and future generations of the Republic of Vanuatu. One (objective Nr.5) out of eight identified priority objectives of the policy address "climate change and disaster risk reduction" and intents to investigate the impacts of environmental and climate

change on fisheries resources and habitats. To achieve this objective the policy outlines three strategic actions for the fishery sector in the field of or relevant to climate change adaptation: (i) undertake baseline assessments marine environment for long term climate change monitoring; (ii) implement mitigation and adaptation and disaster risk reduction activities in readiness for natural disasters; and (iii) strengthen community-based management through co-operative approach.

National Ocean Policy 2016: Vanuatu's maritime jurisdiction comprises 98% of the nation and includes living and non-living marine resources that contribute significantly to the country's economy, that are fundamental to the wellbeing of its citizen. This policy acknowledges the nations dependency on its ocean and intents "to conserve and sustain a healthy and wealthy ocean for the people and culture of Vanuatu, today and tomorrow". The policy outlines actions for six thematic areas, namely: (i) marine spatial planning and marine protected areas; (ii) fisheries management; (iii) marine tourism; (iv) marine transport; (v) deep sea mining; (vi) climate change and disaster risk reduction. The actions identified under the last category six on climate change include to: (i) promote and support efficient, effective Climate Change & Disaster Risk Reduction efforts using Ecosystem-based Approaches; (ii) facilitate and enhance appropriate measures to manage Climate Change & Disaster Risk Reduction knowledge & information; and (iii) promote and support an efficient, effective Low Carbon & Mitigation Approaches & Strategies to ensure safety, security and protection of the marine environment.

Very recently, in June 2018, the Department of Environmental Protection and Conservation (DEPC) published the Vanuatu National Biodiversity Strategy and Action Plan (NBSAP). This strategy and action plan is based on an impressive survey recording over 600 potential Community Conservation Areas (CCAs). A second round of prioritization, conducted by DEPC, led to build a short list of 113 priority areas.

This achievement was completed while the MACBIO regional project was finishing public consultations related to MACBIO regional bioregion survey and biophysically special unique marine areas survey. This promising business as usual scenario presents significant opportunities for further GCF investment to expand Vanuatu's protected area coverage, the effectiveness of its management and its longer term sustainability.

Most notably there is an opportunity to provide the additional technical resources required to support a strategic shift towards a more structured ecologically representative protected area system across the entire archipelago, with particular and new opportunities in offshore marine areas e.g. Ensuring the sustainability of traditional kastom conservation and management efforts; The establishment of coral reef monitoring; Greater protection of Vanuatu's ocean; Improved capacity and collaboration at all levels; Improved management effectiveness and financial sustainability; Improvement of information and evidence-based decision making

Agriculture Sector Policy 2015-2030: This agriculture sector policy is in line with other key planning frameworks and aspires that: "The nation's agricultural resources are managed in an integrated and sustainable manner to provide food and improved incomes as well as contribute to environmental and social services to enhance wellbeing of all people in Vanuatu." The policy outlines clear linkages of other key economic sectors, such as tourism and gives directives under 13 thematic areas – one of which is 'climate variability, climate change, and disaster risk reduction'. The climate change related directive is to "mainstream climate variability, climate change and disaster risk reduction using adaptation and mitigation strategies in all agriculture initiatives and developments."

National Livestock Policy 2015-2030: This Policy framework will guide the development of the livestock sector to realise the vision that "the livestock sector is modern, sustain-

ably managed to benefit all its stakeholders, contribute to greater socio-economic development, and in its endeavours ensures sound environmental and climate proofing practices, including, achieving a national cattle herd of 500,000 heads by year 2025". The policy identifies a lack of knowledge of climate change and adaptation options a constraint and dedicates chapter 8 of the policy to outline desired progress in the field of climate change adaptation and disaster reduction for the livestock sectors.

Gudfala Kakae Policy 2017-2030: These policy intends to promote a healthy and locally sourced nutrition/ food supply for Vanuatu's citizens. To influence the production and availability of aelon kakae (island food) in Vanuatu, the policy comprises six policy objectives, namely: (i) improve access to affordable, nutritious diet through a sustained increase in production of aelon kakae; (ii) promote aelon kakae as a key part of a sustainable nutritionally balanced diet; (iii) improved access to nutritious, convenient aelon kakae through increased access to appropriate technology, knowledge and skills in food production, preservation, marketing, and storage; (iv) facilitate a reduction in consumption of food imports contributing to poor health outcomes; (v) improve resilience of agricultural production systems through the adoption of sustainable and climate smart agricultural practices; and (vi) improved multi-sector co-ordination, implementation and monitoring of action to address food and nutrition security, and food safety.

National Environment Policy and Implementation Plan (NEPIP) 2016–2030: The NEPIP is an overarching policy for the sustainable conservation, development and management of the environment of Vanuatu, and aims to: i) provide for the co-ordination of related activities; ii) promote the environmentally sound and safe management and conservation of the natural resources and environment of Vanuatu; and iii) outline the operational matters necessary to implement i) and ii) above. The NEPIP outlines 5 key goals of which one is directed to climate change: "[to build] a strong and resilient nation in the face of climate change and disaster risks posed by natural and man-made hazards." The associated policy objective is to support the implementation of 'Vanuatu Climate Change and Disaster Risk Reduction Policy 2016 – 2030'.

National Waste Management and Pollution Control Strategy and Implementation Plan 2016-2020: In line with other development plans, this waste management and pollution strategy intents to promote "an environmentally sustainable Vanuatu, in which all types of wastes generated are reduced, collected, reused, recycled and treated by environmentally sound technologies suited to local conditions and waste going to landfill is minimized to the lowest possible amount." To achieve this, the strategy outlines nine objectives under seven thematic areas.

National Gender Equality Strategy 2015-2019: The mission of the policy is "to promote equal rights, opportunities and responsibilities among men and women and to eliminate all forms of discrimination and violence against women and girls." The strategy clearly highlights in one paragraph the differentiated vulnerability of women to climate change due to the fact that more women than men (49% and 41% respectively) are involved in the subsistence economy (Vanuatu National Statistics Office 2011), which makes them more susceptible to poverty, climate change, disasters and other livelihood stresses

Biosecurity Policy: The Mission of the National Biosecurity Policy is: "To protect Vanuatu's borders against the introduction and spread of foreign and invasive pests and diseases that could affect crops, animals, humans and the environment and, to enhance trade of Vanuatu's products". The policy gives a list of concrete prioritized actions categorized into 16 thematic areas, of which one is climate change. The directive for the thematic area of climate change is: "a collaborative effort by all stakeholders is required to mitigate against damages caused by pests due to pest-favoured climatic conditions."

Vanuatu Sustainable Tourism Policy 2018 – 2030: The Vanuatu Sustainable Tourism Policy (VSTP) provides a guiding framework and direction for the Government of Vanuatu (GOV) and all stakeholders to develop their tourism sector in a sustainable manner. The collective vision of the VSTP is to "To protect and celebrate Vanuatu's unique environment, culture, kastom and people through sustainable and responsible tourism."

Vanuatu's main sustainable tourism goals are:

1. To develop and manage a sustainable and responsible tourism industry.
2. Visitors connect with Vanuatu's environment, culture and its people.
3. Sustainable and responsible tourism products and services developed, supported, and marketed to attract responsible high-value tourists.
4. Tourism that enhances, conserves and protects the environmental and cultural resources of Vanuatu.
5. Sustainable and responsible tourism brings improved income and well-being for Vanuatu and its people.

Projects

Based on Vanuatu's priorities stemming from its' NAPA and sector policies, there are several projects with climate change adaptation goals that have been implemented or currently being implemented in country. These are outlined below in Table 4.

Table 3.4: Baseline Climate Change Projects that are registered with the National Advisory Board

No.	Project	Brief Description	Funding
1	Coping with Cli-mate Change in the Pacific Island Region (CCCPIR)	Adaptation support to GoV line Agencies in the components of Climate Governance/Institutions, Policy Mainstreaming, Education, Renewable Energy, Adaptation Trials, Disaster Risk Reduction	USD 2 million MoCC, German Government, SPC, GIZ
2	Increasing Resilience on Climate Change and Natu-ral Hazards (IRCCNH) Pro-ject	Institutional strengthening; Technology investment and transfer; Training; Communi-ty capacity building. Implemented by DLA, NDMO, VARTC, Rural Water Supply, and Agriculture. (2013 – 2018).	USD $ 11.1 million Funding Admin- World Bank Global Environment Facil-ity (GEF), European Union (EU), Global Facility for Dis-aster Risk Reduc-tion (GFDRR)
3	Managing Disaster Risk Reduction (MDRR)	Institutional strengthening; Technology investment and transfer; Training; Communi-ty capacity build. Implemented by NAB / PMU / VMGD. (2013-2015).	USD $ 2,728,000 Funding Admin- World Bank Government of Japan- Policy and Human Resource Devel-opment Trust Fund (PHRD)
4	Global Climate Change Alliance – Vanuatu Project (GCCA-V)	Institutional strengthening; Mainstreaming; Data collection; Policy development. (2012 – 2014).	USD $ 900,000 (approx.) Global Climate Change Alli-ance
5	Pacific Adaptation to Climate Change (PACC)	The PACC is a regional pro-ject developed as a 2nd Phase or follow-up to the CBDAMPIC project implemented in Vanuatu by the NACCC from 2002 to 2005. Focused on Epi island, Varsu Area Council with major fo-cus on resilience of road-ways. (2009 - 2014).	USD $ 750,000 Funding Admin- SPREP UNDP / GEF SCCF
6	Pacific Risk Resilience Programme (PRRP)	Strengthening governance mechanisms for Disaster Risk Management (DRM) and Climate Change Adapta-tion (CCA). Based on Tanna, Tafea Outer islands, Santo and Emae. (2013-2016).	USD $ 4 to 5 million (approx.) Funding Admin- UNDP UNDP/ GEF / AusAID
7	Coastal Community Adaptation Project (C-CAP)	Community based CCA, planning and implementation of plans based in Efate off-shore islands and on Tanna Island. Implemented by DAI / USP. (2013-2018)	USD $ 3 million (approx.) Funding Admin- DAI & USP US A.I.D. funding

No.	Project	Brief Description	Funding
8	(V-CAP) Adaptation to Climate Change in the Coastal Zone in Vanuatu	Focus on community based climate change adaptation measures at 6 different sites with Infrastructure resilience, upland management and coastal resource manage-ment components. Early warning systems and policy support as well. Implemented by PMU, PWD, Environment, Agriculture, and Fisheries & Forestry. (2014-2019).	USD $ 8 million (approx.) UNDP/ GEF
9	A2C2 Climate Change Awareness project	Research, Media Production, Community Awareness, Educational Capacity Building, Mentoring. Implemented by Apidae Development Innova-tions. 6 secondary schools around Port Vila. Starts July 2014 (6 months).	USD $134,776 over four countries in the Pacific AusAID
10	Natural Solutions to Climate Change in Pacific Islands Region: Implementing Ecosystem-based Adaptation	Education and awareness of ecosystem approaches. Sup-port of ridge to reef and inte-grated coastal zone man-agement planning. Imple-mented by Secretariat of the Pacific Regional Environment Programme in collaboration with the SPC-GIZ coping with climate change in the Pacific Island Regional Program (CCCPIR). Port Vila and sur-rounding areas plus one site in Tafea Province. (2014 – 2019).	USD $ 2.9 million International Climate Initiative (German Government)
11	AECOM Pacific Aus-tralia Climate Change Sci-ence and Adaptation Planning (PACCSAP) Program	Infrastructure - Economic analysis of climate change adaptation options to protect low-lying settlements and crit-ical infrastructure. (2014).	USD $ 93,176 Australian Aid - Pacific Australia Climate Change Science and Adaptation Planning (PACCSAP) Pro-gram
12	Restoration of ecosystem services and adaptation to climate change (RESCCUE)	Community-based coastal resource management and monitoring, waste management and conservation trust based in 37 communities of North Efate. Implemented by Opus, C2O, Landcare Research, Live & Learn (2015-2018)	900,000 Euro (approx.) Administered by the Pacific Community (SPC) with FFEM and AFD funding.
13	Climate information services for resilient development in Vanuatu	Provide people and organisations with timely, tailored climate-related information and tools to use to reduce the impacts of climate change on lives, livelihoods and property. (2018-2022)	USD 20.4 million Implemented by SPREP and VMGD under GCF

Coping with Climate Change in the Pacific Island Region (CCCPIR). The regional SPC/GIZ programme 'Coping with climate change in the Pacific Island Region' (CCCPIR) aims at strengthening the capacities of Pacific Island Countries (PICs) and regional organizations to cope with the anticipated effects of climate change that will affect communities across the region.

The CCCPIR is focusing on key economic sectors such as agriculture and livestock, forestry, fisheries, and tourism. Further focal areas are energy and education. In Vanuatu, the primary implementing agency for the CCCPIR is the Vanuatu Meteorology and Geohazards Department.

A key area of CCCPIR support to the Vanuatu government has been the restructuring and institutional reform of national climate change governance. SPC-GIZ worked alongside government partners to create the new National Advisory Board (NAB) on Climate Change and Disaster Risk Reduction, which is now the country's supreme policy-making and coordination body on these issues. In addition, CCCPIR worked to design, staff and recruit members of the new NAB Secretariat.

In Vanuatu, there are two pilot sites, Nguna-Pele island and Teouma (South Efate), for implementing climate change adaptation measures at the community level. Adaptation options for field trials were developed by government technical experts reflecting national priorities and building on the results of detailed vulnerability and adaptation assessments carried out in the pilot sites. Demonstration activities for upscaling at the pilot sites include coastal and hillside erosion control measures through forestry; soil enhancement and composting; and crop diversity trials

for climate resilience.

Increasing Resilience to Climate Change and Natural Hazards (IRCCNH) Project. The IRCCNH Project in Vanuatu is a project belonging to the Vanuatu Government and is currently implemented by the Vanuatu Meteorology and Geo-hazards Department (VMGD) under the Ministry of Climate Change and Natural Disasters. This project aims to help increase the resilience of communities in Vanuatu to the impacts of climate variability and change and natural hazards on food and water security as well as livelihoods. In this regard it pilot investments in priority villages in Vanuatu to increase the resilience to the impacts of natural hazards and climate variability and change, strengthen disaster risk management systems, and support recovery efforts post Tropical Cyclone Pam. The project has four main components being;

- Component 1: Institutional Strengthening for Climate Change Adaptation and Disaster Risk Management.
- Component 2: Increasing Community Resilience in Areas Affected by Tropical Cyclone Pam.
- Component 3: Promotion of Improved Technologies for Food Crop Production and Resilience to Climate Change.
- Component 4: Rural Water Security: Increased Access to Secure Water Supply.

The project has made strong progress toward achievement of its objectives. To strengthen the government's disaster and climate risk management capacity, a new Department of Climate Change was established to formally legislate the functions of the National Advisory Board for Climate Change and Disaster Risk Reduction (NAB).

An updated National Disaster Management Act is now listed for Parliamentary debate and approval, two provincial disaster centers are in full operation, and eight seismic stations are completed and transmitting real time data to the Multi-Hazard Warning Center in Port Vila to monitor volcano, earthquake and tsunami threats in Vanuatu. To date, 73 microprojects have been completed to help selected communities on the islands of Tanna and Shepherds fully recover from Tropical Cyclone Pam and enhance their resilience against disaster and climate risks.

These microprojects created more resilient and reliable of water supply systems (both gravity-fed and rainwater harvesting systems), built multipurpose centers that can be used as evacuation shelters during disasters, and upgraded critical access roads with all-weather surfaces and improved drainage.

