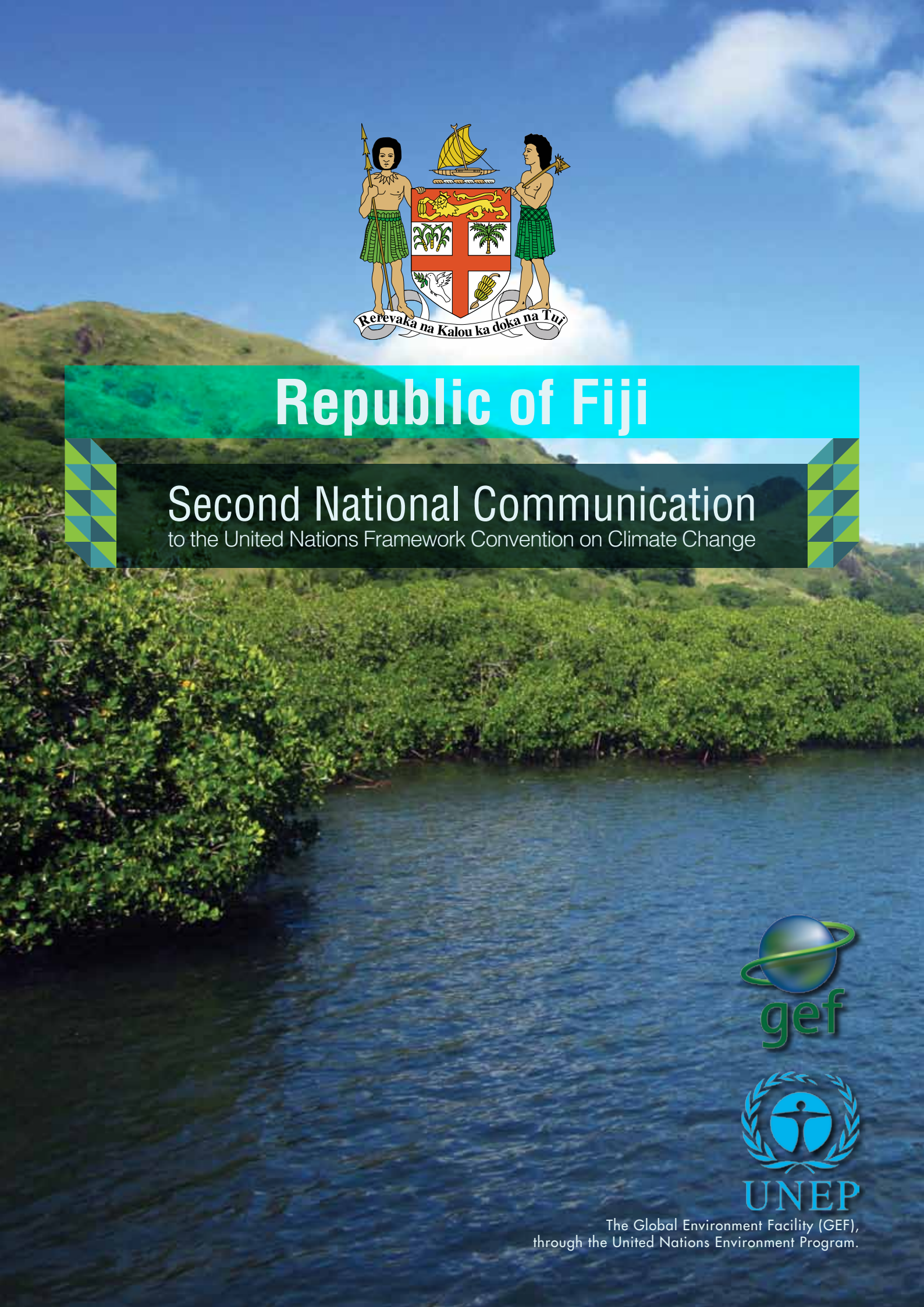

Republic of Fiji

Second National Communication

to the United Nations Framework Convention on Climate Change

gef

UNEP

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through the United Nations Environment Program.

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Prepared by the Government of the Republic of Fiji,
in consultation with the
National Climate Change Coordination Committee
and National Stakeholders.

FOREWORD

Ratu Inoke Kubuabola

Minister for Foreign Affairs and International Cooperation

On behalf of the Government of Fiji, it is an honor and privilege to present Fiji's Second National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC).

The Republic of Fiji is an island nation with an estimated population of 837,271 people (2007) and an annual population growth of 0.8%. There are an estimated 332 islands of which approximately one third are inhabited. Fiji has a total land mass of 18,272 sq km and an exclusive economic zone of 1.3 million square kilometers. The climate of Fiji is generally categorized as an oceanic tropical marine climate and varies over different timescales. The major features that drive Fiji's climate are: the El Nino Southern Oscillation (ENSO) phenomenon that occurs every four years on average, the South Pacific Convergence Zone and the Trade Winds.

Fiji ratified the UNFCCC in February 1993 and is obligated to submit its national communications as per requirement of the UNFCCC. The Initial National Communication (INC) was presented to the UNFCCC in 2005. The Second National Communication (SNC) is a follow up to the INC and built on and continued the work under the convention.

Since the submission of Fiji's INC, much has happened which include the launch of the cabinet approved National Climate Change Policy in 2012. The policy provides a platform for coordination among sectors, and direction on national positions and priorities regarding climate change mitigation and adaptation. The implementation framework of the policy has allowed Fiji to develop a Coordination guideline, Finance Guideline and Relocation Guideline that will enable the policy to achieve its goals in addressing climate change in Fiji.

Fiji's SNC recognizes that climate change is a crosscutting issue which affects all sectors of the economy. Fiji is primarily focusing on an effective and integrated approach to addressing climate change issues that will support the achievement of relevant key performance indicators identified in Fiji's Roadmap For Democracy And Sustainable Socio-Economic Development 2009-2014.

I express my sincere gratitude to the many stakeholders which include Non-Government Organizations, Development Partners, Faith-based Organizations, Civil Society Organizations, Academic Institutions and other Government Ministries for their commitment and assistance. Their involvement has greatly contributed to the comprehensive information contained in this document.

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Among those whom thanks are due for their active involvement and contribution to the comprehensive information contained in this document we would like to mention:

Fiji National University, International Union for Conservation of Nature, Live & Learn Environmental Education and University of the South Pacific for providing the Consultancy Services;

All the line Ministries, Non-governmental Organisations, Civil Society Organizations, Development Partners, Faith-based Organizations, Academic Institutions, and Private Sector in providing data, information and comments for the completion of the Second National Communication reporting;

Special thanks to the members of each of the Thematic Working Groups that were formed under the project for their advise and support.