Mainstreaming Disaster Risk Reduction (MDRR) project. Similar to the IRCCNH project, the MDRR project had a main objective targeting both climate change and disaster risk reduction outcomes. The overall goal of the program is to strengthen urban planning and tsunami preparedness in the main urban areas of Vanuatu.

The project helped strengthen urban planning, where an analysis on urban growths trend was conducted as part of the urban growth strategy activity funded by the project. The project also financed an urban risk assessment of greater Port Vila and Luganville. The risk information resulting from the exercise has been incorporated into the urban growth strategy. The risk assessment has also informed the recently updated Vanuatu subdivision policy, and the Vanuatu Meteorology and Geo-hazard Department now uses the hazard risk information in the approval process for all new land development applications in both urban areas. The data is planned to be used to inform an update of the two draft Urban Master Plans and an Urban Reference Plan for options and strategies for affordable and resilient housing within Port Vila and the rapidly growing adjacent peri-urban areas. In addition, authorities have also been using the hazard maps for disaster preparedness and emergency response plans. The hazard maps have also informed the early warning dissemination strategy and the tsunami warning strategy for both areas. To strengthen tsunami preparedness, a tsu-

nami warning system has been installed and commissioned in the greater Port Vila area and Luganville with 3 sirens in the final stage of installation in Aore Island. Tsunami evacuation route signage and tsunami information boards have been installed in communities around the two urban areas. To disseminate warnings and coordinate emergency evacuation and response, a multi-hazard National Warning Center (NWC) and the National Emergency Operations Center (NEOC) have been established. The NWC played a crucial role in the dissemination of multi-hazard warnings e.g., the cyclone warnings prior to and during Tropical Cyclone (TC) Pam (March 2015), TC Zena (April 2016) and TC Cook (March 2017) and helped minimize fatalities.

The NEOC was in full operational during the emergency operations of these cyclones including the severe drought that followed immediately after TC Pam. The project also supported activities to strengthen the National Advisory Board on Climate Change and Disaster Risk Reduction (NAB).

Global Climate Change Alliance – Vanuatu Project (GCCA-V). The overarching objective of the project is to contribute to increased Vanuatu capabilities to cope with the effects of climate change (CC) by improving its overall understanding on the effects of CC and strengthening climate resilience and disaster risk reduction (DRR) in key sectors within the government of Vanuatu.

The project mainly supported the establishment of the NAB and PMU as an additional section within the Vanuatu Meteorology and Geo-hazards Department. Overall, PMU has supported and steered nine (9) NAB meetings by providing secretariat services based on climate change and disaster risk reduction governance reform in Vanuatu. This laid essential foundations for CC&DRR coordination.

Major activities implemented include chairing monthly CC & DRR working group meetings and coordinating key GCCA-V activities including; the Agro-meteorology summit, Traditional Knowledge (TK) workshop and development of a draft TK Framework, provincial consultations and stakeholder mapping to enhance coordination of CC and DRR initiatives throughout all six provinces of Vanuatu. Further other substantive activities involved desk reviews to contribute to the climate change and DRR policy draft write up.

Pacific Adaptation to Climate Change (PACC). The Pacific Adaptation to Climate Change (PACC) project is a regional which supports the integration of climate change risks into policy frameworks and the implementation of community-based adaptation measures in 14 countries throughout the Pacific. In Vanuatu project the assisted the Government of Vanuatu and key stakeholders in Epi island to develop capacity to design and implement improved road infrastructure in order to increase resilience to climate change-related risks.

PACC Vanuatu has implemented long term adaptation measures that has aided in protecting the communities and helped preserve the livelihoods of the people living in Epi and the surrounding islands. By improving the resilience of the road infrastructure against the negative impacts of coastal erosion, PACC Vanuatu contributed to the improved health of the local community (by ensuring better access to the local hospital), supported agricultural production (by supporting the transportation of crops to market), and preserved livelihoods (by ensuring that communities are able to sell their crops and bring revenue to the local economy).

Pacific Risk Resilience Programme (PRRP). The Pacific Risk Resilience Programme (PRRP) works with Pacific island countries to ensure that managing the risks to climate change and disasters are central to development decision making. It does this by improving the core components of their risk governance structures: the people, mechanisms and processes, referred to as the risk governance building blocks. These constitute the main instruments of the programme and are delivered through development pathways from national, sub-

national to community level. The main objective of this work is to risk-inform development in a gender and socially inclusive manner as defined by the core principle of the Framework for Resilient Development in the Pacific (FRDP) for achieving resilient development.

In Vanuatu, PRRP has supported the establishment of resilience posts or structures in key ministries or agencies such as the Department of Strategic Planning, Policy and Aid Coordination (DSPPAC), Ministry of Agriculture, NAB Secretariat, Department of Women's Affairs, Vanuatu Chamber of Commerce and Industry (VCCI) and the National Disaster Management Office (NDMO).

The project has also assisted in the formulation of key national development processes such as the National Climate Change and Disaster Reduction policy, Risk informed Subnational Development Planning guide and the Meteorology, Geological Hazards and Climate Change Act.

Coastal Community Adaptation Project (C-CAP). A regional project with the main objective to build the resilience of vulnerable coastal communities to withstand more intense and frequent weather events and ecosystem degradation in the short term, and sea level rise in the long term. The project works directly with coastal communities across the Pacific Islands region to rehabilitate or construct new, small-scale community infrastructure that is resilient to the impacts of climate change; and to build capacity for disaster prevention and preparedness.

In Vanuatu, C-CAP has implemented activities in 10 communities. The project has implemented via the main components of risk identification, capacity building, infrastructure adaptation, and disaster preparedness. Methodologically Infrastructure Prioritization Index (IPI) decision support tool was utilized to analyze asset vulnerability to climate change and identify high-priority infrastructure needs for adaptation. By using the tool, the majority of communities have already agreed upon their priority adaptation infrastructure interventions, which include drainage and flood control system upgrades, rainwater catchment system improvements, cyclone-proofing of community buildings, and coastal protection and erosion control projects.

Adaptation to Climate Change in the Coastal Zone in Vanuatu (V-CAP). The overarching goal of V-CAP is to increase resilience of island communities to future climate change induced risks such as declining coastal and marine resources, intensifying climatic hazards and lack of awareness. The overall objective of the project is to improve the resilience of the coastal zone and its communities to the impacts of climate change in order to sustain livelihoods, food production and preserve and improve the quality of life in targeted vulnerable areas. V-CAP has four (4) main components:

- Component 1: Integrated community approaches to climate change adaptation
- Component 2: Information and early warning systems on coastal hazards
- Component 3: Climate Change Governance Outcome
- Component 4: Knowledge management

The project has undertaken a number of major adaptation activities within the six (6) provinces of Vanuatu.

These activities entail actions such as the installation of automated weather stations, climate proofing select community roads, deploying fish aggregating devices (FADs), establishing agro –forestry demonstration plots, planting of vertiver grass for soil erosion prevention and the construction of climate proof offices for area councils.

Climate Change Awareness Project (Action Against Climate Change - A2C2). This initiative entailed Port Vila high school students presenting their own climate change television, radio and other media productions to key decision makers.

High school students from Port Vila's Central School and Lycée Louis Antoine de Bougain-

ville (LAB) shared their stories about climate change and its impacts on their environment and their future. These Vanuatu youths presented the short films, radio programs and other media productions they have produced with the support of their local climate change and media mentors. The project has also highlighted the importance of enabling those most affected by climate change to propose their solutions to climate change impacts, and for these solutions to be heard locally and more broadly through effective engagement with the media. The presentations included TV documentaries, a role play, TV drama, newspaper article and even a radio program. The students shared the message: "What are we gonna do about it now?"to highlight the importance of taking action now to address climate change issues and involve their friends, families and communities in local solutions.

Natural Solutions to Climate Change in Pacific Islands Region: Implementing Ecosystem-based Adaptation (PEBAC). PEBACC or the Pacific Ecosystems-based Adaptation to Climate Change Project is a five year project that explores and promotes Ecosystem-based Adaptation (EbA) options for adapting to climate change. The Project is implemented by the Secretariat of the Pacific Regional Environment Programme (SPREP) in partnership with the Governments of Fiji, Solomon Islands and Vanuatu.

The overall intended outcome of the project is: EbA is integrated into development, climate change adaptation and natural resource management policy and planning processes in three Pacific island countries providing replicable models for other countries in the region.

The PEBACC Project is part of the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) supports this initiative on the basis of a decision adopted by the German Bundestag.
In Vanuatu, PEBACC has implemented a number of activities such as ecosystems and socio-economic resilience and mapping (ESRAM) assessments on Port Vila and Tanna; execution of an urban forestry project in Port Vila involving riparian restoration and establishment of community based nurseries; and delivery of environmental impact assessment (EIA) trainings for key development agencies.

Pacific Australia Climate Change Science and Adaptation Planning (PACCSAP) Program. The PACCSAP program aims to develop the capacity of PICs to manage climate risks. The Pacific Adaptation (Costs and Benefits) Scenarios study is a component of PACCSAP, and aims to increase the capacity of decision makers in PICs to make informed decisions using CBA.

Under this PACCSAP project a training session was delivered in-country to local stakeholders; the vast majority of the training attendees were employees from government agencies in the finance, environmental, agricultural and infrastructure sectors. The training sessions focused on CBA and climate change adaptation (including risk management).

Additionally, a detailed CBA case study was applied to the Pacific Adaptation to Climate Change (PACC+)project implemented by Public Works Department(PWD) in North Epi Island(Vanuatu). The CBA considered the costs and benefits of constructing a new road and making the existing network 'all weather roads' with concrete slabs, drainage and culverts. The CBA demonstrated the net monetary benefits for the transport and agricultural sectors. Benefits to the health, education and employment sectors were also identified.

Restoration of ecosystem services and adaptation to climate change (RESCCUE). RESCCUE is a regional project implemented by the Pacific Community (SPC). The overall goal of RESCCUE is to contribute to increasing the resilience of Pacific Island Countries and Territories (PICTs) in the context of global changes. To this end RESCCUE aims at supporting adaptation to climate change (ACC) through integrated coastal management (ICM), resorting especially to economic analysis and economic

and financial mechanisms. RESCCUE's activities have primarily focused on North Efate, covering two marine area protected networks i.e. Tasi-Vanua and Nguna-Pele.

RESCCUE is supporting the development and implementation of an integrated coastal management (ICM) plan for North Efate. The implementation of the ICM plan is divided into three areas:

i. Terrestrial ecology
ii. Household waste management
iii. Marine resource management

Supplementing the ICM plan, RESCCUE has undertaken a number of climate change adaptation activities (CCA) such the desk review of expected climate change impacts on North Efate, developing the ICM plan activities' contribution to CCA and the establishment of operational activities in collaboration with local authorities and other CCA stakeholders.

Climate information services for resilient development in Vanuatu (VAN KIRAP). The GCF funded project aims to increase the ability of decision makers; development partners; communities and individuals across five target development sectors (agriculture, fisheries, infrastructure, tourism and water) to plan for and respond to the long and short term impact of climate change.

VAN KIRAP will help build Vanuatu's capacity to harness and manage climate data; develop and deliver practical CIS tools; support enhanced coordination and dissemination of tailored information; enhance CIS related information and technology infrastructure and support the application of relevant CIS through real-time development process.

VAN KIRAP thus far has rolled out its' support through activities such as the establishment of sector technical working groups, development of the project's environmental and social safeguards framework, restoring and digitizing historical meteorological data, and supporting the Vanuatu Meteorology and Geo-hazards Department with tailored climate products (e.g. the enhanced Vanuatu Climate Update – VCU, Monthly Climate Summary and the Early Alert Rainfall Watch).

Green Climate Fund Readiness

Vanuatu's aspires to have direct access to the Green Climate Fund (GCF) and to benefit from funds provided by the GCF. Several Readiness activities have been undertaken or underway to meet these broad goals as summarized below:

Table 3.5: GCF Readiness Activities

GCF Readiness Activities	Documents / links
1. Strategic Frameworks, country programmes & pipeline development	
Country programme survey was launched in September 2017, from which public opinions were collected with regards to Vanuatu GCF priorities	Survey: http://bit.ly/2eQucPK
On-going stakeholder engagement in pipeline project development.	Pipeline of Ideas: https://drive.google.com/open?id=1DFr8gFMk8ddkrZeQTblclRWW3ajEZamf
2. National stakeholders engagement processes	
a) Workshops & consultation	
GCF Public Forum (March 2017)	Workshop documents: http://nab.vu/event/public-forum-green-climate-fund
GCF Readiness Programme Summit (September 2017)	Workshop documents: http://nab.vu/event/vanuatu-green-climate-fund-readiness-program-summit
GCF Readiness Workshop on Standard Operating Procedure for Project Appraisal Process (Novem-ber 2017)	Workshop documents: http://nab.vu/event/gcf-readiness-programme-workshop-sop-project-appraisal
GCF Readiness Workshop on Vulnerability Assessment Framework (December 2017)	Workshop documents: http://nab.vu/event/gcf-readiness-programme-workshop-vulnerability-assessment-framework
Private Sector Tradeshow (2018)	Tradeshow Report available at this link: http://www.nab.vu/event/vanuatu-private-sector-climate-finance-tradeshow Link to the Tradeshow Highlights Video: https://youtu.be/LgKtR3guUiw Link to the Tradeshow Photos & Presentations: https://drive.google.com/open?id=11dPnsLH8NDEhNOnSjpe9U0hLeAML1v-K
b) Engagement mediums / Awareness materials	
CCDRR Finance tab on the NAB portal has been revised. Attempt to be a one stop-shop for stakeholders interested in finding out more on grant sources and CCDRR finance in Vanuatu	CCDRR Finance Tab: http://nab.vu/climatefinance
Several informational materials developed	GCF Booklet: http://nab.vu/document/vanuatu-and-green-climate-fund-information-booklet List of Accredited Entities: http://www.nab.vu/document/green-climate-fund-accredited-entities-vanuatu-and-pacific-region List of Grant Sources: http://www.nab.vu/document/directory-climate-finance-sources-vanuatu CCDRR Matrix: http://www.nab.vu/document/policy-search-tool-beta
NAB portal guide for stakeholders is currently being developed and is in draft form. This is to support CCDRR stakeholders in supporting information sharing, increasing information access on CCDRR on the national CCDRR portal.	https://www.nab.vu/node/26814

Capacity Building, Education & Training

Numerous climate change programmes and projects have been implemented by various regional and national stakeholders over the years. These have generated knowledge, experience and best practices on local climate change impacts, on local options for adaptation and mitigation, and on awareness-raising.

Key government departments such as the Vanuatu Meteorology and Geo-hazards Department (VMGD) undertake climate change awareness programs (generally relative to climate science and climate variability) using a number of dissemination means to schools and other climate dependent sectors e.g. agriculture, water, infrastructure and tourism. Similarly, these critical climate dependent sectors are increasingly integrating climate change considerations or adaptation measures into their own core activities via training and knowledge sharing of department/sector personnel. Moreover, major donor projects such as the VAN KIRAP and V-CAP have been active in supporting the VMGD and key development sectors with capacity building oriented adaptation initiatives.

In the education sector, regional projects such as the CCCPIR have provided substantive support to the Vanuatu government to embed climate change into national curriculum. CCCPIR has supported the Department of Education and the Curriculum Development Unit (CDU), to train teachers on how to teach the climate change elements of K-13 new Vanuatu Curriculum. Workshops were held by the CDU with CCCPIR technical and financial support in the provinces of Malampa, Torba, Sanma and Tafea to teach principals and provincial education officers on the new curriculum as well as specially developed climate change teaching resources which CCCPIR developed including the Learning About Climate Change the Pacific Island Way poster training, the Pou & Miri Climate Change Books and the Cloud Nasara animation on ENSO and training package. CCCPIR worked closely in 2016 with the Ministry of Education, the Vanuatu Qualification Authority and its local experts, the Vanuatu Institute of Technology (VIT) and the EU PacTVET programme, to finalize the region's first accredited Certificate I Course on Climate Change & Disaster Risk Reduction. This course was designed for men and women in rural areas who have a passion to help their communities adapt to climate change and reduce the impacts of disasters, the six-month course contains eleven units that impacts knowledge about climatic changes and disasters that have affected Vanuatu in the past and at present, and are likely to affect the nation in the future. The course covers activities available to reduce the impacts of climate change and natural hazards, both as individuals and in local communities, and to adapt to these changes in the future. Highly practical, course students will upgrade skills in interpreting and drawing maps and graphs and in processing statistical information, as well as demonstrate a number of adaptation measures to others and how to assess a community's level of risk to hazards and climate change. Furthermore, in 2018, SPC in partnership with the ADB supported the creation of Certificate III in Climate Change Resilience as a follow on to the Certificate I course.

The Vanuatu Skills Partnership program, is an initiative that is mainly involved with building capacity at the vocational level by integrating climate change adaptation into its' relevant training activities across the tourism, handicraft and agribusiness sectors.

NGOs and civil society organizations are also playing an active role in building capacity at the local level. Organizations such as the Vanuatu Red Cross, Care International, Oxfam and the Vanuatu Christian Council have been over the years conducting climate change awareness or skills based adaptation training within their target intervention sites.

Gaps and Opportunities

The GoV is already taking proactive steps to address climate change in their development planning and some degree of budgeting, both on national and sub-national levels. However, there are still many barriers and gaps (policy, regulatory, institutional, technical, financial, business, social and cultural in nature) that need to be addressed in order to be able to shift the paradigm to transform the development and address climate change into tangible solutions, pragmatic actions, investments and inclusive business opportunities on the ground in driving towards a resilient and low carbon economy, community, and nation.

The country's constrained financial resources and limited absorptive capacity in and coordination between government agencies and the private sectors create additional challenges to successfully mainstream climate change and align development aspirations with climate change response strategies.

Vanuatu continues to face a multitude of barriers for the scaling up of effective climate adaptation for achieving the climate and development goals and for meeting its UNFCCC obligations. The various obstacles include insufficient institutional and financial resources; lack of research data; information management problems and; inadequate human resources and infrastructure.

More needs to be done to build awareness both within the Government and the community about Vanuatu's vulnerability to climate change. There is also an apparent need to feed information, knowledge and technologies to enable improved decision-making and environmental management. The major institutional, policy, research, data and Information gaps are discussed below.

The key issues, barriers and opportunities are summarized below:

- The capacity building and public awareness program and activities need to be focused and relevant in the local context. Efforts should be focused on making reliable, accurate and palatable climate-change information available to a wider audience.
- Topics related to global climate change needs to be incorporated in the curricula of primary and secondary schools and appropriate training of teachers in environmental education.
- Provide incentives to the students for choosing technical, vocational and higher education in environment, climate change and related development studies.
- At the sectoral level, more data collection and research is very much needed to capture the economic implications or linkages between climate change and the various development sectors.

Conclusion

Vanuatu is considered to be the most vulnerable nation in the Pacific region and the world when it comes to its' vulnerability to climate change impacts. Economic and social development is already bearing the brunt of climate change. It is anticipated that impacts on the agriculture, forestry, fisheries, infrastructure, water, health and tourism sectors will worsen in the years to come. On the other hand deliberate and coherent efforts are needed across all levels of governance to better document the economic impacts of climate change on critical sectors.

Adaptation is therefore vital to transform Vanuatu's development paradigm and build resilience to climatic impacts. Equally, a number of government agencies, donors, and civil societies are working to strengthen adaptive capacity to climate change impacts. On the other hand, it is also critical that additional resources are mobilized to better support effective adaptation actions at all governance levels using a "no regrets" and climate risk informed approach for Vanuatu's sustainable development journey.

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CHAPTER 4

Mitigation Assessment Report

Background

Small Island Developing States (SIDS) has been recognised by the United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC) as the most vulnerable countries to face the effects of climate change. Vanuatu being a part of SIDS share similar challenges.

The Republic of Vanuatu, a Y-shaped string of more than 80 islands situated in the South Pacific, is home to approximately 270,000 people. The majority inhabitants live in rural, off-grid areas, rely largely on subsistence agriculture and are not part of the formal economy. Vanuatu anticipates many impacts from climate change on its society, economy, environment and human health and Vanuatu through the Ministry of Climate Change is actively cooperating with United Nations agencies and international development partners to assess these effects and develop appropriate plans through climate change mitigation.

Energy is one of the crucial development indicators in any country and, like the other Pacific Island Countries, Vanuatu's primary energy needs are mainly met by imported petroleum fuel. The nation's primary energy supply is dominated by petroleum products for urban energy production and transportation, as well as firewood for cooking purposes. It is estimated that approximately 80% of urban households and only less than 17% of rural households have access to electricity. The volcanic archipelago's mountainous topography and the population's spatial disbursement over 65 inhabited islands have made the delivery of energy supplies and services costly and technologically difficult. Thus, only a small portion of the population has access to reliable electricity.

Of the 75% of rural dwellers, only 9% have access to any form of electricity other than battery powered mobile lamps or radios. Apart from physical geographical constraints, the main barriers to extension of electricity grids and to the implementation of local stand-alone-grid solutions are economic ones. The small number of households per community, combined with large distances between the communities, results in high upfront installation costs that cannot be recovered through operation in a commercially viable time span. The economic barriers mentioned above are heightened by the limited ability to pay for energy services in rural communities. In general, the rural population has very little disposable income. With its population distributed over many islands distribution of energy services is both technologically challenging and costly.

This results in very low electrification rates and high fuel prices. The result of these factors is that energy services are available only to a small share of the population, and at high prices. The retail price for diesel is among the highest in the region, which is partly due to taxes, as prices before tax are about the same as in comparable countries in the region. The key development challenge is lack of access to sustainable and affordable energy supply for rural communities in Vanuatu exacerbated by impacts of climate change.

The National Energy Roadmap (NERM) clearly identifies the issues in the energy sector as a challenge to the country's economy, and as restricting economic and social development. In the NERM, access to electricity is identified as one of the country's five development priorities, from remote rural areas to those who are already serviced by a utility under an existing concession. The goal of NERM is to increase electricity access for the rural population and extend the existing grid to reach an increasing number of people.

The updated NERM (2016-2030) which was endorsed by the Government in June 2016 has the same vision as the earlier NERM, and its objectives, targets, and actions are intended to be consistent. The update was meant to provide more detail on particular areas (especially energy efficiency and green growth), and improve consistency of the priorities and objectives. The updated NERM focuses on five priorities: accessible energy, affordable energy, secure and reliable energy, sustainable energy, and green growth.

Vanuatu ratified the United Nations Framework Convention on Climate Change (UNFCCC) on 25th March 1993 and the Kyoto Protocol on 17th July 2001. As a party to the convention, Vanuatu officially submitted its Initial National Communication (INC) to the UNFCCC in 1999 (5th COP). The Second National Communication (SNC) was submitted in 2016.

Vanuatu parliament ratified the Paris climate change agreement on 18th June 2016. Upon ratification, the INDCs with emission reduction targets has become Nationally Determined Contributions (NDCs). The new Paris agreement on climate change entered into force on 4th November 2016.

The mitigation contribution for the Vanuatu NDC submission is a sector specific target of transitioning to close to 100% renewable energy in the electricity (energy) sector by 2030.

Vanuatu has also developed an implementation roadmap and associated institutional framework including a Monitoring, Reporting and Verification (MRV) tool which aims to enhance Vanuatu's ability to achieve its mitigation NDC target. The overall impact of the programme is that Vanuatu can effectively reduce and monitor its GHG emissions in the energy sector and achieve its NDC commitment.

Vanuatu's past emissions have been miniscule and have only become locally significant in the past decade or two. In general development issues dominate rather than climate change mitigation.

Vanuatu is a small developing nation with absolute levels of CO2eq emissions very small at under 0.0016% of world emissions. The country is also one of the most vulnerable to the effects of climate change and has much to lose should the worst predictions from increased temperature levels eventuate. As such the country will do its best to mitigate but would require financial, technical and capacity building support to do so.

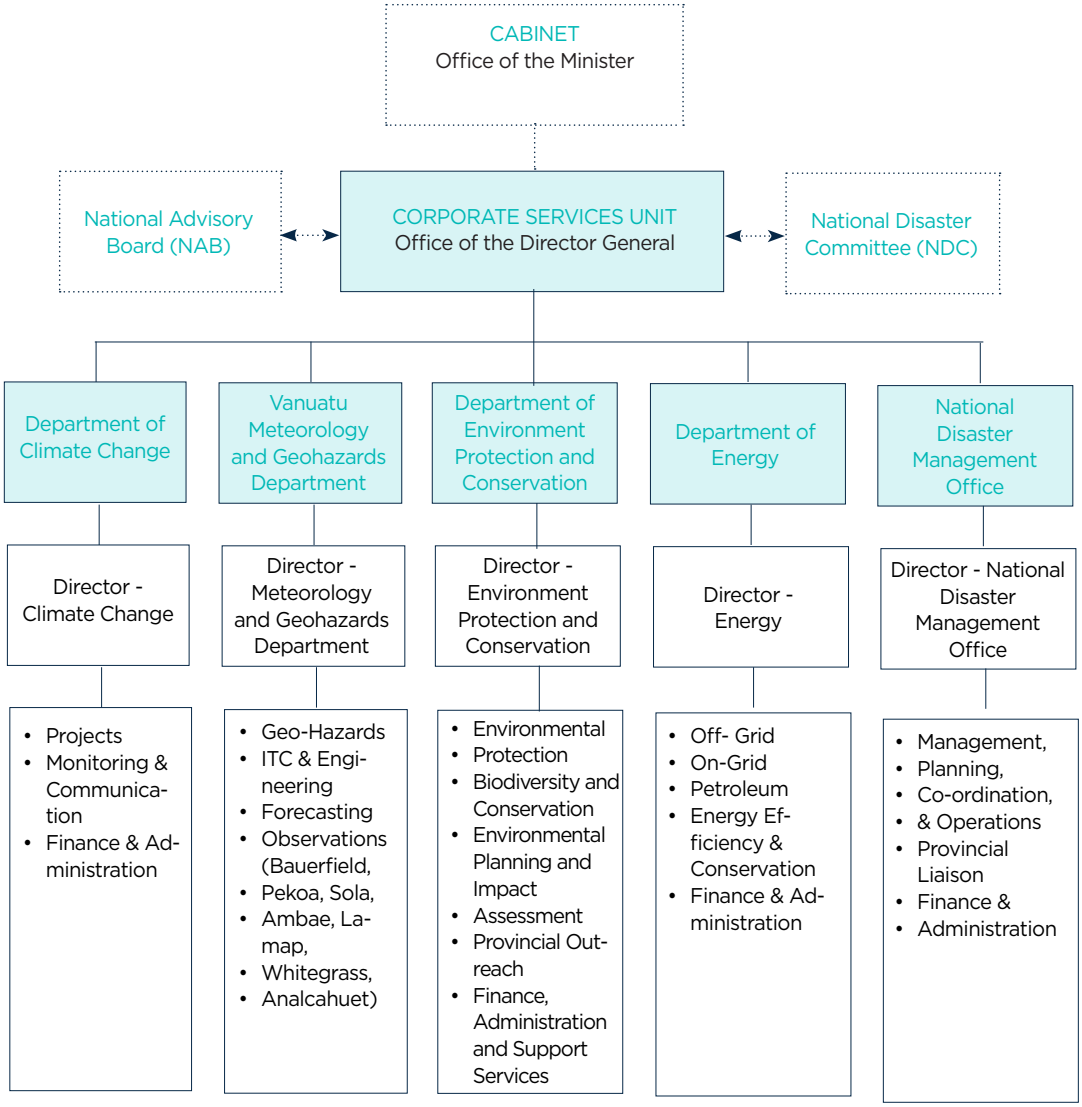
Overview of Climate Change Mitigation Sector

Institutional Arrangement

The Ministry of Climate Change Adaptation (MCCA), Meteorology & Geo-Hazards, Energy, Environment and National Disaster Management is the nodal agency as part of the Government's efforts to streamline Vanuatu's climate change response, natural disasters and sustainable development of the environment.

This Ministry is the youngest Ministry in Vanuatu Government created in 2014 as a strategic alignment of Departments responsible for response to natural disasters and sustainable development of the environment; with a vision to "Promote a resilient, sustainable, safe & informed Vanuatu" and mission to "Develop sound policies & legislative framework and provide timely, reliable, scientific information for service delivery to enable resilient communities, a sustainable environment and economic development". The organizational and institutional structure of the ministry is as follows:

Figure 4.1: MCCA - Institutional Arrangement and Organization Structure

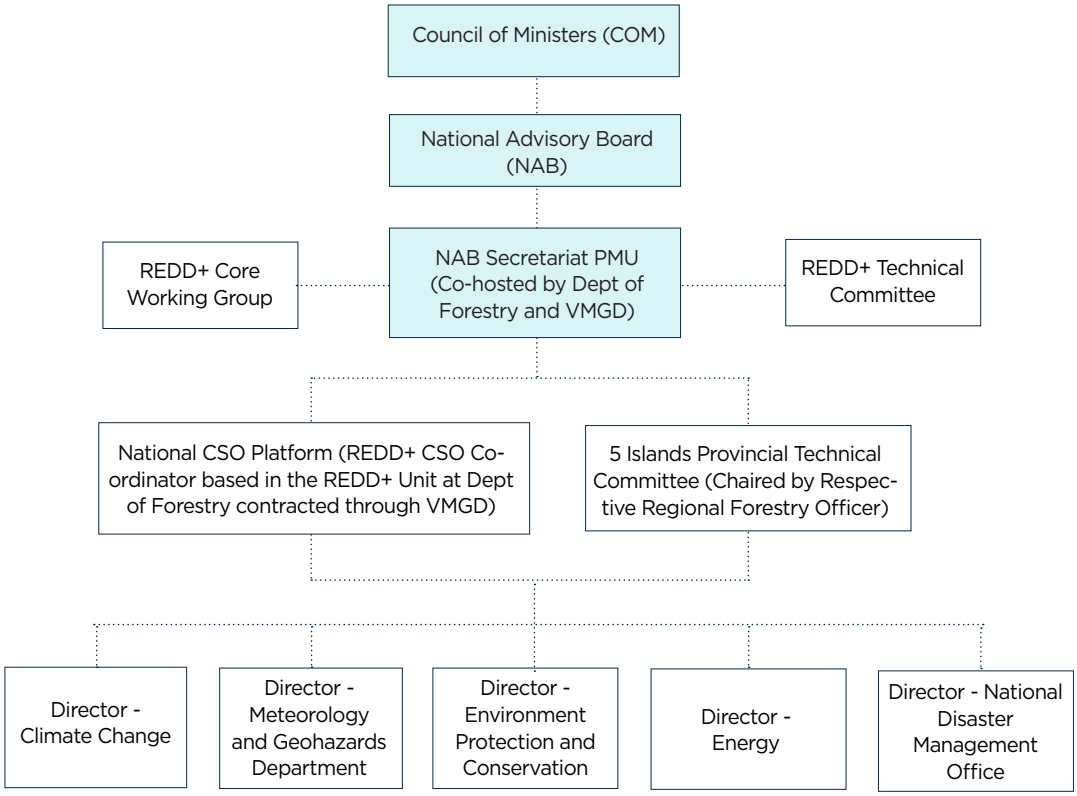


The ministry includes the Vanuatu Meteorological and Geo-hazards Department (VMGD), the National Disaster Management Office (NDMO), the Department of Energy (DoE), the Department of Environment and the Project Management Unit (PMU). The Ministry and the National Advisory Board (NAB) are mandated with coordinating all government and non-government initiatives addressing climate change and disaster risk reduction in the country.