EXECUTIVE SUMMARY

INTRODUCTION

The Republic of Fiji ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1993, and thus became legally obligated to adopt and implement policies and measures to mitigate the effects of climate change and to adapt to such changes. This Second National Communications (SNC) to the UNFCCC follows and builds on the Initial National Communication (INC) submitted in 2005, and has been prepared in fulfillment of Fiji's obligations to the UNFCCC under Articles 4 and 12. The

SNC follows the UNFCCC guidelines and includes information on Fiji's Greenhouse Gas Inventory in 2004 because of the unavailability of data for the year 2000. The document also includes measures to mitigate emissions and adapt to climate change in key sectors. The SNC project was executed by the Climate Change Unit under the Ministry of Foreign Affairs and International Cooperation, implemented by United Nations Environment Program (UNEP) and funded by the Global Environment Facility (GEF).

NATIONAL CIRCUMSTANCES

Geography, climate and natural resources

Fiji is a large archipelago with diverse landscapes and climate. More than 332 islands are scattered over 1.3 million square kilometers of the South Pacific Ocean, lying between latitudes of 15 degrees and 22 degrees South and between longitude 175 degrees East and 178 degrees West. The two largest islands are Viti Levu, where most of the population resides, and Vanua Levu to the North. Together, they comprise 87 per cent of the total land area. The islands are characterized by diverse ecosystems including significant areas of natural forest. Wide ranges of coastal and marine ecosystems exist, ranging from extensive areas of mangroves to various coral formations.

Fiji has a mild tropical climate with plentiful rain under prevailing conditions. It is, however, subject to potentially catastrophic climate events such as cyclones, flooding and multiple landslips that can have a major impact on the economy and infrastructure. The predicted climate change and sea level rise could have profound consequences for some urban centers, agriculture and coastal development.

On the larger volcanic islands dominated by steep deeply incised mountainous terrain, a relative abundance of annual rainfall, perennial rivers, good surface drainage and numerous springs ensure that there is no fundamental problem in obtaining domestic water supplies. On the low-lying, smaller and outer islands, there are no such perennial streams. Fresh water is a much scarcer resource. In such situations, shortages are a common occurrence, but this is more due to the deficiencies in water collection and retention on the part of the islands than as a consequence of the lack of rainfall.
Approximately 70% of the main island of Viti Levu is drained by three large river systems, one of which with the largest catchment area covering one third of the island. There are a total of 10 rivers with distances ranging from 21 miles to the longest 73 miles. Freshwater wetlands occupy 0.3% of Fiji's land area. Fiji's total land mass is 18277 square kilometres, almost all forest cover is on communally owned native land, 13,960 ha on private freehold and 5,600 hectares on government lease land.

Economic Sectors

Biodiversity

Fiji signed the Convention on Biological Diversity at the Earth Summit in 1992. With the signing of the Convention, Fiji delivered its commitment by producing the Fiji National Biodiversity and Action Plan (FNBSAP) in 2003 but was only endorsed by Cabinet in 2007. Fiji is also a signatory to other key conventions and protocols that are geared towards addressing loss of biodiversity resources such as the Cartagena Protocol on Biosafety, the Nagoya Protocol, Wetlands Convention and Convention on International Trade of Endangered Species of Wild Flora and Fauna (CITES).

Land Resources

Enforcement of the land use policy has not been effective given the lack of understanding and coordination between key stakeholders on the importance of conservation. The lack of adherence to the Environment Management Act and the absence of a statutory authority is a draw back in the implementation of proper land use and the enforcement of proper land management.

The promulgation of the Land Conservation Act is expected to provide some authority for the implementation of the land use policy. This will ensure that land user and developers will adhere to the requirements of the Act and at the same time exercise greater precaution on land degradation activities.

A number of initiatives have been implemented in line with Government's land reform agenda.

Agriculture and Forestry

In Fiji, agriculture is organized more along commercial lines, although the subsistence sector remains important. Large-scale agriculture comprises mainly of sugarcane. Typical constraints faced by producers include a shortage of labour, poor quality and availability of planting material, a lack of efficient pest control and monitoring programmes, high post-harvest losses, poor animal health and high cost of purchased feed, and weaknesses in both domestic and export marketing.

The National Forest Inventory, the formalization of the Fiji Forest Policy Statement and the National Forest Program provides the framework for the sustainable management of Fiji's forest resources. These tools represent a paradigm shift in the management focus away from timber production towards conservation and sustainable management. With emphasis on sustainable forest management, increased landowner aspirations, expansion in nature reserves, a forestation, climate change adaptation and globalization, there is more awareness on the social functions provided by forests to improve water source quality, improve agricultural land and reduce vulnerability to natural disasters especially flood mitigation.

Water Resources

The accessibility of clean, safe-piped water and efficient sewerage services are crucial for inducing greater economic activity and commercial developments. However, increased urbanization is putting greater pressure on this infrastructure. Close to 75% of Fiji's population have access to piped water with some form of treatment, while 25% of the population having access to sewerage facilities.

A number of institutional reforms have been undertaken in order to improve the delivery of services in this critical area. Major public sector investments continue to be made in the upgrading and augmentation of water supply and sewerage schemes in major centers particularly to cater for the expanding population. Similar work is being undertaken in the Western part of Viti Levu to cater for the increase in demand from tourism developments. Remote island communities are also assisted in the identification and development of their groundwater sources.

Coastal and Marine Resources

The coastal and marine areas of Fiji contain a rich biological diversity which supports food security and economic development. Over the past decade, the impact of increasing human activities influenced by urbanization, globalization, and the market system has seen increased pressure placed on these resources. This has resulted in depleting fish stocks, loss of habitat and biodiversity, degradation of coastal zones and marine species including mangrove systems and coral reefs. Like other Small Island Developing States (SIDS), these impacts have direct negative socio-economic repercussions on the Fiji's local population.

Over the past few years, Government has sought to address existing legislative shortcomings in the management of marine resources. The Marine Spaces Act Cap 158A and Fisheries Act Cap 158 are currently being reviewed in an effort to modernize Fiji's laws in line with international and regional obligations relating to fisheries management. Likewise a new Fisheries Aquaculture Decree and Inshore Fisheries Management Decree are being developed.

Offshore tuna fisheries dominate the fisheries sector in output and value. Government is in the process of reviewing the existing Tuna Management and Development Plan to reassess the sustainable level of annual catch and number of licenses to operate within Fiji's EEZ. The management of the tuna stock has been an area of concern, not only nationally, but regionally and globally, particularly in the wake of intensive offshore fishing within the Western and Central Pacific Region.