The Department of Energy (DoE) is responsible for central coordination of the development of the energy (climate change mitigation) sector in Vanuatu. This includes the existing electricity grids, the petroleum sector and energy efficiency issues, but the DoE is also responsible for the development of electricity access in rural areas.

For the forestry sector mitigation Vanuatu is engaging both the government and the Civil Society Organization (CSOs) as main stakeholders for national REDD+ program in Vanuatu. The Department of Forests with the oversight of the National Advisory Board for Climate Change & Disaster Risk Reduction (NAB), and the Vanuatu Geo-Hazard and Meteorological Department (VGMD) as the focal point, is taking the lead role as the key implementing agency in implementing the national Reduced Emissions from Deforestation and forest Degradation (REDD+) program in Vanuatu.

Figure 4.2: REDD+ Institutional Arrangement and Organization Structure



National Advisory Board (NAB)

The National Advisory Board on Climate Change and Disaster Risk Reduction (NAB) is a committee made up of government and non-government members. Its primary purpose is to: "act as Vanuatu's supreme policy making and advisory body for all disaster risk reduction and climate change programmes, projects, initiatives and activities". As such it is the main governmental stakeholder in the proposed Nationally Appropriate Mitigation Actions (NAMA).

The NAB is co-chaired by the Director of the Vanuatu Meteorology and Geo-Hazards Department (VMGD)

and the Director of the National Disaster Management Office (NDMO). Members are senior-level representatives from key sectoral government agencies, and NGO representatives, including a representative of the Vanuatu Humanitarian Team (VHT) Network, the Vanuatu Climate Adaptation Network and the Vanuatu Association of Non-Governmental Associations (VANGO). Members are nominated in the first instance by the Directors of the VMGD and the NDMO at an official NAB meeting.

Project Management Unit (PMU)

The Government of Vanuatu has established institutional arrangements for joint governance of climate change and disaster risk reduction through the NAB and a Project Management Unit (PMU) within the Ministry. The PMU is responsible for coordinating all Vanuatu's climate change related programmes and projects and aligning the climate change initiatives with development strategies, including the annual and medium-term government budgets. The PMU is also responsible for ensuring that climate change programmes and projects are carried out within their specified timeframes and for ensuring activities meet the necessary public participation and stakeholder requirements.

The PMU also has the authority to act as a Financial Management Agent for externally funded programmes and projects and will thus, on behalf of the NAB and the Ministry, be responsible for project financial management and administration.

Department of Energy (DoE)

The Department of Energy (DOE) has responsibility for energy sector planning and administration and has long had a key role in assessing rural energy resources, identifying rural energy supply projects, and developing and implementing these projects, nearly always donor-funded.

The DoE works closely with PMU in developing project proposals and managing donor funds as it has the authority to act as Financial Management Agent for externally funded programmes and projects on behalf of the ministry.

Utilities Regulatory Authority (URA)

The Utilities Regulatory Authority (URA), established in 2008, provides oversight for electricity supply in 'concession' supply areas (currently held by UNELCO and VUI), is responsible for provision by utilities of safe, reliable and affordable electricity (and water) services, deals with consumer complaints and advises the government on matters related to electricity. It also reviews and sets the maximum level of retail tariff for each concession, with provision for binding arbitration in the vent of disagreements.

Other Ministries

The Ministry of Infrastructure and Public Utilities (MIPU) is responsible for all the public infrastructure of the government and the Ministries of Education and Health have been involved providing small solar PV systems for remote schools and health centres. The ministry of Finance will be involved in any arrangements for financing remote energy systems.

Power Utilities – Private Sector

UNELCO Engie (UNELCO) and Vanuatu Utilities & Infrastructure Limited (VUI) are the key economic player in the Utilities sector in Vanuatu; Both are private sector enterprise and the utilities concessionnaire for the production, transport and supply of electricity and water in respective concession area.

UNELCO Engie holds 4 geographical concessions, being EFATE island, the two administrative centres of Norsup (MALEKULA) and Lenakel (TANNA) for the provision of electricity, as well as the capital, Port Vila, for the supply of water.

VUI is a wholly owned subsidiary of Pernix Group Inc. has a Memorandum of Understanding (MOU) with the Government of Vanuatu for the Luganville Electricity Concession on the island of Espiritu Santo, Vanuatu. The concession involved a complete takeover of the utility including but not limited to operation and maintenance of the Hydro and Diesel generation plants, transmission and distribution, sub-station, customer service and billing, meter readings, extensions, expansion, etc.

UNELCO and VUI are currently the only two private sector power utilities operating in Vanuatu working within their concession areas.

Non-governmental Organizations (NGOs) and Other Private Sector Service Providers

Several local and regional NGOs have been involved in implementing remote energy projects (e.g. VANREPA, IUCN, ACTIV), and some could have a role in providing equipment and/or managing RE systems. This is also true of local companies. About 5 years ago, a now-discontinued Australian assistance programme (Vanuatu Electrification for Rural Development or VERD) identified eleven potential Renewable Energy Service Companies (RESCOs) that could be involved in remote electrification: Cloud Zero Power Supplies, Energy 4 All, GreenTech, Jem Solar, Pacific Power Products, Solar Communication, VanGlobal, VANREPA, Vanuatu Son Solar, Vate Electrics, and White Sand Engineering. At the time, these had an average of five employees each and were all headquartered in Port Vila. VANREPA is apparently now inactive but some of the others are still operating.

Policy and Planning Framework

Vanuatu has positioned itself as a regional leader in the fields of Climate Change (CC) and Disaster Risk Reduction (DRR) and has been widely applauded for its initiative to establish a National Advisory Board for Climate Change and Disaster Risk Reduction (NAB) as a means of improving coordination and governance around the two issues. Vanuatu's implementation of the UNFCCC has progressed exponentially in recent years as government sector agencies become more organized and civil society, academic, the private sector, development partners and regional agencies have stepped up their activities in Vanuatu.

Vanuatu is committed to formulating strategies, national policies and best practices for addressing GHG emissions and making a practical contribution to the global mitigation efforts. While at the same time the country is also pursuing its national and regional development priorities and sustainable development objectives. The development objectives are planned to be achieved by integrating GHG abatement efforts with other social, environmental and economic priorities.

Transportation infrastructure development is one of the priority sectors for Vanuatu and with this view the Government has initiated a long-term Vanuatu Transport Sector Support Program (VTSSP).

The Government of Vanuatu is also focusing on mitigation options for emissions from land, sea and air transport sectors. Measures include public transportation awareness programmes, vehicle emission standards, promoting fuel-efficient and alternative fuel vehicles, improving public transport services, introducing financial incentives to encourage energy efficiency and promoting non-motorized transport. Currently, however, transportation emissions are relatively small due to the small number of motor vehicles.

Unlike many island nations in the Pacific, the emissions from the agriculture and waste sectors make a significant contribution to GHG emissions from Vanuatu. In particular, the large number of livestock (Cattles, Pigs etc.) in the country, together with the Nitrogen fertilizer requirements of the associated pasture, present large Methane (CH4) and Nitrous oxide (N2O) emissions. In this regard it is thought that mitigation measures will be difficult without reducing animal numbers.

The GoV has also revised the 1997 National Forest Policy and developed the "Vanuatu Forest Policy 2011 – 2020" for the sustainable development and management of the forestry sector. The new forestry policy presents clear directives (short-term, urgent, medium-term, and long-term) supported by implementation strategies including timelines and responsibilities.
Vanuatu is an active participant in Pacific island regional affairs and has signed on to a number of regional policies and initiatives that have implications for climate change mitigation. Vanuatu is also a Party to many other UN conventions, such as those, among others: biological diversity, biosafety, protection of the ozone layer, persistent organic pollutants, and combating desertification. Adaptation to climate change and risk management of natural hazards is one of the core development issues for Vanuatu.

Nationally Determined Contribution (NDC) Implementation Roadmap and Monitoring, Reporting and Verification (MRV) Framework and MRV-Tool

Vanuatu has developed the NDC implementation roadmap for the energy sector, Vanuatu's only sector with an NDC target and an integrated Monitoring, Reporting and Verification (MRV) framework and MRV tool.

The NDC implementation roadmap will be used to access international climate finance with the aim of structuring finance for implementation, including leveraging international public and private sector contributions for NDC implementation.

In addition, the integrated MRV tool will enable routine compilation of data and information on progress towards the realisation of the NDC targets including sustainable development goals (SDGs) pursuits.

The integrated MRV framework is also well aligned with reporting requirements under the National Communications (NC) and Biannual Update Reports (BUR). Stakeholder capacity building for implementation of the mitigation contributions will also be supported to strengthen the NDC implementation process.

Under the NDC Implementation Roadmap First of all, there are basic interventions, which are recommended to be implemented:

Interventions under implementation or preparation: project under implementation such as VREP II or the Talise Hydro Power Project bring good contributions towards the target and should be finalised as planned. Focus should be on implementations under preparation to secure funding and push for implementation.
Coconut for Fuel Strategy: this is the key element in providing a sizeable contribution to achieving the NDC target and is the first implementation step to be carried out.

Revision of the Electricity Supply Act: this is a key step for stronger involvement of the private sector and should allow attracting private capital for the investment into renewable energy projects. Batteries: a total of 37 MWh of battery storage capacity are necessary to secure a well-functioning grid, where overproduction can be stored for later consumption.

In addition to these basic interventions, 2 options are suggested for achieving the NDC target.

- **Option 1** includes the installation of 7.6 MW solar PV and 5.1 MW wind, which together can contribute around 30% to the target. The majority of the contribution towards the target (57%) will come from the use of coconut oil.

  Total costs of Option 1 are USD 73.3 m (excluding costs for the Sarakata hydro power project as they haven't been determined yet). It is assumed that a pricing arrangement for coconut oil can be found, which is not leading to ongoing operation costs, the costs for carrying out the Coconut for Fuel Strategy are included.

- **Option 2** includes the installation of 7.6 MW solar PV, which is seen as the renewable energy source with lowest generation costs. The main contribution in Option 2 will come from geothermal (36%), which requires successful drilling and considerable investment for the implementation.

  The availability of geothermal allows reducing the input of wind energy and it suggested that only half of the additional capacity (2.6 MW) is installed. The remaining gap will be covered by coconut oil and a total of around 6 million litres will be required to achieve the target.

  Total costs of Option 2 are USD 66.5 m (excluding costs for the Sarakata hydro power and the geothermal project as they haven't been determined yet). It is assumed that a pricing arrangement for coconut oil can be found, which is not leading to ongoing operation costs, the costs for carrying out the Coconut for Fuel Strategy are included.

National Energy Roadmap (NERM 2016-2030) and Updated Implementation Plan (IP)

In the past, no consistent energy policy or strategy existed in Vanuatu. Those Renewable energy policies and projects that were implemented were fragmented and often driven by proposals from development partners. This approach was not successful, and in response, the government developed a comprehensive National Energy Road Map (NERM) in 2013.

The NERM identified five priorities for the energy sector: access, petroleum supply, affordability, energy security, and climate change. It set out objectives, targets and actions to achieve these priorities and contribute to the NERM's overall vision.

The NERM clearly identifies the issues in the energy sector as a challenge to the country's economy, and as restricting economic and social development. In the NERM, access to electricity is identified as one of the country's five development priorities, from remote rural areas to those who are already serviced by a utility under an existing concession.

The goal of NERM is to increase electricity access for the rural population and extend the existing grid to reach an increasing number of people. The updated NERM (2016-2030) which was endorsed by the Government in June 2016 has the same vision as the earlier NERM, and its objectives, targets, and actions are intended to be consistent. The update was meant to provide more detail on particular areas (especially energy efficiency and green growth), and improve consistency of the priorities and objectives. The updated NERM focuses on five priorities: accessible energy, affordable energy, secure and reliable energy, sustainable energy, and green growth.

The updated NERM of 2016 included in Appendix B: Implementation Plan a long list of investments and actions that could help meeting the NERM targets. The planned activities were grouped into the following categories:

- Investments and Donor Programmes
- Policies, laws and regulations
- Analysis and studies
- Capacity building and institutional development
- Other
- This category basically covers the following types of investments:
- Renewable energy
- Rural electrification
- Energy efficiency
- Grid extension

During 2019, the NERM Implementation Plan (NERM-IP) was reviewed and updated. The NERM progress towards targets was also investigated. The NERM-IP includes a total of 12 indicators to measure progress and has targets defined both for 2020 and 2030. In the priority Accessible Energy, there is excellent progress with the electrification of households and the 2020 targets have been or will be achieved. Electrification of public institutions is behind schedule.

In sustainable energy, the share of electricity generated from renewables has seen a sharp decline and was 0% in 2017 due to coconut oil prices. For the other indicators under this priority, further work on defining monitoring procedures is required. In the priority Green Growth, the share of coconut oil has been at 0% in 2017, but electricity use by rural tourism bungalows is above target. Based on the progress up to now and the targets defined for 2020 and 2030, measures required for achieving the targets have been identified.

In line with GoV's decentralization policy supporting development of all the 6 provinces and town municipalities it is essential to decentralise the efforts of the NERM and to better integrate provincial governments and municipalities in the NERM-IP.

Mainstreaming of the NERM IP into Provincial Governments and Municipalities Development Strategies were also carried out as part of the NERM-IP review and updating. A sustainable energy strategy and action plan for the local administrative bodies (Provincial Governments and Municipalities) has been developed). Recommendations on the follow-up strategy by DoE to support the municipal & provincial stakeholders to implement the action plan is also included in the action plan.

The updated Vanuatu National Energy Road Map 2016-2030 defines a robust Monitoring, Verification, and Evaluation Plan (MRV) to monitor the status and progress for the NERM actions. The objectives, quantitative targets, and implementation plan under the NERM sets the framework for DoE to monitor and evaluate NERM implementation.

Based on the integrated MRV tool that has been developed for Vanuatu's NDC goal tracking, a standalone MRV tool has also been developed to monitor and track the progress of NERM priorities, goals and indicators. The tool allows DoE to remain up-to-date with implementation progress and gives more opportunity to address implementation challenges and issues encountered. A comprehensive capacity building and hands-on training programme has been planned for the stakeholders on the NERM IP MRV tool.

Table 4.1: Updated NERM Implementation Plan (NERM-IP)

Accessible Energy						
Activity	**Description**	**Priority**	**Cost**	**Lead responsibility**	**Status**	**Timing**
Extension of VREP I	There are considerable unused fund under VREP I. According to the latest Project Report (Jan-Jun 2018), a total of USD 3.14 million has still be available by 30 June 2018. Taking into account the total budget (USD 7.8 million) and the number of households which received access to electricity between project start and 30 June 2018 (6,034), approximately 4,000 additional off-grid households can be provided with access to electricity. Reducing the grant contribution per household (aligning with VREP II) would help in increasing this number to around 6,000 households.	High	USD 6.2m	DoE, World Bank	Ongoing, fully financed	2019
VREP II	Under VREP II, micro grids will be installed and Solar Home Systems will be disseminated to off-grid households. Until 2022, a total of 8,400 households will be electrified. The project is fully financed and operational.	High	USD 5.4m	DoE, World Bank	Ongoing, fully financed	2022
Extension of GPOBA	The GPOBA provided one-off subsidies to assist low-income households to connect to the existing electricity grid in concession areas in Port Vila, Tanna, Malekula and Luganville. A continuation of the project is suggested, funding has not been secured. A minimum of additional 1,000 households need to be receive electricity access to achieve the NERM targets.	High	USD 1.1m	DoE	No financing	2025
BRANTV	2,000 households will gain access to village-scale power systems or to family compound-scale nano-grids installed in all compounds in a village. Project is fully financed and activities started. Work will end in 2022.	High	USD 20.8m (entire project)	DoE, GEF, UNDP	Ongoing, financed	2022
Wintua/ Lorlow mini-grid	Under the Wintua/Lorlow mini-grid, around 75 households and 14 public buildings will be electrified. The project is fully financed and construction is about to start.	High	USD 1.1m	DoE, Austrian government	Ongoing, financed	2020
Ambrym mini-grid	Erection of 2 solar PV mini-grids on Ambrym island, connecting around 160 households to the grid. Concept is being prepared with DoE Office.	High	USD 2m	DoE, GCF	No financing	2022
Distributed Energy Generation	DoE is interested to explore the option of using the "Distributed Energy Generation" by installing micro/mini grids in concession areas (Efate, Santo, Malekula & Tanna) in locations where grid extension is hard to reach or very expensive. Once the grid penetration is achieved eventually the micro/mini grids could be integrated on to the main grid.	High	USD 5m	DoE	No financing	2023

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing
Electrification of all Educational and Health Centres by 2022	DoE is keen to launch a programme similar to VREP focusing on electrification of all education and health centres in Vanuatu by 2022. The idea is to have a targeted approach to electrify on one of the key sub-sectors (Schools & Health centres) and replicate the approach across other sub-sectors. DoE is of the view that this kind of approach could assist in efficient utilization of resources and fast track achieving the NERM targets. DoE intends to explore potential subsidy options under VREP and GCF submissions.	High	USD 1.3m	DoE, Ministry of Health, Ministry of Education & Training	DoE, Ministry of Health, Ministry of Education & Training	2022
Extension of VREP I+II	A minimum of additional 800 households need to receive electricity access to achieve the NERM targets.	High	USD 0.3m	DoE	No financing	2025
Affordable Energy						
Conversion of diesel generators on Tanna	Existing diesel generators should be converted to make sure coconut oil can be used for electricity generation	Medium	n/a	DoE, UNELCO	No financing	2021
Investment in Barge	Invest in a barge to improve the efficiency and reliability of fuel distribution within Vanuatu by shifting away from deliveries of fuel in drums and towards the use of regular bulk deliveries to outer islands	Medium	USD 1.6m	GoV & Pacific Petroleum	No financing	2022
Sustainable Energy						
Brenwe 400 kW Hydro Power Project	The Brenwe Hydro Power project is a 400kW run-of-river hydro power plant on the island of Malekula. Funding secured is secured and the project will be fully financed through and ADB loan and contributions from the Government of Vanuatu. Completion is expected in 2022.	Medium	USD 6.5m	DoE, UNELCO	Preparation for implementation, fully financed	2022
Sarakata 800 kW Hydro Power Extension Project	Preparation of the project is underway, currently the feasibility study is being carried out. Funding through Japanese Grant for Projects envisaged, the project will also receive a contribution from Government of Vanuatu. Commissioning is expected for 2023	Medium	n/a	VUI, GoV	Feasibility study under preparation, funding under preparation	2023
Vanuatu Rural Electrification Project (VREP) Phase II (micro-grids)	VREP II will finance around 4.5 MW installed capacity of solar PV with battery backup, generating around 2.7educational GWh annually of solar based power. The project has received approval and implementation has started. It is expected that the installations of SHS and micro grids is finalised by 2022, therefore 2023 will be the first year of full operation of these systems.	High	USD 6.8m	DoE, World Bank	Ongoing, fully financed	2023
Talise 75 kW Micro Hydro Power Project	Project is currently under preparation and will be supported through the BRANTV Project. It is expected that the project will be operational latest 2022	Medium	USD 0.5m	DoE, GEF, UNDP	Ongoing, fully financed	2022

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing
Revision of Electricity Supply Act and Coconut for Fuel Strategy	Revision of the Electricity Supply Act is necessary to allow Independent Power Producers (IPPs) to erect grid-connected renewable energy projects. The Coconut for Fuel Strategy is a key component of the NDC Implementation Roadmap to secure a well-established agreement among all relevant stakeholders to provide coconut oil for electricity generation.	High	USD 0.3m	DoE, Ministry of Agriculture and Rural Development, Ministry of Trade and Finance, URA, Co-conut oil produc-ers, utilities	Financing under preparation	2020
Batteries (Efate grid)	Due to the planned expansion of renewable energy capacities (solar PV and wind), batteries are a key component for the functioning of the grid. Surplus electricity will be stored and will then be consumed at times when renewables do not provide sufficient contribution	Medium	USD 25.9m	DoE, UNELCO	No financing	
Expansion solar PV	Solar PV will be expanded by 7.6 MW on Efate to achieve total installed capacity of 10 MW, in combination with storage capacity.	High	USD 11.7m	DoE, UNELCO	No financing	2022-2026
Expansion wind	Addition of 5.1 MW (Option 1) or 2.6 MW (Option 2) on Efate, in combination with storage capacity.	Medium	USD 13.5m	DoE, UNELCO	No financing	2022-2026
Coconut oil	Usage in Efate grid up to a maximum of 12.5 liters (Option 1) or 6 million liters (Option 2) in 2030. Agreements between key stakeholders based on Coconut for Fuel Strategy.	High	n/a	DoE, Ministry of Agriculture and Rural Development, Ministry of Trade and Finance, URA, Co-conut oil produc-ers, UNELCO	No financing	2020-2030
Geothermal	First stage of 4 MW in Takara, providing base load to the Efate grid. Batteries will need to be added to the grid to balance the fluctuations in production of electricity from wind and solar.	Medium	n/a	DoE	No financing	n/a
Mini geothermal	Potential project in Takara under investigation, using 50°C warm source without deep drilling. A draft business proposal submitted to DoE.	Medium	n/a	DoE, Greenstorc Oceania	n/a	n/a
Solar for hydrogen	An Australian company is interested to develop a 3.5 MW solar farm, which will be used in a second phase to produce hydrogen (to be used in pilot fuel cell cars) and feed excess to grid. The company is currently negotiating land for the project. DoE has received a draft proposal.	Medium	USD 6.0m	DoE, MyGrid Va-nuatu	No financing	n/a
Airport solar farm	Airports Vanuatu Limited (AVL) has expressed interest to implement 1 or 2 MW solar farm as part of the airport upgrade project. It's still not clear whether it would be a grid connected or a stand-alone initiative.	Medium	n/a	Airports Vanuatu Limited (AVL)	No financing	n/a
BRANTV	12,000 households will be provided with energy efficient cook stoves under the program	High	USD 20.8m (entire project)	DoE, GEF, UNDP	Ongoing, financed	2022

Activity	Description	Priority	Cost	Lead responsibility	Status	Timing
National energy efficiency strategy and action plan	Development of a national energy efficiency strategy and action plan. In process of applying for GCF Readiness funding to undertake this task	High	USD 0.3m	Ministry of Cli-mate Change, GGGI	No financing	2020
Import duties, tariffs and VAT reform	Reform import duties, tariffs and VAT to encourage imports of energy efficient and renewable energy equipment: • Energy efficient products for use in buildings—in particular, efficient electrical appliances and lights • Spare parts for vehicles and marine vessels • Energy efficient vehicles • Improved cook stoves and crop dryers • Renewable energy systems (solar PV, wind, biomass) and spare parts	High	n/a	Ministry of Fi-nance (with DoE)	No financing	2020
GHG Emission Inventory Tool	Develop GHG Emission Inventory for transport sector based on GIZ-IFEO tool.	Medium	USD 0.1m	DoE, Ministry of Infrastructure and Public Utilities, Public Works Department	No financing	2021
Pilot projects hybrid/ electric vehicles	Development of strategy to improve efficiency in transport sector	Medium	USD 0.3m	DoE, Ministry of Infrastructure and Public Utilities, Public Works Department	No financing	2021
Green Growth						
Coconut for Fuel Strategy	The Coconut for Fuel Strategy is a key component of the NDC Implementation Roadmap to secure a well-established agreement among all relevant stakeholders to provide coconut oil for electricity generation.	High	Costs already covered under Sustainable Energy	DoE, Ministry of Agriculture and Rural Development, Ministry of Trade and Finance, URA, Coconut oil pro-ducers, utilities	Financing under preparation	2020
Coconut oil	Usage in Efate grid up to a maximum of 12.5 liters (Option 1) or 6 million liters (Option 2) in 2030. Agreements between key stakeholders based on Coconut for Fuel Strategy	High	Costs already covered under Sustainable Energy	DoE, Ministry of Agriculture and Rural Development, Ministry of Trade and Finance, URA, Coconut oil pro-ducers, UNEL-CO	No financing	2020-2030
Expansion of VREP I or II for bungalows	Use the existing structure in the VREP program to supply equipment to around 20 bungalows.	Medium	0.1	DoE, Ministry of Tourism	No financing	2022

Table 4.2: Sustainable Energy Action Plan for Local Administrative Bodies

Province (Area Councils/ Municipal Council)	Access to Energy/Sustainable Energy Strategies to be included in the Corporate / Strategic Plan as per NERM Priorities
Sanma Province (Area Councils: West Santo, North Santo, South Santo, East Malo, West Malo, Canal – Fanafo, East Santo, South East Santo North West Santo,Municipal Council: Luganville)	• Grid Extension, East Cost Santo (Matevulu to Shark Bay, Port Olry, Stone Hill and Palekula) • Low Voltage and Medium Voltage Extensions, Santo • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • Lighting of Luganville Town Streets • 1,512 Energy efficient cook stove to be sold in Luganville and Santo • Implement household and institutional scale biogas digesters for cooking energy needs • Village-scale Community PV Demos: i. Kori, Santo - 5 kW ii. Bodmas, Santo 5 kW • Family-Scale PV-Nano-grids (of 300 W): i. Lelek, Santo: 8 systems x average of 300 W per system (2.4 kW) ii. Lathi, Santo: 11 systems x average of 300 W per system (3.3 kW) iii. Kole, Santo : 8 systems x average of 300 W per system (2.4 kW) iv. Sara, Santo : 8 systems x average of 300 W per system (2.4 kW) • Sarakata Hydro Power Extension Project (600 kW), Santo • Assessment of Renewable Energy Sources: Incremental pico- and small micro- hydro demo sites: i. Falambil, Santo (5 kW) ii. Vussvongo, Santo (5 kW) iii. Village near Wasat River, Santo (5 kW)
Shefa Province (Islands: Efate outer islands, Efate, Epi, Sheperd islands; Area Councils: South Epi, Tongariki, Eratap, Eton, Malorua, Makimae, Varisu, Erakor, Emau, Nguna, North Efate, Vermaul, Mele, North Tongoa, Pango, Ifira and Vermali; Municipal Council: Port Vila)	• Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • Vermaul Area Council: Establish power supply for Burumba Dispensary • Identification of potential power sources (focused on Renewable sources) for all Area Councils offices. • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • Efate Area Council: Expand power supply to increase accessibility of Shefa residents • Implement household and institutional scale biogas digesters for cooking energy needs • Village-scale community PV demos to demonstrate off-grid renewable energy systems. i. 5 kW Village-scale Community PV Demo on Epi Island • Distributing EE cook stove beyond Port Vila/ Efate to allow lower cost and more effective distribution of the cook stoves; specifically, in northern Efate and the two mainland sites of Epau and Lelepa, and the offshore island of Nguna, with a target of 530 EE stoves to be sold. • Crop drying technology based on an energy efficient stove model combined with solar-powered fan to be developed, demonstrated and deployed. • Relocation of two new 5 million litre petroleum storage tanks in Port Vila, Efate • Reduction in petroleum distribution costs by 10%-15% (primarily by using a barge to supply outer islands and developing wharves in Port Vila and outer islands).

Tafea Province (Islands: Tanna, Aniwa, Futuna and Erromango; Area Councils: Middle Bush Tanna, South Tanna, West Tanna, Whitesands, South West Tanna, North Tanna, Aneityum, North Erromango, Futuna, South Erromango, Aniwa; Municipal Council-Lenakel)	• Whitesands Solar PV Micro-grid, Tanna • Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • UNELCO Grid extension in Tanna • Extension of off grid electricity access under Rural Electrification programme in Tanna and Aniwa. • Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos on Tanna: i. Isaka, Tanna (7.5 kW) ii. Site near village on Mt. Malin, Tanna (5 kW) iii. Tanna site 3, Tanna (5kW) iv. Village near site in DOE hydro study, Aneityum (5 kW) • Village-scale Community solar PV Demos: i. Port Resolution, Tanna (7.5 kW) ii. Sulfur Bay, Tanna (7.5 kW) • Improving diesel generation efficiency (g/kWh) • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • Distributing EE cook stove in all Area Councils (ACs) • Implement household and institutional scale biogas digesters for cooking energy needs
Torba Province (Area Councils: Mere Lava, Torres, Mota, Gaua, Urepa-rapara, Mota Lava, Vanua Lava)	• Off-grid rural electrification using the Biofuels for residential (for over 300 HH) and institutions including hospitals, dispensaries and schools • Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos: i. Siriti/ Nemen/ Santa Maria, Gaua (15 kW) ii. Barvet/ Aworor, Gaua (7.5 kW) • Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • Distributing EE cook stove in all Area Councils (ACs) • Implement household and institutional scale biogas digesters for cooking energy needs
Malampa Province (Area Councils: South East Malekula, South West Malekula, North West Malekula, South East Ambrym, West Ambrym, North East Malekula, Paama, Central Malekula, South Malekula, North Ambrym)	• Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • North East Malekula Rural Electrification Project • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • UNELCO Grid extension in Malekula - Low Voltage and Medium Voltage Extensions • Implementation of a comprehensive hydro-based energy generation demo program – 600 kW mini-hydro unit (Brenwei Hydro on Malekula) • Extension of off grid electricity access under Rural Electrification programme in Malekula • Brenwe Hydro Power Project (< 1.2MW), Malekula • Brenwei Hydro is a 400-kW mini-hydro project with mini-grid on Malekula • Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos: i. Lawa Village, Malekula (10 kW) ii. Lambugu Village, Malkeula (5kW) • Village-scale Community PV Demos: i. Uri Island, Malekula (5kW) ii. Ambrym 1 (5 kW) iii. Luli, Paama (5 kW) iv. Tahal Nesa, Paama (5 kW) • Distributing EE cook stove in all Area Councils (ACs) ; specifically in northeast Malekula, on the offshore islands of Vao, Achin, and Urpil, a target of 1,620 stoves to be sold. • Improve Diesel generation efficiency (g/kWh)
Penama Province (Area Councils: North Pentecost, East Ambae, North Maewo, Central Pentecost-1, South Maewo, West Ambae, Central Pentecost-2, North Ambae, South Pentecost, South Ambae)	• Develop a provincial energy roadmap to extend access to sustainable and affordable energy across all Area Councils (ACs) • Off-grid rural electrification using the Biofuels for residential (for over 350 HH) and institutions including hospitals, dispensaries and schools • Carry-out sustainable energy/RE resource assessment at the provincial and municipal level • 75 kW micro-hydro unit (Talise Hydro on Maewo) • Pico-Hydro/ Small Micro-Hydro Mini-Grid Demos: i. Rangusuksuk, Pentecost (7.5 kW) ii. Melsisi, Pentecost (10 kW) iii. Bwatnapni Pentecost (5 kW) iv. Nambwarangiut, Pentecost (5 kW) v. Waterfall, Pentecost (7.5 kW) vi. Laringmat, Pentecost (5 kW) vii. Big Water, Maewo (7.5 kW) • Village-scale Community PV Demos: i. Laone, Pentecost (5 KW) • Distributing EE cook stove in all Area Councils (ACs); specifically, in northern Pentecost, Ivo and 3 or 4 other villages, with a target of 1,225 EE cook stoves to be sold.