Tourism

Fiji possesses a diversity of resources and different environments that are attractive for tourism. The island group is made up of volcanic islands and limestone islands, and all major forms of reefs (barrier, fringing and seaward) are presented. Fiji is an "ecological theatre" with unique geological sequences of island development and a significant biodiversity that should be secured with a network of protected areas. Another important component of Fiji's tourism product is its cultural heritage and the strong association between heritage and the natural environment.

Tourism is increasingly important to the national and local economy. Several attempts have been made to improve the environmental performance of the Tourism industry in Fiji, including projects on energy efficiency and renewable energy sources.

Mining

Fiji has good prospects with regard to epithermal gold (associated with volcanic centres), porphyry copper-gold (Namosi), and smaller base-metal deposits (Udu, Wainivesi). Mining and exploration in Fiji has been dominated by gold production from Vatukoula mine, in the Western part of Viti Levu however the existence of several mining prospects such as Tuvatu (gold mine), Wainivesi (copper mine), Mount Kasi (gold mine), Namosi (copper mine) and other solid mineral deposits could mean more revenue, foreign exchange, and employment from this sector than from Vatukoula alone. Fiji has been a major regional gold producer for more than 80 years.

Energy

Fiji depends on imports of fossil fuels, although unlike most other Pacific Island Countries this is supplemented by significant use of indigenous renewable energy resources. Imported petroleum products provide energy for all sectors, and are particularly used for transport (liquid fuels), cooking (kerosene and LPG), and to supplement electricity generation. Petroleum imports were around FJD$400 million in 2004.

Fiji's National Energy Policy (NEP) has four strategic areas: national energy planning, energy security, power sector and renewable energy. Around 66.8% of the country's electricity requirements are met from renewable energy sources which include: 62.1% hydro, 4.1% biomass, 0.6% wind. Imported petroleum for thermal generation meets the remaining 33.2%.

Government has also focused on increasing access to electricity, particularly in rural and remote areas. The 2007 Census revealed that 80% of Fiji's population has access to electricity. Government Rural Electrification Programme is focused on increasing the coverage to the entire population by 2016 through expanding renewable energy projects such as solar home systems.

Transport

Fiji also has a well established road network system. The management of roads has been reformed in the past year as Government seeks to bring the management of Fiji's roads up to international standards. There is extensive telecommunication coverage in almost all parts of Fiji. The presence of the Southern Cross Cable has allowed the expansion of fast broadband in major centers. This has also been fuelled by the liberalisation of the telecommunication sector. The focus of Government has been on spreading the benefits of these advancements to the whole population, particularly those residing in rural areas. Since liberalizing the telecommunication sector in 2008, a number of additional measures and incentives have been introduced to expand the adoption of Information, Communication and Technology (ICT) in the economy.

To improve access to communities in the outer islands, Government continues to prioritize the construction of key regional jetties that would benefit many island communities. Government is also in the process of reviewing the existing shipping fares and freight rates for all sea routes.

Investments have been made in the past three years on improving the infrastructure in domestic airports (Labasa, Savusavu, Lakeba, Nausori, and Nadi) to be in compliance with the International Civil Aviation Organisation (ICAO) standards.

Waste

With a growing population, increased urbanization, and changing consumption patterns, waste management has become a major concern in Fiji. The absence of appropriate infrastructure and organized waste management systems are a major source of pollution. External support from regional and international organizations has allowed the implementation of various projects to address various waste management issues.

The Environment Management Act (EMA) 2005 sets out the framework for waste management and pollution control in the Fiji Islands. It prohibits any commercial or industrial facility from discharging any waste or pollutant into the environment or handling or storing hazardous materials without a permit and gives the Waste and Pollution Control Administrator power to issue permits. The Act came into force in 2009 and the Department of Environment (DoE) has been to date progressively enforcing permit requirements for commercial and industrial facilities and farms.

To improve the management of solid waste, a number of institutional measures have been implemented such as the review of the National Solid Waste Management Strategy 2005-2010.

Health

A healthy and productive population is central to sustained economic and social development. Similar to many developing countries, the Fiji health system is attempting to cope with the triple burden of communicable disease, non-communicable disease and injuries. Health service delivery continues to be challenged with the shortage of medical professionals and inadequate health facilities, particularly in the rural areas. Consistent with Government's direction towards decentralization of health services to the community level, medical equipments have been procured and a number of nursing stations and health centers constructed in the past three years, with the aim of making health services more accessible to people in the rural areas.

External support for Fiji's health system comes from a number of bilateral and multilateral partners such as World Health Organisation (WHO), United Nations Population Fund (UNFPA), United Nations Children's Fund (UNICEF), Secretariat of the Pacific Community (SPC), Global Fund for AIDS, Tuberculosis and Malaria, Australian Agency for International Development (AusAID), New Zealand Agency for International Developmen (NZAID), Japan Internation Cooperation Agency (JICA), India, Korea, and the People's Republic of China (PRC).

To improve access to quality medicines, an Essential Medicine List of 450 medicines has been developed. Newborn and child health are central to the agenda of primary health care. During the review period, Government continued to work with development partners to support access for children's health through various interventions.

Government has promulgated a number of decrees and regulations in an effort to modernize the regulatory framework for the health system in Fiji.

NATIONAL GREENHOUSE GAS INVENTORY

Fiji's Greenhouse Gas Inventory (GHGI) is based on data for 2004, as data for the year 2000 was scarce. However, 2004 data, while limited, were sufficient to compile Fiji's GHGI. This inventory is the second inventory to be prepared for Fiji following the 1994 inventory in the INC (2005). It is a review of the anthropogenic sources and sinks for greenhouse gases in Fiji. The inventory does not account for Greenhouse Gas (GHG) emissions occurring in other countries resulting from the manufacture of consumer goods in other countries that that are imported by Fiji. The inventory is broken down into five sectors which are prescribed in the Intergovernmental Panel on Climate Change (IPCC) Revised 1996 Guidelines for National Greenhouse Gas Inventories. Overall, Fiji is a net sink for GHGs.

In terms of GHG emissions and removals, emissions arise from the energy and agriculture sectors while the land-use change and forestry sector (LUCF) is a net GHG sink. There are uncertainties in the data for all the three sectors. The major limitation with the agriculture sector generally is the lack of activity data for 2004 while for the LUCF sector generally is the lack of data for 2004 for both the forest areas and carbon stocks. In the energy sector, sectoral data from the Yearbook was used but could not be verified or sectors defined.

The largest differences in emissions and removals between the 1994 and 2004 inventories occur in the energy and LUCF sectors. The primary reason for the increase in the energy sector GHG emission is due to diversification of generation from 97% hydro in 1994, to include a larger proportion of thermal generation from diesel and heavy fuel oil (43% by 2004). It should also be noted that in 1994 the FEA grid only supplied part of the main island of Viti Levu, while by 2004 the network had expanded to include large areas of Vanua Levu and other islands. The primary reason for the change (increase) in LUCF GHG removal is due to removals in standing forests.