Rural Electrification NAMA

The rural electrification NAMA design document has as its main concern rural electrification and micro grids to improve access to electricity in the predominantly rural sector.

NAMAs are voluntary, non-binding policy instruments that provide a framework for pursuing a country's socio-economic and development goals, while contributing towards global greenhouse gas mitigation efforts. Thus, they have the dual objective of mitigating climate change while allowing economic objectives to be reached. INDCs on the other had have the prime objective to reduce emissions of greenhouse gasses, although it is realised that developing countries have the opportunity to improve their well-being, at least until their per capita emissions draw level with world average levels; after which the pressure to reduce emissions will intensify.

The NAMA covers two interventions. Under Intervention 1, micro grids will be established. Rural communities/tourism and agricultural facilities/health centres/ schools are the focus of these micro grids due to their demand for electricity for lighting, cooling and appliances. The micro grids will use renewable energy sources (solar, wind, hydro) and will provide electricity for lighting, radio and phone charging for households, and for service and production activities in Rural Productivity Zones (RPZs).

Intervention 2 will support extension of existing electricity grids on different islands. Households, public institutions and tourism/commercial consumers in the proximity of lines will be connected.
Electricity will be provided for lighting, audio/TV, mobile phone charging, coastal fishing (refrigeration of the fish catch), tourism facilities (lodges), agricultural facilities (preparing, processing and packaging produces) or the production of handicrafts.

The total cost of the NAMA is estimated at around US$5.5 million. This includes support to cover the investment costs of the two interventions as well as extensive capacity-building efforts. According to the NAMA report over the 15-year lifetime of the NAMA, emission reductions will reach around 13,500 tons of CO2 which amounts to around 900 tons per annum or 0.9Gg per annum.

Under the UNDP NDC Support Programme, the Department of Energy (DoE), Government of Vanuatu has carried-out a detailed techno-economic feasibility study for a solar micro-grid for Wintua and Lorlow village communities located in South West Bay on Malekula island. Under the NAMA programme, The Ministry of Climate Change (MoCC) has now secured funding from Government of Austria for implementation of a solar micro-grid for Wintua and Lorlow village communities located in South West Bay on Malekula island.

IRENA Renewables Readiness Assessment

This detailed report reiterates that like all Pacific Island nations Vanuatu has an excellent solar resource and that this resource is available throughout the populated areas of the country and could be used to generate electricity to offset the cost of imported fuels.

The report notes that several solar photovoltaic (PV) projects with a total capacity of more than 2.6 megawatt (MW) are under consideration. Interest from independent power producers (IPPs) in solar PV electricity generation has been increasing. Moreover, the first stage 4 MW geothermal plant is expected to go on stream before 2020, and some hydropower may also be added. The Port Vila grid currently has 3 MW of wind and the 26.5 MW diesel generator sets use between 5% and 20% coconut oil the quantity depending on availability and the economics of using the bio fuel instead of diesel. The Luganville Grid on Espiritu Santo has a 1.2MW hydro plant and 2.9 MW diesel generations. In addition there is a small amount of grid connected solar PV.

The report also suggest that to fulfil the aims in National Energy Road Map, it would be necessary to establish and enforce technical standards for grid-connected systems and regulatory capacity for small scale distributed generation systems. In addition detailed models of the grid need to be pursued as the addition of intermittent sources such as solar PV could stretch the stability of the (30MW) grid system on Efate in particular.
In terms of major mitigation options this report identifies a mix of geothermal, wind, biofuels and solar PV as the key technologies suitable for Vanuatu. The report is not, however, particularly ambitious in terms of projected installed capacity of PV citing grid stability concerns that would limit PV penetration to a few MW. In addition, the geothermal sources are still at the exploratory stage and with estimated upper temperatures of around 50 – 60 degrees C the plant efficiency is likely

to be relatively low.

One of the problems identified by the report was how to handle the large night time load on the Efate grid from solar PV in particular. Most of this load is likely to be air conditioning and so one option would be to generate cooled water during the day and circulate the water from storage tanks at night. The other more conventional option for load shifting would be to use storage batteries.

National Green Energy Fund

To contribute to achieving its energy access and sustainability targets, the Government of Vanuatu (GoV) approved the establishment of a National Green Energy Fund (NGEF) in April 2016. The NGEF is intended to mobilize a pool of financial resources sufficient to provide all households with access to electricity and meet the sustainable energy target by 2030.

The general characteristics of NGEF include:
It will operate as a revolving fund, with an anticipated initial start-up capital of USD 10 million, to be sourced mainly from international sources, and from yearly contributions from domestically consolidated energy funds, totalling USD 300k.

It will offer four types of funding:

- Debt via intermediaries, including financial institutions and non-financial institutions in Vanuatu
- Project equity for project developers and technology providers
- Risk sharing, in the form of a first loss facility for local banks
- Small grants for public institutions (no more than 5% of total fund investments)
- Energy efficiency investments should be included as well as renewable energy development, with a primary focus on increasing energy access in off-grid areas.

Renewable Energy Electrification Master Plan for Vanuatu

A renewable energy-based off-grid electrification master plan for remote islands of Vanuatu was developed during 2016 which would both: i) fit the specific cases of pilot islands (Mataso, Makira, Emae and Aneityum) pre-selected by the government of Vanuatu), and ii) subsequently allow a broader replication to further remote islands in Vanuatu.The master plan has two main components:

i. preliminary technical designs for renewable-energy based electrification for the four islands; and
ii. based on this sample of islands, development of a masterplan for electrifying Vanuatu's outer islands through affordable renewable energy.

National Sustainable Development Plan 2016-2030

The National Sustainable development plan (2016-2030) also called as "Vanuatu 2030 - The People's Plan"; charts the country's vision and overarching policy framework for achieving a Stable, Sustainable and Prosperous Vanuatu within the next fifteen years, and in doing so sets out the national priorities and context for the implementation of the new global Sustainable Development Goals over the same period.

The key goals and policy objectives under the Vanuatu 2030 also include enhanced resilience and adaptive capacity to climate change and natural disasters (adaptation) and Prioritizing renewable sources of energy and promote efficient energy use (mitigation).

The Ministry of Climate Change through its departments and the National Advisory Board (NAB) ensures that climate change priorities are streamlined and linkages made under the broader national development priorities and policies.

Vanuatu National Forest Policy (2013-2023)

Vanuatu acknowledges the need to adapt to climate change and targets to "integrate climate change adaptation issues into forestry sector planning and activities". However, the enforcement of regulations is hindered by the fact that all forests are privately owned, whereas the constitution demands from landowners to manage their land in a way that "safeguards the national wealth, resources and environment in the interests of the present generation and of future generations".

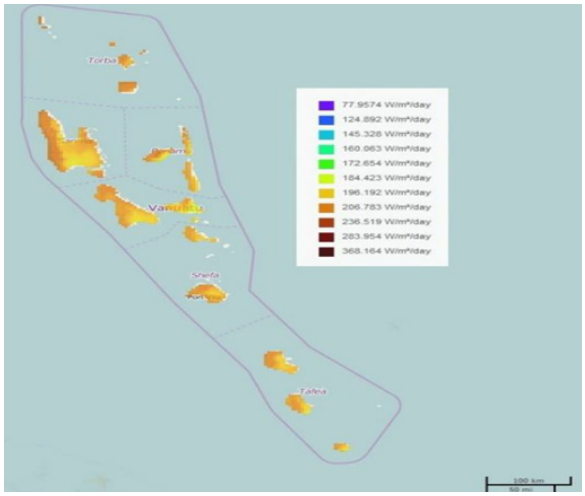
The policy identifies the integration of climate change mitigation issues into forestry sector planning and activities as a specific objective. In particular, this includes the development of a national REDD+ initiative by the Department of Forests, the National Advisory Board on Climate Change and Disaster Risk Reduction (NAB) and non-governmental organizations.

Climate Change Mitigation Options for the Future

Solar Energy

For a specific site, the useable solar energy depends on many variables such as cloud cover, shade patterns, the season and the geometry of the receiving surface. However, Figure 10 from The Global Atlas for Renewable Energy from the International Renewable Energy Agency (IRENA) show that Vanuatu generally has a good solar energy resource for all islands, with typically 200 W/m2/day on a horizontal surface. Vanuatu's Meteorological Service has collected solar insolation data at several sites for many years but the data are too limited in scope for detailed designs for solar applications in most remote areas of the country.

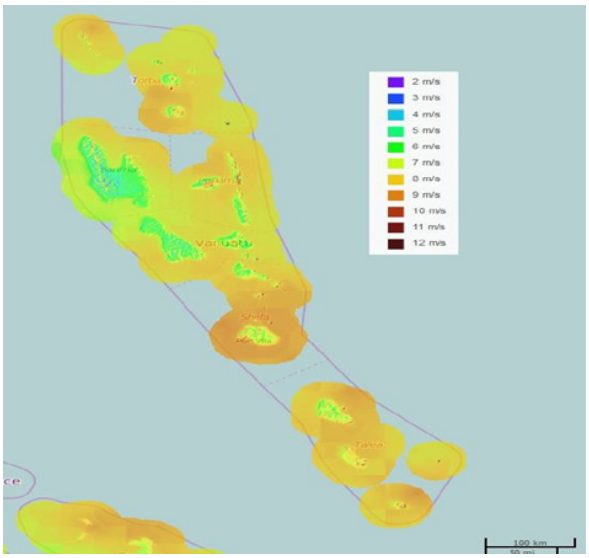
Figure 4.3: Vanuatu Indicative Solar Insolation Map



Wind Energy

IRENA's indicative wind energy map for Vanuatu (Figure) suggests that the wind resource is broadly favourable with average wind speeds of about 6 m/s in many locations. However, average speeds are not useful for project development and wind energy is very site specific. Since the available energy varies as the cube of wind speed, a 20% reduction in actual wind speed results in a 73% reduction in potential wind energy. The DoE has installed wind-monitoring towers in each of Vanuatu's six provinces (at Vanua Lava, Pentecost, Santo, Malekula, Tongoa and Tanna) and monitored wind speeds for about 24 months but no results are available.

Figure 4.4: Vanuatu Indicative Wind Energy Map



Biofuel –Coconut Oil

Coconuts can be an excellent resource for producing biofuel and a potential source of rural employment and income. Information on land area under coconuts, and coconut production, in Vanuatu is outdated and available data are generally limited to provinces. Although copra is a significant cash crop in much of Vanuatu, available data do not provide information on the amount of copra produced by island, the total resource which might be available for conversion to fuel, the resource which can be economically harvested, or the relative value of coconuts for fuel and for other purposes.

The value of copra and coconut oil as exports is quite volatile, with the resource available locally for energy

varying according to the export value of copra and oil, the import cost of petroleum products, and the cost of petroleum fuel at a proposed biofuel site. Coconut oil has been increasingly more valuable as an export commodity than as a diesel replacement in the past four years so the quantity that can be considered as a likely energy resource has declined.

Small–Scale Hydropower

Vanuatu has considerable technical potential for hydropower, but its porous geological structure makes it unsuitable for dam-impounded storage ponds leaving the more seasonal run-of-the river type installations as the main option. Useable hydropower resources have been identified on many islands including Vanua Lava, Santo, Maewo, Malekula, Epi and Tanna. Small run-of-river systems may be economically attractive in several locations, and one has been constructed on Maewo island, but costs are very site-specific and these systems are extremely vulnerable to damage or destruction during periods of very high water flow during cyclone passages (which can exceed a thousand times typical flows). Before the energy potential of a site, and the potential for flood damage, can be accurately determined, the resource must be measured for at least several years. Although some resources have been identified, only a few sites have been assessed and very few hydropower systems have been developed.

ESMAP has agreed to support further investigation of sites in late 2016 with the potential to provide 100 kW to 5 MW of generation capacity and plan to visit at least twenty promising sites.

Biomass

Recent estimates suggest that 44-67 kilotonnes of oil equivalent (ktoe) of fuel wood is burned each year in Vanuatu for cooking and crop drying. IRENA reports that there is no evidence that this is detrimental to Vanuatu's forests, as deforestation appears to be tied mainly to agricultural expansion and logging. Annual saw log yields are around 10,000 cubic meters (m3) with a sustainable harvest level estimated by IRENA as 38,000-60,000 m3, with the Forestry Department estimating 68,000 m3 from the 20% of the land under accessible commercial forests.

As forest plantations expand, mature and are harvested, substantial forest production waste could in principle be used for powering forest products facilities and providing electricity to nearby villages. However, the sustainable resource is only an estimate as there has not been a national forest sector study since 2000 and there is no disaggregated data by island.

According to the Forestry Department, a key issue is land disputes in forest areas or areas with potential for development, which continue to hamper forest development. Disputes about ownership of land and forest resources disrupt forestry operations, cause financial losses for forestry investors and limit the establishment of development projects.

Biogas

The conversion of biological materials, usually manure, to burnable methane through biogas digesters has been used with varying levels of success in the Pacific, mostly for cooking. The primary technical problem is collection of the large quantities of manure and maintaining the conditions (such as temperature and water content) in the biogas digester conducive to gas production.

A large number of animals (pig, cows) need to be confined so manure can be economically collected. Few remote farms have either the number of animals or easy access to their manure in order to make biogas sufficient for power generation.

Geothermal and Ocean Energy

Although Vanuatu has substantial geothermal resources, development for power generation is practical only for relatively large scale development such as the 4-8 MW system being considered for Efate.

Recent studies suggest that sea wave sites with 7 kW per meter of wave front may be technically feasible for development, and 11 kW/m have been measured off parts of Efate and 9 kW/m for Tanna. Although most of the rural population in Vanuatu lives along the coast, wave energy, tidal current energy and ocean thermal energy conversion (OTEC) are not commercially available or technically proven for small scale power gen-

eration and would be at very high risk during cyclones.

Waste Management

Unlike many island nations in the Pacific, the emissions from the agriculture and waste sectors make a significant contribution to GHG emissions from Vanuatu. In particular, the large number of cattle in the country, together with the nitrogen fertiliser requirements of the associated pasture, present large Methane (CH4) and Nitrous Oxide (N2O) emissions. In this regard it is thought that mitigation measures will be difficult without reducing animal numbers.

It is envisaged GoV intends a planned cooperation with New Zealand and other nations interested in mitigating methane (CH4) and associated emissions for ruminant and pasture management.

Potential Climate Change Mitigation Sectors

The next step is the identification of updated potential mitigation sectors for Vanuatu, which can be ascertained from the sectoral breakdown of GHG emissions. As identified in the inventory section of this report the main sources of emissions in the Vanuatu are the energy sector, agriculture and waste. There are virtually no industrial emissions other than those produced by refrigerant gasses.

Energy Sector

Vanuatu depends upon imported petroleum products for much of its energy needs; hence the fluctuation in global fuel prices significantly affects the performance of all economy sectors. Further, a precipitous decline in world copra prices has reduced the real income of much of the population and has put increased pressure on other resources (i.e., timber, fisheries, and traditional agriculture). The energy sector mitigation has been almost entirely concentrated in the electricity sector with a move from diesel fuelled generation being replaced by various renewable options.

Land Transport

Transportation infrastructure development is one of the priority sectors for Vanuatu and with this view the Government has initiated a long-term Vanuatu Transport Sector Support Program (VTSSP). The Government of Vanuatu is also focusing on mitigation options for emissions from land, sea and air transport sectors. Measures include public transportation awareness programmes, vehicle emission standards, promoting fuel-efficient and alternative fuel vehicles, improving public transport services, introducing financial incentives to encourage energy efficiency and promoting non-motorized transport. Currently, however, transportation emissions are relatively small due to the small number of motor vehicles.

Air Transport

Air transport is difficult to mitigate in light of the preference to gain tourist numbers. The main route here is the often-used Port Vila to Santo and Tanna flights but flights to other islands also contribute.

Energy Efficiency

Energy Efficiency has also been identified as a relatively low cost easily implemented option but, however, one that has not been seriously implemented in the country for various reasons including financial constraints.

Energy efficiency will become more important as higher cost renewable resources are employed but as efficiency improvements are always limited by the laws of physics it is thus unlikely to give the reductions needed for the complete decarbonisation that would be necessary to mitigate climate change after mid-century.

Waste Sector – MSW and Waste Water

Most of Port Vila and Luganville lack sewage and wastewater treatment systems and waste is generally disposed of via illegal stormwater connections, direct discharge, or into poorly designed and maintained septic systems, which leach contaminants into adjacent coastal and freshwater systems. There are currently no regulations for wastewater management.

Undertaken by the Japan International Cooperation Agency (JICA) in 2011, an audit of daily household waste in Port Vila shows a rate of 0.427kg. A further study in 2014 established an average household daily waste generation in Luganville of 6.8kg. Both studies show that the majority of waste is organic, followed by plastic. Yet another study, taking into account Tafea Province, established a per capita waste generation rate of approximately 0.5kg a day on islands with pop-

ulations of less than 5,000, and 0.8kg a day on islands of more than 5,000.

Forestry

Vanuatu's total land area is about 12,336km2 with more than 36.1% (440,000 hectares) covered by tropical forest. By 2006, about 4,800 hectares were covered with planted forests; about 3% of the mid-to high forest (about 6,000 hectares) and 0.7% of the low forest (about 1,400 hectares) are in protected areas.

Vanuatu is pursuing forestry sector measures to reduce deforestation and promote good land care to accepted mitigation practices under the REDD+ programme. Under REDD+ Vanuatu has identified as stated in the Readiness Preparation Proposal (R-PP) five major islands with high rate of deforestation and forest degradation. These islands have both Provincial Technical Committee and Provincial CSO Network established and supported.

Projected GHG Emissions in Vanuatu

In Vanuatu, electricity generation has shown a steady increase over the past years (2012-2017);. From a total of 69 GWh in 2012, electricity generation in the concession areas (Efate, Santo, Malekula and Tanna) has increased to 77.23 GWh in 2017. This represents an annual increase of 2.3% p.a. Electricity generation in 2015 was lower due to the effects from cyclone Pam, but the drop in 2015 was already compensated in the following year.

In the same time period, the share of renewables was fluctuating between 16.19% in 2011 (33.7% in 2013) and 18.03% in 2017. The main reason for these fluctuations and especially the drop in the share of renewables in 2016 and 2017 is due to higher world market prices for copra, which reduced the use of coconut oil in electricity generation (in 2017, no electricity was generated from coconut oil).

Figure 4.5: Total Electricity generation and share of renewables (2011-2017)

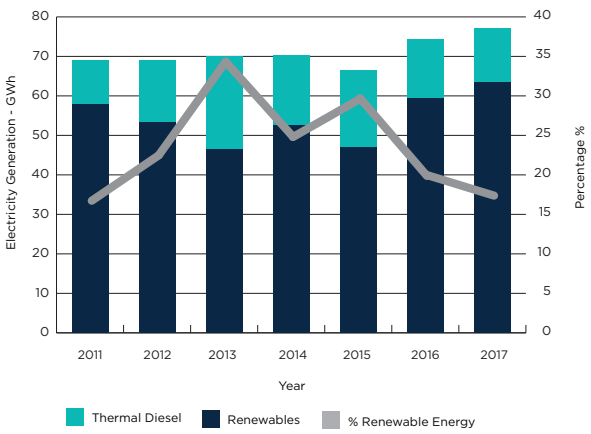
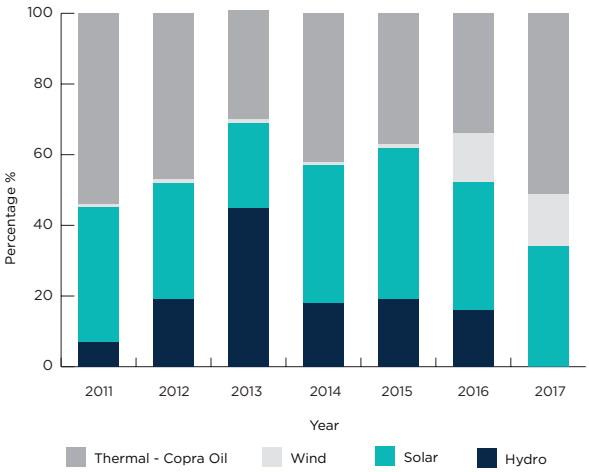


Figure 4.6: Renewable Electricity Generation by Source (2011-2017)



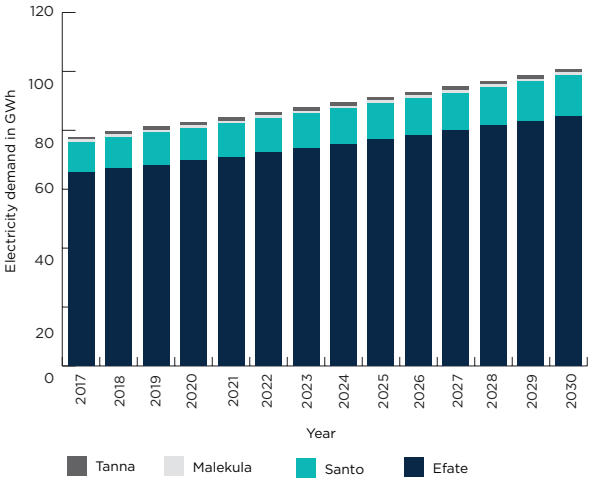
To project the further development of electricity demand and generation needs, consultations with the two utilities were held. These resulted in the following assumptions:

- UNECLO, concession areas in Efate, Malekula and Tanna: projections of electricity demand are to be seen in relation to GDP development. Experience from historic figures shows that electricity demand increase is about 1.0-1.2% lower than GDP growth. With GPD growth projected at 3.2% for 2018 and 3.0% for 2019, a demand growth of 2% p.a. is seen as realistic.
- VUI, concession area in Santo: increase in electricity demand is estimated at 2% p.a.
- The general assumption of a 2% p.a. increase of electricity demand between 2017 and 2030 is consistent with the trend over the last years, which showed an annual increase of 2.3% p.a. The following figure and table show the electricity demand projections from 2017 to 2030. Based on the 2% increase p.a., total electricity demand increases from 77.9 GWh in 2017 to 100.7 GWh in 2030, a total increase of 29.4%.

Table 4.3: Electricity demand projections in GWh 2017-2030

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Efate	65.6	67.0	68.3	69.7	71.0	72.5	73.9	75.4	76.9	78.4	80.0	81.6	83.2	84.9
Santo	10.5	10.7	10.9	11.1	11.3	11.6	11.8	12.0	12.3	12.5	12.8	13.0	13.3	13.6
Malekula	0.8	0.8	0.9	0.9	0.9	0.9	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.1
Tanna	1.0	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3
Total	**78.0**	**79.5**	**81.1**	**82.7**	**84.4**	**86.1**	**87.8**	**89.6**	**91.4**	**93.2**	**95.0**	**96.9**	**98.9**	**100.9**

Figure 4.7: Electricity Demand Forecast (2017-2030)



Petroleum product consumption is expected to increase by about half during the period 2015 to 2030. Land vehicles will continue to be the dominant contributor with an increasing share from 50% of petroleum fuel use in 2010 to 71% in 2030. This projected trend for land transport is based on the growing number of registered vehicles, expected development of road infrastructure, and greater need for ground transportation for commercial and industrial activities.

The second driver for petroleum consumption is air transport with an expected 10% increase by 2030. Petroleum product consumption related to cooking, sea transport and other uses are expected to continue to grow, but the share in the overall volume should stagnate at around 5% for each usage.

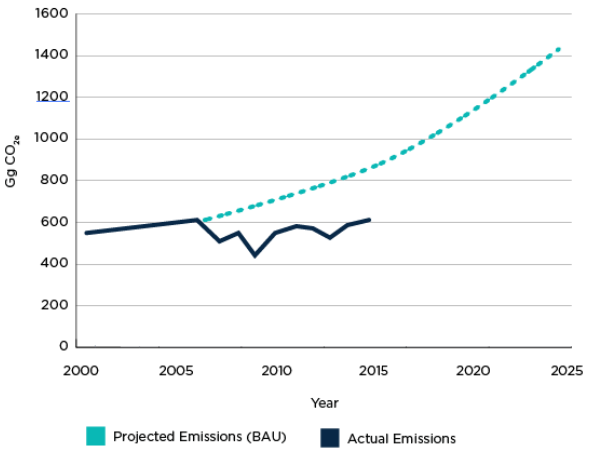
The quantity of kerosene for lighting will continue to decrease, and be replaced over time by grid electricity or stand-alone renewable energy systems.

If no measures are taken to manage growth, the demand for biomass energy will almost double in the next 15 years, driven by the need of rural populations for cooking and crop drying. This could potentially increase localized deforestation currently experienced in Vanuatu.

Biomass sources in Vanuatu are 50% mixed fuelwood (5% moisture content) and 50% coconut residues (air dry – 0% moisture content). These types of biomass are locally available to the rural population at no, or very low cost. Biomass-based charcoal is also used but no data is available on quantities. With an annual increase between 3% and 4%, the required volume of fuelwood and coconut residues being burnt aligns with the assumptions used for population and GDP growth, respectively 3.1% and 3.6%. Emissions in the energy sector only are projected to grow more modestly at around 3% p.a.

For mitigation, in common with other countries, Vanuatu sees replacing diesel generation with renewable energy sources as a high priority. For the future, BAU projections show emissions (excluding removals) rising to over 1400 Gg by 2025.

Figure 4.8: BAU Scenario Projected Total GHG Emissions (excl. Removal - Year 2000-2025)



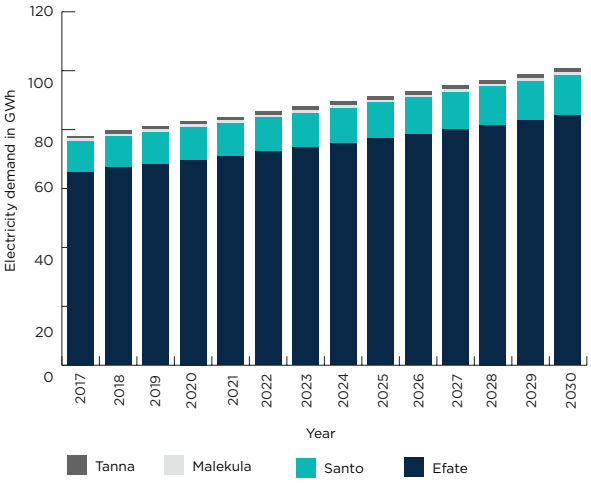
Proposed Climate Change Mitigation Measures

Electricity Generation

Vanuatu has submitted its INDC to United Nations Framework Convention on Climate Change (UNFCCC) on 29 September 2015 and the same document was endorsed and submitted as the first Nationally Determined Contribution (NDC) on 21 September 2016. Although being a Small Island State with a small carbon footprint, Vanuatu has committed to a challenging mitigation target in its NDC of transitioning to close to 100% renewable energy in the electricity sector by 2030. Achieving this target would replace nearly all fossil fuel requirements for electricity generation in the country.

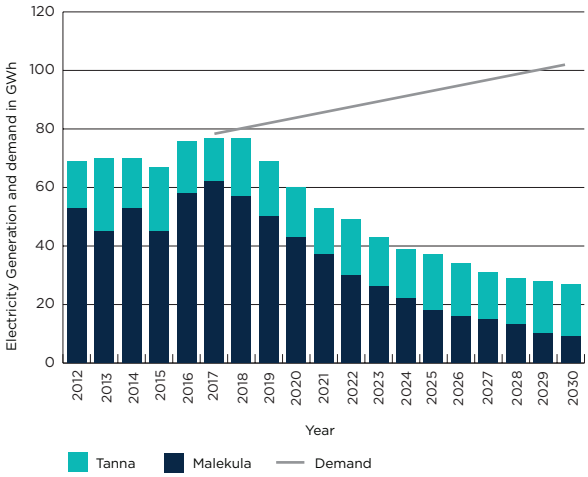
The NDC Implementation Roadmap (NDC-IR) developed during 2019 provides a pathway for the implementation of specific mitigation actions in Vanuatu. In the business as usual (BAU) electricity demand scenario, an increase in electricity demand from 77.9 GWh in 2017 to 100.7 GWh in 2030 is projected. This is a total increase of 29.4%.

Figure 4.9: Electricity Demand (2017-2030)



Vanuatu has been very active in implementing renewable energy projects for electricity generation, including solar PV, wind and coconut oil. The gap analysis takes note of these activities and determines the additional efforts necessary for achieving the target. Assuming a reduction in diesel generation of 15% p.a. from 2019 onwards and with the operation of the Sarakata 1.2 MW hydro power project, the Devil's Point 3.6 MW wind farm and smaller solar PV units at Tagabe, Tanna and Malekula, the gap which needs to be filled with additional renewable energy projects is expected to be 74 GWh in 2030.

Figure 4.10: Electricity generation and demand BAU scenario



There are a number of newly implemented renewable energy projects as well as initiatives currently under implementation or preparation, which will have sizeable contributions towards the NDC target:

- Undine 510 kW solar PV plant, commissioned in 2016
- Parliament Building and Meteo complex 767 kW solar PV plants, commissioned in 2016
- Kawene 1.0 MW solar PV plant, put in operation in early 2018
- Brenwe Hydro Power Project
- Sarakata Hydro Power Extension Project
- Vanuatu Rural Electrification Project (VREP) Phase II
- Talise Micro Hydro Power Project

All these projects will reduce the gap to 60 GWh in 2030. To fill the remaining gap, a number of interventions need to be implemented and two different combinations to achieving the NDC target are proposed:

Figure 4.11: Contributions to target

Contribution to target indicator 10%	
Basic Interventions	
Interventions under implementation or preparation	14%
Revision of Electricity Supply Act and Coconut for Fuel Strategy	0%
Batteries (37 MWh)	0%
Option 1	
7.6 MWp solar PV	15%
5.1 MW wind	14%
Coconut oil (12.5 ml)	57%
Option 2	
7.6 MWp solar PV	15%
2.6 MW wind	7%
Geothermal (4 MW)	36%
Coconut oil (6 ml)	28%

First of all, there are basic interventions, which are recommended to be implemented in any case:

Interventions under implementation or preparation: project under implementation such as VREP II or the Talise Hydro Power Project bring good contributions towards the target and should be finalised as planned. Focus should be on implementations under preparation to secure funding and push for implementation.

Coconut for Fuel Strategy: This is the key element in providing a sizeable contribution to achieving the NDC target and is the first implementation step to be carried out.

Revision of the Electricity Supply Act: this is a key step for stronger involvement of the private sector and should allow attracting private capital for the investment into renewable energy projects. Batteries: a total of 37 MWh of battery storage capacity are necessary to secure a well-functioning grid, where overproduction can be stored for later consumption.
In addition to these basic interventions, 2 options are suggested for achieving the NDC target.