In order to improve future GHG inventories, the recommendations below have been identified:

- Establish a GHG data unit within the Climate Change Unit.
- GHG data unit to assess changed requirements for Third National Communication under the 2006 IPCC guidelines (particularly the transport and stationary energy sub-sectors) and work proactively with data holders to set up data collection systems and agreements.
- Ensure data collection process is documented in a way that enables comparison with previous inventories to facilitate analysis and support plans for mitigation.
- Future improvements in the GHG inventory data used in Fiji's UNFCCC national communications for the agriculture sector can be made by picking a year that is close to a national census year for this sector. Also, as the next national communication can be expected to use the IPCC 2006 Guidelines, it would additionally be valuable to have a near term review made of these 2006 Guidelines for this sector (and other sectors). Such a review should identify improvements that can be made in both the estimates of the activity data and, as well, the use of calculation factors that are more specific to the country circumstance of Fiji.
- Future improvements in the GHG inventory data used in Fiji's UNFCCC national communications for the LUCF sector can be expected to emerge from the considerable effort currently underway to develop comprehensive Measurement, Reporting and Verification (MRV) methodologies and data sets related to a national Reducing Emission from Deforestation and Forest Degradation (REDD+) programme. These efforts are intended also to serve the needs of the IPCC

2006 Guidelines for the Agriculture, Forestry and Other Land Use (AFOLU) sector and IPCC Good Practice Guidance for the Land Use, Land Use Change and Forestry (LULUCF) sector.

- It may be of value to consider using indicators for sectors such as road transport (e.g. fuel usage per vehicle-km, per passenger-km or per tonne-km), to compare measures of activity with the fuel use and therefore identify the efficiency of sectors. This could then be developed as targets should Fiji wish to participate in the Decade of Sustainable Energy for All and focus on efficiency improvements.
- The Environmental Management Act 2005 provides for waste permitting and reporting through its subsidiary regulations. Discuss opportunities to improve data collection for specific industries and stakeholders with the Department of Environment.
- For areas that are consider key, identify where defined sampling (either physical or surveys) is worth the investment in additional information to improve both emissions reporting, and mitigation activities.

IMPACTS, VULNERABILITY AND ADAPTATION

The adverse effects of climate change and sea level rise present significant risks to the sustainable development of SIDS. The long term effects threaten the very existence of some small islands. Since ratifying the UNFCCC in 1993, Fiji has pursued policies that recognize the importance of managing the environment and natural resources, to ensure social and economic prosperity in the present and for the future. While not a major contributor to climate change, Fiji, like other small island countries, is at the frontline of its impacts. Climate change is having a widespread impact, affecting all sectors of the economy from health, infrastructure, water resources, agriculture, forestry and fisheries. The burden of this impact is being shouldered more by the rural populace because of their dependence on vulnerable sectors such as agriculture and tourism, for their livelihood.

Government has endorsed a new National Climate Change Policy (2012). The policy defines objectives and accompanying strategies to mainstream climate change into relevant sector plans. It ensures Fiji meets its international commitments under the UNFCCC and other international conventions such as the CBD and the UN Convention to Combat Desertification. In addition, a Disaster Risk Reduction programme has been introduced to address the relocation of communities threatened by rising sea levels.

Climate Projections in Fiji (Global Climate Model)

The most likely projected change for Fiji centred around 2030, is for warmer and little change in rainfall with annual mean temperature increases of 0.7°C and negligible (-1%) change in mean annual rainfall that is represented by 69% of the models. Warmer and drier change in projected climate are represented by 6% of the models with annual mean air temperature increases of 0.6°C and annual mean rainfall decreases of 6%. Warmer and wetter future conditions are represented by 13% of the models with annual mean air temperature increases of 0.8°C and annual mean rainfall increases of 7%. The seal level projections was based from fourth IPCC report that global seal level changes are expected to be ranging from 0.21 to 0.48 meters by end of the century (IPCC, 2007). There is significant uncertainty surrounding ice-sheet contributions to sea level rise and a larger rise than that projected cannot be excluded.

Sectoral Impacts

Sector	Potential climate change impact
Agriculture	• Extreme events such as high rainfall, floods and droughts can affect livestock production and management;
	• Land arability could be reduced due to salt water intrusion, coastal and riverbank erosion, exposure to salt water spray, and heat stress on soils;
	• Floods, droughts and cyclones may physically damage crops, farm equipment and infrastructure;
	• Reduced food security in terms of food production, food quality, nutritional availability, affordability and access;
	• Impact on the national economy as Fiji is an agro-economy country;
	• Increase in pests and diseases.
Human health/ welfare	The direct and indirect impacts of climate change on human health are summarised below:
	Direct Impacts
	• Increasing temperature
	• Rainfall variability
	• Storm activity
	Indirect Impacts
	• Increased spread of disease
	• Compromised food and water sources
	• Psychosocial impacts due to population displacement and income loss
	The direct and indirect impacts listed above can lead to:
	• Increased incidence and severity of vectorborne, zoonotic and infectious diseases, e.g. Dengue fever
	• Increased food and water-borne diseases, e,g, diarrhoeal illnesses
	• Increased injuries and longer-term consequences of extreme weather events
	• Impacts on mental health, food and water security and malnutrition
	• Increased cardiovascular respiratory and renal diseases
Marine and fisheries	• Climate and related oceanic variations already have impacts on fish catches, both subsistence and commercial (SPREP nd);
	• The combination of the high rainfall experienced during cyclonic activity and storm events with steep bare slopes, causes rapid runoff with river floods and sediment discharges into the near-shore seagrass and coral reef habitats, which has adverse impacts on the fisheries sector (World Bank nd);
	• Prolonged periods of elevated sea surface temperatures coupled with other climate factors has led to increased frequency of coral bleaching;
	• Ocean acidification caused by increased CO_2 concentration may reduce the ability of many marine species to form calcareous skeletons, thus disrupting food webs and habitat structure;
	• Changes in climate are causing migratory shifts in tuna aggregations to other locations (FAO 2008). Skipjack and yellow-fin tuna are displaced eastwards during ENSO events and westward in La Nina (Kirby 2007 in FAO 2008). This may become more pronounced with projections for a more ENSO-like climate (FAO 2008);
	• Increase in sea level, sea surface temperature changes and alteration of the mixing layer thickness will ultimately affect plankton productivity;
	• More stormy weather and intense cyclones may render fishing trips unsafe and less productive.