Option 1 includes the installation of 7.6 MW solar PV and 5.1 MW wind, which together can contribute around 30% to the target. The majority of the contribution towards the target (57%) will come from the use of coconut oil.

Total costs of Option 1 are USD 73.3 m (excluding costs for the Sarakata hydro power project as they haven't been determined yet). It is assumed that a pricing arrangement for coconut oil can be found, which is not leading to ongoing operation costs, the costs for carrying out the Coconut for Fuel Strategy are included.

Option 2 includes the installation of 7.6 MW solar PV, which is seen as the renewable energy source with lowest generation costs. The main contribution in Option 2 will come from geothermal (36%), which requires successful drilling and considerable investment for the implementation. The availability of geothermal allows reducing the input of wind energy and it suggested that only half of the additional capacity (2.6 MW) is installed. The remaining gap will be covered by coconut oil and a total of around 6 million litres will be required to achieve the target.

Total costs of Option 2 are USD 66.5 m (excluding costs for the Sarakata hydro power and the geothermal project as they haven't been determined yet). It is assumed that a pricing arrangement for coconut oil can be found, which is not leading to ongoing operation costs, the costs for carrying out the Coconut for Fuel Strategy are included.The integrated MRV system to be installed allows tracking of the process and can give feedback on corrective action necessary for achieving the target.

Energy Efficiency

The Department of Energy with the technical assistance from the Pacific Community and funding from the Australian Department of Foreign Affairs and Trade (DFAT) have developed the Energy Efficiency of Electrical Appliances, Equipment's and Lighting Products Act No. 24 of 2016. This means that all refrigerators, freezers, air conditioners and lamps imported to Vanu-

atu now have to meet minimum energy performance standards (MEPS). Refrigerators, freezers and air conditioners also have to carry an energy label.

Energy efficiency is usually identified as a relatively low cost easily implemented option but, however, one that has not been seriously implemented in Vanuatu for various reasons including financial constraints. Energy efficiency will become more important as higher cost renewable resources are employed but as efficiency improvements are always limited by the laws of physics and they are unlikely to give the reductions needed for complete decarbonisation.

Land Transport

As mentioned above, mitigating the transport sector is very difficult due to the social attachment people have for individual motorised transport and the economic benefits perceived by the government for such transport. From a key sector analysis land transport is the single largest source of GHG emissions.

e-Vehicles: In recent years there have been considerable advances in the use of electric vehicles that could be considered for the main populated areas (Port Vila and Luganville). Personal transport in Port Vila has been much more focussed on cars and mini bus options making electrified transport even more of a good opportunity. The updated NERM implementation plan also aims to develop pilot projects for hybrid/electric vehicles for government vehicle fleet.

The advantage of introducing electric vehicles is that Vanuatu is progressing well in terms of increasing the penetration of solar systems on Efate grid to the extent that connecting them to the grid would assist the storage problem. Electric vehicles could have a reduced electricity charging tariff if charged at times of excess solar availability and it is possible that they could sell electricity back to the grid at times of shortage.

Electric buses are also emerging as solution for sustainable public transport system, with over 150,000 electric buses in service around the world (2016), mostly in China. In a few other countries, electric bus fleets of varying seating capacities (large and mini buses) and for speciality services exist at the level of a few tens of buses (100 in India, 94 in the Netherlands, 30 in Sweden and 21 in Japan, according to EVI data submissions), and are deployed as pilots and demonstration projects in a few major cities. This represents a very rapid increase over the past two to three years, and the number is expected to continue to grow fairly rapidly in more countries.

On Efate some of the public transport mini buses could usefully be converted to use electric transport alternatives, although the current global solution in terms of electric busses would probably need to some redesign with an electrified alternative to the “Bula Bus” used in the Denarau tourist district in Fiji being a possible alternative.

Vanuatu Transport Sector Support Program (VTSSP). The Government of Vanuatu is also focusing on mitigation options for emissions from land, sea and air transport sectors. Measures include public transportation awareness programmes, vehicle emission standards, promoting fuel-efficient and alternative fuel vehicles, improving public transport services, introducing financial incentives to encourage energy efficiency and promoting non-motorized transport. Currently, however, transportation emissions are relatively small due to the small number of motor vehicles.

Bio-Diesel: There an opportunity exists to use the bio-diesel in the road transportation vehicles. Bio-diesel can be manufactured from the copra-oil and easily used in the internal combustion engines. There are couple of experiments taking place in pacific and this can be explore as one of the viable option; however the economic value and price volatility of copra oil poses measure threat. Detailed research and techno-economic feasibility study is required to explore this option.

Waste Sector

In a bid to protect its marine life and also manage the problem of plastic litter and pollution around its islands, the Vanuatu government passed a legislation to ban the use, manufacture and importation of single use plastic bags in the country. The legislation, which came into effect on 1 February 2019, also extends to polystyrene takeaway food containers.

Vanuatu has implemented long-term policies and strategies for the environment, pollution control, and waste management. Limited human resource capacity and lack of access to government funding, however, are challenges that continue to hamper attempts to govern waste management. Improved domestic shipping services and infrastructure, as a result of the Inter-Island Shipping Support Project, will offer significant opportunities to recover recyclable materials from the outer islands. Communities also will be able to participate in future CDSs and extended producer responsibility schemes.

On the livestock waste front, it is thought that mitigation measures will be difficult without reducing animal numbers. It is envisaged GoV intends a planned cooperation with New Zealand and other nations interested in mitigating methane (CH4) and associated emissions for ruminant and pasture management.

Forestry

Reducing Emissions from Deforestations and forests Degradations (REDD+) is an international mechanism to assists countries to reduce levels of deforestation and forest degradation. It is being developed under the United Nations Framework Convention on Climate Change (UNFCCC) that seeks to reduce emissions from deforestations and forest degradation by incentivising land use change while protecting and replanting the forests.

In Vanuatu, the Department of Forests is the implementing agency with its REDD+ Unit taking the coordinating role. The programme also support the Civil Society Organization (CSO) to be part of implementing the National REDD+ Programme.

Under the REWDD+ programme Vanuatu has chosen to pursue the Forest Carbon Partnership Facility (FCPF) format. This offered the most realistic and short term potential for funding. In order to access this funding, the countries needed to formulate a Readiness - Preparation Proposal (R-PP). These were basically strategic plans on how to achieve REDD+ Readiness and served also as the basis for funding from FCPF to assist in getting to Readiness (implementation of the Readiness strategy).

The R-PPs covered four main components: appropriate institutional set-up, adequate REDD+ national policy/strategy/legislation, a functional MRV system and the establishment of REL. The project assisted in formulating the R-PPs, at times in a lead position, mainly however, with complementary but important activities in addition to other development partners' efforts. These activities included assistance in managing the overall process, bringing in experienced international consultants who had formulated R-PPs in other countries to assist in formulating R-PPs as well as the incorporation of experiences from the demonstration sites and other related activities.

Challenges and Barriers for Implementation of Mitigation Measures

There are many barriers for effective mitigation options in Vanuatu, many of which are common to developing countries in general and some are country specific. The IPCC lists some common barriers including:

Capital: Access to capital is limited. The capital costs of renewable energy technologies are generally higher than those of conventional technologies. Also, owing to the risks perceived for new technologies, financing costs will tend to be higher.

Trade barriers: Although many countries are revising their trade policies in order to liberalise markets, substantial tariff barriers remain in many cases for imports of (emission reducing) foreign technologies including energy supply equipment.

Vested Interests: National interest groups such as powerful extraction and construction companies can influence technology choices in favour of conventional technologies.

Institutional and administrative difficulties: Such difficulties exist in terms of developing technology transfer contracts, which can be a necessity to qualify regional construction companies as potential partners of the entrepreneurship.

Regional Cooperation: There is a need for greater regional cooperation among developing countries, both in R&D work and in the international commercial contracting network.

Access to information: Developing countries have in general poor access to information. It is one thing to recognise that the information and technology desired are available but is quite another issue to gain access to them.

Differing needs: The needs of the developing countries are quite different to those of the developed countries. Developing countries are generally still focused on large capacities of cheap, reliable power with low technical risk, and have new technologies as a lower priority. In addition, most developing countries rate development as a higher priority than reducing emissions. Economic incentives: Incentives for donors are weak mainly when energy demand is scarce and scattered. This barrier can be minimised by the additional potential value gained through JI/CDM schemes.

These barriers are discussed specifically in terms of the specific situation below:

Capital/Finance: The main barrier to mitigation options being realise in Vanuatu (and most developing countries) has been the slow progress of finance transfer from the international UN mitigation effort. To date there has been an emphasis on obtaining market finance and on market mechanisms to pay for mitigation options.

The current status of the Paris agreement (2015) is testament to the difficulty in assuming market forces will provide the necessary money flows. Projections for the current global iNDCs indicate that some trillions of US$ would be needed to be transferred to developing countries just to keep the temperature increase below 3.7 degrees. Unless this transfer eventuates, the action plans developed for mitigation are not likely to be actually acted upon and will continue to exist in paper format only.

To progress keeping the temperature increase below 2 degrees will require an even higher level of transfer and a real commitment on the part of the developed nations of the world and at the same time a real level of decrease in developed country emissions. Vanuatu has

been fortunate in recent years in that there has been a good deal of aid and technical expertise made available from the multi-lateral, bi-lateral and other global climate finances sources.

Vested interests: These constitute a considerable barrier in several areas. One is in terms of data sharing. In the Vanuatu it has been difficult to extract sectoral and sub-sectoral data from the major stakeholders. Another is in the transport sector where the vehicle importing companies have considerable interest in increasing the number of vehicles. Finally, the vested interest of the private sector in growing the economy is often at odds with serious emissions reduction.

Institutional and administrative difficulties: Such in country difficulties can be serious obstacles to easy technology transfer. Also included here might be the difficulty in retaining qualified people in administrative positions in government.

Regional cooperation: This has generally not been a large problem in the Pacific as there are a number of regional organisations (SPC, SPREP etc.) fostering cooperation all with good intentions in terms of assisting with climate change mitigation and adaptation.

Access to information: There appear to be difficulties. However, in terms of sharing information between government departments in Vanuatu, improvements could be considered.

Differing needs: The differing needs of all developing countries compared to the developed nations is a serious barrier globally to emissions reduction, a barrier that has played out at all of the major UN meetings designed to encourage countries to cooperate on emissions reductions. The issue is one of equity and of who has been responsible for past emissions. In almost all cases developing countries insist that climate change must be integrated with development not subservient to development.

Economic incentives: The problem of attracting aid transfers was covered in the lack of capital barrier but in addition there has been a problem of private sector participation in Vanuatu, particularly in terms of the on-grid electricity sector. There are of course other barriers including the lack of expertise in country to facilitate the realization of mitigation options, but these are largely also related to lack of finance due to a brain drain of experienced people from the country to greener pastures in terms of salaries. Government departments in particular have great difficulty retaining qualified staff due to relatively low salary levels. Training is obviously needed but unless such measures are accompanied by mechanisms to keep the trained staff, they are less likely to succeed.

Conclusion

Vanuatu is a small developing nation with absolute levels of CO2 emissions very small at under 0.0016% of world emissions. The country is also one of the most vulnerable to the effects of climate change and has much to lose should the worst predictions from increased temperature levels eventuate.

As such Vanuatu will do its best to mitigate but would require financial, technical and capacity building support to do so. With the hindsight of the 2015 Paris agreement and the present commitments from the countries of the world leading to a projected temperature increase in excess of 3 degrees Celsius it is difficult to be optimistic in terms of conclusions for any specific country such as Vanuatu.

Nevertheless, there are options for Vanuatu to do its share in terms of mitigation as discussed earlier. The key barrier, however, is securing the required finance for its technology needs. In addition, it is clear that developing countries need to see some real action from developed countries both to give incentive to their own efforts and to spearhead mitigation measures, such as electric vehicles and solar PV, that can be then cost effectively transferred to developing countries.

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CHAPTER 5

Constraints and Gaps, Finance, Technology and Capacity Needs

Constraints and Gaps, Finance, Technology and Capacity Needs

The GoV is already taking proactive steps to address climate change in their development planning and some degree of budgeting, both on national and sub-national levels. However, there are still many barriers and gaps (policy, regulatory, institutional, technical, financial, business, social and cultural in nature) that need to be addressed in order to be able to shift the paradigm to transform the development and address climate change into tangible solutions, pragmatic actions, investments and inclusive business opportunities on the ground in driving towards a resilient and low carbon economy, community, and nation.

Financial Needs

The constrained financial resources of the country and limited absorptive capacity in and coordination between government agencies and with the private sectors create additional challenges to successfully mainstream climate change and align development aspirations with climate change response strategies. Vanuatu's Nationally Determined Contributions has established a mitigation target of achieving 100% renewable energy in the electricity sub-sector contingent and 30% overall in the energy sector.

In order to roll out the key planned NDC mitigation interventions a substantial amount approximately US$180 million to proceed at the time frame needed.

While specific adaptation targets are not established with Vanuatu's current NDC, a Climate Public Expenditure and Institutional Review (CPEIR) report carried out in 2013 estimates adaptation costs to be at approximately 1.5% of a country's GDP. For Vanuatu, this equates to an investment of US$9.5million per year.

Overall, the target of Vanuatu for implementing its' conditional NDC targets is at least USD400 million.

Furthermore, under the Green Climate Fund Country Programme initiative an estimated amount of USD 710,312,106 was earmarked to undertake a pipeline of 43 projects (75 percent adaptation and 25 percent in nature).

Technology

Vanuatu has recently, in 2019, embarked on its' technology needs assessment as part of the Global Technology Needs Assessment (TNA) project. Agriculture and water are the principal adaptation sectors being assessed. While under the mitigation sector, energy and waste to energy are the sub sectors being considered with regards to technology assessment.

The technology prioritization phase, using a Multi-Criteria Analysis process, has been undertaken with prioritized technologies listed in the table below.

Table 5.1: Prioritized sub-sector climate technologies

Adaptation		Mitigation	
Agriculture	Water	Energy	Waste to energy
• Crop diversification and new varieties • Agro-forestry • Farmer field schools	• Rainwater harvesting from roof tops • Water safety plans • Flood hazard mapping	• Efficiency wood stoves • Battery electric vehicle • Solar electric boat	• Manure based biogas digester • Compact biogas digester • Anaerobic digestion biogas plant

Market assessments, as part of the Barriers Analysis and Enabling Framework (BAEF) phase, are now underway on these prioritized technologies. Technology Action Plans (TAPs) for Vanuatu will be put together and finalized by the end of 2020 or early 2021.

Capacity needs

Vanuatu continues to face a multitude of barriers for the scaling up of effective climate responsive actions for achieving the climate and development goals and for meeting its UNFCCC obligations. The various obstacles include insufficient institutional and financial resources; lack of research data; information management problems and; inadequate human resources and infrastructure. More needs to be done to build awareness both within the Government and the community about Vanuatu's vulnerability to climate change. There is also an apparent need to feed information, knowledge and technologies to enable improved decision-making and environmental management. The major institutional, policy, research, data and Information gaps are discussed below.

The key issues, barriers and opportunities are summarized below:

- The capacity building and public awareness program and activities need to be focused and relevant in the local context. Efforts should be focused on making reliable, accurate and palatable climate-change information available to a wider audience.

- Topics related to global climate change needs to be incorporated in the curricula of primary and secondary schools and appropriate training of teachers in environmental education.

- Provide incentives to the students for choosing technical, vocational and higher education in environment, climate change and related development studies.

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