Sector	Potential climate change impact
Forestry	• Higher temperatures will make forests more vulnerable to fires;
	• Higher temperatures and changes in rainfall patterns may lead to increased occurrence of invasive species and pests;
	• Forest health could be reduced due to salt water intrusion, coastal and river-bank erosion and exposure to salt water sprays and heat stress on soils;
	• Floods, droughts and cyclones may physically damage forest plantations, natural forest and associated infrastructure;
	• Changing temperature and rainfall patterns may cause shifts in habitats and boundaries of certain tree species, pollinators and seed dispersers;
	• Changing temperature and rainfall patterns can affect the flowering behaviour of certain tree species;
	• Loss of arable land due to climate change would place added pressure on forest areas.
Communications	• Cyclones, storm surges and other extreme weather events could damage infrastructure, leading to disruption of communication.
Transport	• Cyclones, storm surges or other extreme weather events could disrupt land, sea and air transportation;
	• Failure of transport infrastructure could increase the impacts of extreme weather events by isolating victims from food, water and medical treatment.
Water resources and water infrastructure	• Potential impacts to water supply
	- Potable and non-potable water supply will be affected as a result of decreased rainfall, sea level rise, and saltwater inundation/ intrusion;
	- Extreme rainfall events could result in water contamination, overflow of dams;
	- Cyclones, storm surges or other extreme weather events could damage water supply infrastructure and disrupt water treatment and distribution;
	• Potential impact on wastewater treatment
	- Overflow of wastewater treatment ponds could result in contamination of water supply and waterways;
	- Cyclones, storm surges, droughts or other extreme weather events could damage infrastructure, disrupt wastewater collection and treatment, and contaminate water supply and waterways.
	• Potential impact to storm-water drainage
	- Extreme rainfall events could exceed the capacity of storm-water drainage networks;
	- Cyclones, droughts, storm surges and other extreme weather events could damage storm-water infrastructure and disrupt drainage through blockage or excessive water flow
Waste and Waste Infrastructure	• Changing climatic conditions will impact on landfill management practices.
Energy and Energy Infrastructure	• Cyclones, storm surges and other extreme weather events could damage infrastructure and disrupt generation, storage and distribution of electricity;
	• Decreased rainfall could reduce the environmental flow and impact hydroelectricity generation capacity. In 2010, hydroelectricity represented 48% of the average electricity generation mix (FEA 2010).
Tourism	• Damage to buildings and infrastructure from sea level rise, storm surge, cyclones, floods, salt-spray, coastal erosion and landslides;
	• Disruption of land, sea and air transport to facilities
	• Decrease in tourist arrivals due to changing weather conditions and patterns, degradation of pristine natural attractions and damage to infrastructure;
	• Increasing costs to implement adaptation measures that would be subsequently absorbed by tourists and related service providers;
	• Growth in the tourism sector may be hindered by the need for increased capital investment and increased climate related challenges.

Sector	Potential climate change impact
Urban development and housing	• Extreme events such flooding and cyclones incur an economic cost to townships;
	• Extreme events or natural disasters will affect lives of people in poorly built or poorly located houses — marginal communities are likely to be more severely affected;
	• Added pressure on services and utilities to cope with demands brought about by extreme events such as heat-waves, water shortages and disease outbreaks;
	• Land loss and reduction in arable land could lead to migration in urban centres, resulting in over-crowding;
	• Floods, storm surges, cyclones and other extreme weather events can damage houses and residential buildings, and have the potential to put their occupants in danger during or after an extreme weather event.

MITIGATION

This chapter reports on measure planned to mitigate climate change through a reduction in GHG emissions. Despite having a very small GHG emission profile, Fiji faces some of the worst effects of climate change. Moreover, Fiji's high dependence on expensive imported fossil fuels for transport and electricity generation is a substantial burden on the economy. These fuel challenges make climate change mitigation activities an important exercise for the sustainable development of Fiji.

Fiji's energy situation is characterized primarily by a high reliance on imported fuels. Although this is unlikely to change in the foreseeable future, there is still a need to reduce Fiji's reliance on imported fuels as much as possible.

Grid-based power supply has arguably the most potential to make Fiji's energy sector more efficient, cost effective and environmentally sustainable. Over 50% of Fiji's electricity is already generated from hydropower but there are still likely a number of medium sized undeveloped hydro sites and significant unexplored geothermal, solar and wind resources. The majority of the population has access to modern forms of energy, thanks to significant improvements in the last two decades through rural electrification initiatives. Fiji is struggling to provide remote areas and isolated islands with access to electricity in a sustainable manner.

The transport sector is the main user of imported fuel in Fiji. There have been attempts to reduce petroleum imports through the use of bio-fuels, but research and development both locally and abroad has shown that its economic viability is uncertain at best. Serious reductions in the cost of energy consumption in the transport sector will be challenging and will take time.

Improving Fiji's energy efficiency across the different sectors is likely a cost-effective way to reduce the cost and increase the availability of energy in Fiji despite the fact that Fiji has a relatively low energy-intensive economy.

OTHER INFORMATION

Technology Transfer

Technology transfer is essential for Fiji both in adaptation and mitigation sector. However, there is still need to enhance capacity, research and awareness at different level and for different stakeholders.

Education And Public Awareness

Education and public awareness on climate change is very crucial. The Ministry of Education has already audited the school curriculum to include the climate change in the primary & secondary. While, at the tertiary level scholarships are offered to study climate change.

At national level Climate Change Summit

is being held every year from 2012 in order to create a platform for information sharing for everyone. There is radio talk-back shows in Fijian, Hindi and English to create awareness on climate change.

In spite of all these efforts there are certain gaps such as providing training the teachers on how to disseminate the climate change information to the students and clear monitoring framework has to be addressed.

CONSTRAINTS AND GAPS, AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS

The gaps and constraints that exist in addressing climate change in Fiji is mainly due to the lack of existing frameworks that clearly identifies and outlines the necessary action that should be taken to effectively respond to climate change.

Adequate resources (including finances) are required in order to undertake any climate change adaptation and mitigation activities. The review of Fiji's Climate Change Framework for the development of Fiji's National Climate Change Policy identifies strategies that ensures that the national budgeting processes includes the assignment of funds for climate change mitigation and adaptation research, planning and programme implementation. The implementation framework of the policy also identifies lead and implementing agencies that ensures that the strategies are implemented.

Fiji's technical and capacity need lies on the needs for financial resources as well as a finance policy to guide the establishment of a National Trust Fund to finance adaptation and mitigation activities and a long term investment in research and developments.

Fiji has an expressive need for development of new technologies and transfer of existing technologies. This lies on the initial gap that exists within the legislation and regulation for the transfer of clean energy and energy efficient technology and equipment.

In contemplating the energy sector, the main constraint identified is the exchange and sharing of data, information, expertise and financial capacity at regional and international levels in order to enhance appropriate and effective responses.

Moreover, the Vulnerability and Adaptation Sector (V&A) covers gaps and constrains identified from water, agriculture, coastal zone, forest, health, tourism and building sector respectfully.

With the growing opportunities in the area of international carbon trading, Fiji has supported the development of five PINs for regular standard CDM projects and 4 PINs for PoAs. Local and international consultants work together to build up local expertise in CDM project development and to demonstrate the benefits of CDM through project implementations.

The highlights for information on implemented adaptation measures is the vulnerabilities of local communities in Fiji are due to the low availability of resources, remoteness and susceptibility to natural disasters. To enable workable and effective adaptation measures, ministries as well as institutions and non-government organizations, must consider integrating climate change in their planning and budgeting in all levels of decision making.

Furthermore, Fiji realizes the importance of national capacity building across all sectors thus requires well-trained scientific, technical and managerial staff that will not only understand climate change but also be involved in responses to climate change that will create a need for a well equipped institutional structure that will provide facilities and finances to support climate change programmes and activities.

ACRONYMS & ABBREVIATIONS

ACP	African, Caribbean and Pacific
ADB	Asian Development Bank
ADCPs	Acoustic Doppler Current Profiler
ADO	Automotive Diesel Oil
AFOLU	Agriculture, Forestry and Other Land Use
AIDS	Acquired Immunodeficiency Syndrome
AOSIS	Alliance of Small Islands
ASA	Air Services Agreement
ASL	Above Sea Level
ASU	Arizona State University
AWS	Automatic Weather Station
AusAID	Australian Agency for international Development
BSc	Bachelor of Science
BAT	Best Available Technology
BE	Bachelor of Engineering
BKB	Brown coal briquettes
CAO	Civil Aviation Organisation
CBA	Community-based adaptation
CBD	Convention on Biological Diversity
CC	Climate change
CCA	Climate change adaptation
CCU	Climate Change Unit
CDM	Clean Development Mechanism
CDU	Curriculum Development Unit
CH_4	Methane
CMNHS	College of Medicine, Nursing & Health Sciences
CO_2	Carbon dioxide
CP	Conference of the Parties
CROP	Council of Regional Organizations of the Pacific
CRP	Climate Risk Profile
deg C	Degree Celsius
DIREKT	Developing Island Renewable Energy Knowledge and Technology transfer network
DoE	Department of Environment (Fiji)

DRR	Disaster Risk Reduction
DWR	Directional Wave Recorder
EBA	Ecosystem–based adaptation
EE	Electrical Engineering
EEZ	Exclusive Economic Zone
EGM	Emperor Gold Mine
EIA	Environmental Impact Assessment
ENSO	El Niño Southern Oscillation
EMA	Environment Management Act 2005
EU	European Union
EUGCCA	European Union Global Climate Change Alliance
EWG	Energy Working Group
EXIM	Export - Import
FAESP	Framework for Action on Energy Security in the Pacific
FAO	Food & Agriculture Organisation
FDoE	Fiji Department of Energy
FEA	Fiji Electricity Authority
FBS	Fiji Bureau of Statistics
FMS	Fiji Meteorological Service
FO	Fuel Oil (also HFO, RFO)
FRA	Forest Resource Assessment
FRCA	Fiji Revenue and Customs Authority
FREPP	Fiji Renewable Energy Power Project
FRUP	Fiji Road Upgrading Project
FSC	Fiji Sugar Cooperation
FNU	Fiji National University
FSC	Fiji Sugar Corporation
FSM	Federated States of Micronesia
FSPI	Foundation of the peoples of the South Pacific International
FSTE	Faculty of Science, Technology and Environment
GCPV	Grid-connected Photovoltaic
GDP	Gross Domestic Product

Gg	Gigagram (109 grams or 1 kilotonne)
GHGs	Green House Gases
GHGI	Greenhouse gas inventory
GJ	Gigajoules (109 Joules)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
ha	Hectare(s)
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon(s)
IAS	Institute of Applied Science
ICAO	International Civil Aviation Organisation
ICM	Integrated Coastal Management
ICT	Information, Communication & Technology
IDO	Industrial Diesel Oil
IMO	International Maritime Organisation
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IRERAS	Integrated Renewable Energy Resource Assessment System
JICA	Japan International Cooperation Agency
JNAP	Joint National Action Plan
KOICA	Korea International Cooperation Agency
km^2	Square Kilometres
kW	Kilo watts
LPG	Liquefied Petroleum Gas
LRPD	Division of Land Resource Planning and Development
LUCF	Land use change & Forestry
LULUCF	Land Use, land use Change and Forestry
MDGs	Millennium Development Goals
ME	Mechanical Engineering
MEA	Multilateral Environmental Agreements
MFA	Ministry of Foreign Affairs
M&E	Monitoring and Evaluation
MoH	Ministry of Health
MPA	marine protected areas
MPI	Ministry of Primary Industries
MOU	Memorandum of Understanding
MRV	Measurement Reporting and Verification

MWh	Mega Watts per hour
N_2O	Nitrous oxide
NAP	National Action Plan
NAR	National Assessment Report
NCD	Non Communicable Diseases
NEP	National Energy Policy
NGO	Non Government Organisation
NBSAP	National Biodiversity Strategic and Action Plan
NCCP	National Climate Change Policy
NCCAS	National Climate Change Adaptation Strategy
NBSAP	National Biodiversity Strategic Action Plan
NDMO	National Disaster Management Office
NMVOC	Non-Methane Volatile Organic Compounds
NZAID	New Zealand Agency for International Development
OTEC	Ocean Thermal Energy Conversion
PEOG	Pacific Energy Oversight Group
PACC	Pacific Adaptation to Climate Change
PACE-SD	Pacific Centre for Environment and Sustainable Development
PDD	Project Design Document
PESTRAN	Promotion of Environmentally Sustainable Transport
PG Dip	Postgraduate Diploma
PIEP	Pacific Islands Energy Policy
PIEPP	Pacific Islands Energy Policy and Plan
PIESAP	Pacific Islands Energy and Strategic Action Plan
PIN	Project Information Note
PLA	Participatory Learning and Action
PoA	Program of Activities
PPNDRM	Pacific Partnership Network for Disaster Risk Management
PPSRCI	Pacific Plan for Strengthening Regional Cooperation and Integration
PSC	Public Service Commission
PV	Photovoltaic
PICTs	Pacific Island Countries and Territories
PIFACC	Pacific Island Framework for Action on Climate Change
PIN	Project Information Note
RE	Renewable energy
REBREPPE	Renewable Energy Based Rural Electrification with Participation of Private Enterprise

REC	Rural Electrification Unit
REDD	Reducing Emission from Deforestation and Forest Degradation
RESCO	Renewable Energy Service Companies
REU	Rural Energy Unit
RDSSED	Roadmap for Democratic, Sustainable, Socio-economic Development
SEAIPI	Sustainable Energy Industry Association of Pacific Islands
SEEDS	Sustainable Economic and Empowerment Development Strategy
SF_6	Sulphur Hexafluoride
SFM	Sustainable Forest Management
SIDs	Small Island Developing States
SLM	Sustainable Land Management
SOI	Southern Oscillation Index
SOPAC	Pacific Islands Applied Geoscience Commission
SPC	Secretariat of the Pacific Community
SPCZ	South Pacific Convergence Zone
SST	Sea surface temperature
SWDS	Solid Waste Disposal Sites
TCBWG	Training & Capacity Building Working Group
TNA	Technology needs Assessments
ToT	Train the Trainer
UK	United Kingdom
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USP	University of the South Pacific
V&A	Vulnerability and Adaptation
VA	Vulnerability assessment
VOCTEC	Vocational Technical
WAF	Water Authority of Fiji
WHO	World Health Organisation
WWF	World Wide Fund for Nature

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1 INTRODUCTION

Fiji ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1993 as a Non-Annex 1 Party and became legally compelled to adopt and implement policies and measures intended to adapt and to mitigate the effects of climate change. The Global Environment Facility (GEF) through the United Nation Environment Program (UNEP) provided funding for the development of Fiji's Second National Communication (SNC) to the UNFCCC which is required to fulfill the country's obligation under the Convention.

The Fiji National Climate Change Coordinating Committee (NCCCC), which comprises of Permanent Secretaries and senior officials of line ministries, is responsible for overseeing the coordination of Climate Change issues in Fiji thereby the implementation of the SNC project. This project (SNC) is the continuation of the completed Initial National Communication (INC) of Fiji which was presented to the UNFCCC in 2005. The INC was composed in accordance to guidelines issued following the 2nd Conference of Parties (COP2) to the treaty. It presented an overview of national circumstances, particularly aspects that relate to climate-change issues, furthermore a GHG inventory, and analyzed mitigation strategies, vulnerability assessment and adaptation assessments and options. An overview of policies and programmes relating to the implementation of the convention was also presented, including identified project concepts for further refinement and funding.

Nevertheless, more in-depth assessments were needed to attempt and address the gaps that were extremely sensitive to climate change effects therefore a series of top-up studies were needed in preparation of SNC. Therefore, the SNC report reflects the overviews of Green-House Gas Inventory, Mitigation Measures & Analysis, Vulnerability & Adaptation Assessment and Education, Training & Awareness Rising to fulfil Fiji's obligations under Article 4 and 12 of the UNFCCC.

GEOGRAPHY AND GEOLOGY

The Republic of the Fiji Islands lies in the heart of the southwest Pacific Ocean, between longitudes 175° East and 178° West and latitudes 15° and 22° South. Fiji's Exclusive Economic Zone contains approximately 332 islands, of which about a third are inhabited. The Economic Exclusive Zone (EEZ) covers about 1.3 million square kilometres.

The Fiji Group is made up of two major islands - Viti Levu and Vanua Levu, with land areas of 10 429 and 5 556 square kilometres respectively (Fig. 2.1). Other main islands are Taveuni (470 km2), Kadavu (411 km2), Gau (140 km2) and Koro (104 km2). Total land area of the Fiji Islands is 18 272 square kilometres. The Republic includes the island of Rotuma (43 km2), located 650 kilometres north-northwest of Suva.

Fiji is composed of large mountainous islands, which are largely of volcanic origin, such as Viti Levu and Vanua Levu (which take up 87% of the total land area), and numerous small volcanic islands, low-lying atolls and elevated reefs. The largest islands have a diverse range of terrestrial ecosystems, including extensive areas of indigenous forest. The high islands have distinct wet and dry sides due to prevailing wind patterns. Coastal ecosystems include mangroves, algae and sea-grass beds in shallow reef and lagoon areas, and various reef types such as barrier, fringing platform and atoll or patch reefs.

CLIMATE

The climate in Fiji has an oceanic tropical climate. Average daily temperatures remain relatively constant year-round at 25 °C (77 °F), only becoming a few degrees higher during the rainy season. Annual rainfall distribution on the main island of Viti Levu is affected by the island's central mountain range. As a result, the eastern half of the island receives 3-5 meters of annual rainfall, while the western half receives 2-3 meters. The rainy season lasts from November to April, and Fiji is frequently affected by tropical cyclones during this period. El Niño events are associated with reduced rainfall on the islands, in part due to shifts in the typical path of tropical cyclones away from Fiji. The 1997-1998 El Niño events contributed to bringing about one of the worst droughts on record.

RAINFALL

The positioning of the South Pacific Convergence Zone (SPCZ) has a strong influ-

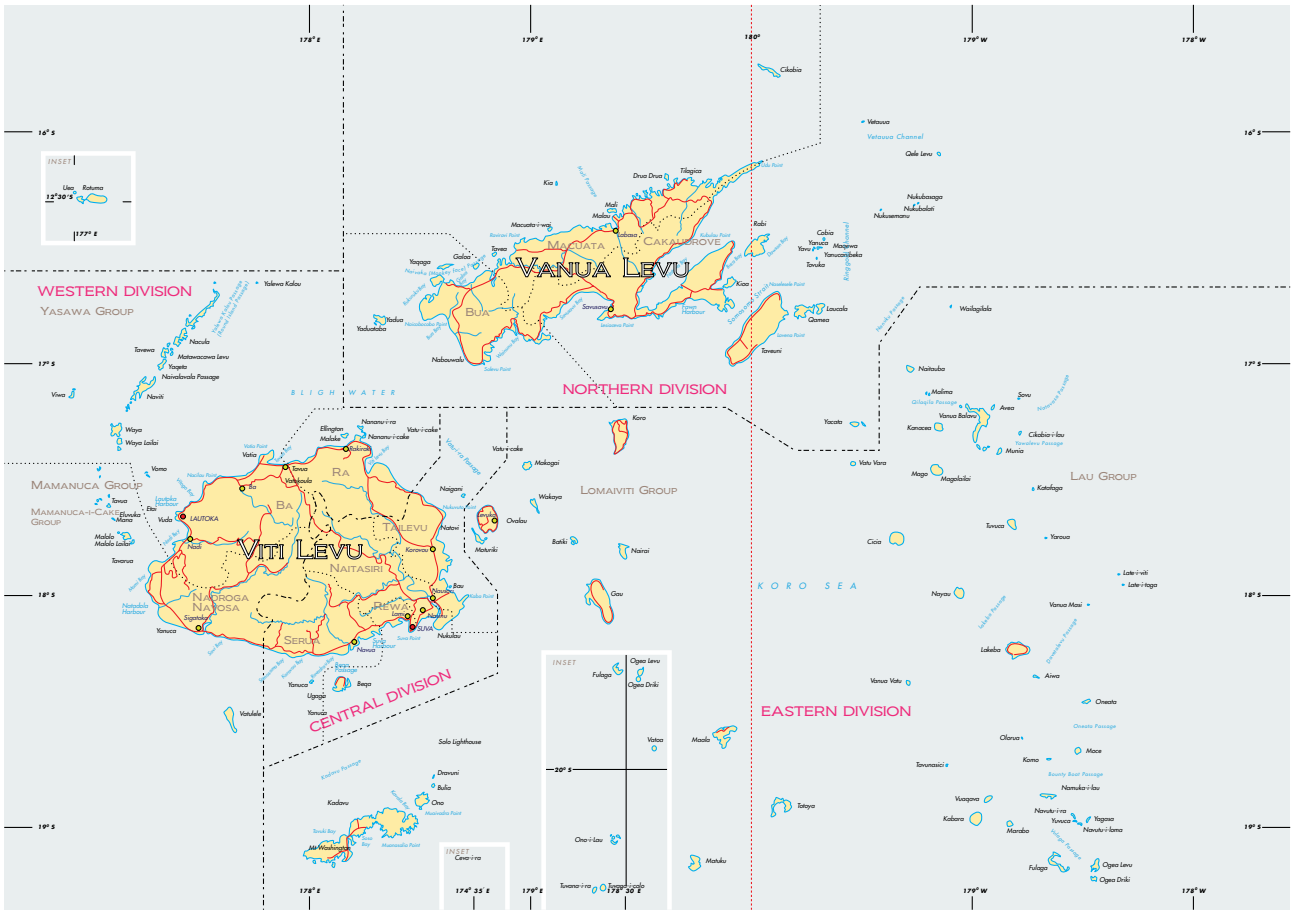


Figure 2.1: Map of Republic of Fiji

ence on rainfall over Fiji. During the dry season (May to October) the SPCZ tends to be positioned more to the northeast of Fiji. In the rainy season (November to April) the SPCZ tends to be located over Fiji. In addition to these seasonal variations, there is also a high degree of inter-annual variability in rainfall, which is strongly influenced by ENSO and SPCZ fluctuations.

Another important influence on rainfall is the southeasterly trade wind, which carries moist air onto the islands. On the larger islands, Viti Levu and Vanua Levu, the southeastern regions are the high-rainfall areas. The mountains of these high islands have a strong influence on the distribution of rainfall, with the regions on the leeward (western) side of the mountains being much drier on average. The annual rainfall in the east of Viti Levu, where Suva is located, ranges from 3000 mm to 5000 mm, while in the west of Viti Levu, where Ba, Lautoka, Nadi and Sigatoka are located, annual rainfall ranges from 2000 mm to 3000 mm.

While the prevailing wind is from the southeast, tropical cyclones and depressions tend to track from the north and west. Thus, although the west of Viti Levu is drier on average it can experience very heavy rainfall events and associated flooding.

TEMPERATURE

The average daily temperature varies seasonally, from 23°-25°C in the dry season and from 26°-27°C in the rainy season. On average, temperature during the colder months (July- August) and the warmer months (January-February) vary by about 3°-4° C. Inter-annual fluctuations in temperature are relatively low.

EL NINO

El Nino events, which lead to a north-east positioning of the SPCZ, is the major cause of drought in Fiji. During an ENSO event, conditions drier and hotter than normal can be expected from December to February and drier and cooler conditions can be expected from June to August. While lower than normal rainfall can be expected over most of Fiji, the most severely affected areas tend to be in the west of the main islands.

Fiji is located in a part of the Southwest Pacific region where anomalies in annual rainfall are strongly correlated with the Southern Oscillation Index (SOI). The 1997/1998 ENSO event greatly influenced Fiji's rainfall pattern. It intensified from April to June of 1997 where the SOI for June reached its lowest value since 1905. In September of 1997, most parts of the country recorded 20% to 50% below average rainfall. The western parts of the country recorded less than 10 mm of total rainfall, that is, below 7% of the average. In December, all sites recorded 50% to 90% below average rainfall. All coastal sites in Viti Levu and parts of Vanua Levu recorded lowest-ever rainfall totals for the period of 8 consecutive months from September 1997 to April 1998.

NATURAL & ENVIRONMENT DISASTERS

Fiji is located amongst the most vulnerable sub-regions in the Pacific in relation to the intensity and frequency of severe natural disasters which occur during the November-April wet/cyclone season. In the past 3 years, Fiji has endured two severe tropical cyclones and at least four major flooding incidences. As shown in Figure 2.2, approximately 85% of all natural disasters in Fiji over the past 30 years have been tropical cyclones, with an average of 2 cyclones occurring annually.

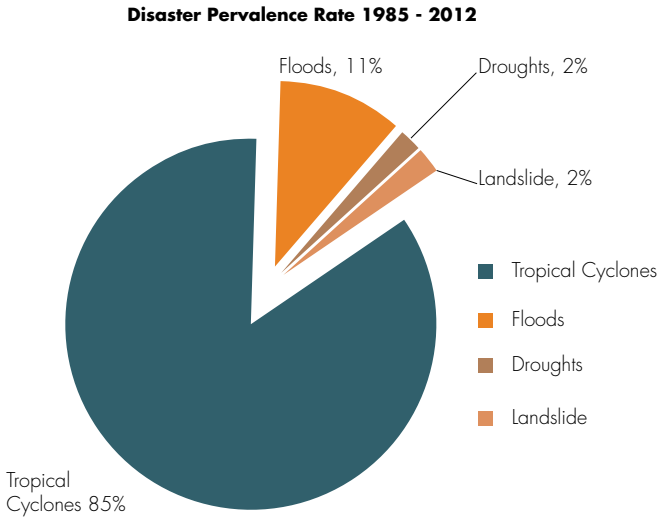


Figure 2.2: Disaster Prevalence rate 1985-2012 (source: Mauritius Implementation Strategy Report 2012)

POPULATION

Fiji's population in 1999 was 775,077 (Table 2.1). The total population in Fiji in 2007 was estimated at 837,000.

While migration levels had stabilized over the 1990s, political turmoil in 1987, 2000 and 2006 has created upsurges in migration, primarily of educated and skilled citizens. People aged over 65 years comprised 4.6% of the population in 2007, compared to 2.4% in 1976. Over the same period, the number of people aged less than 15 years had declined from 41% to 29%. The proportion of population living in rural areas has been declining, decreasing from 53% in 1996 to 49% in 2007. More than 75% of the population lives on Viti Levu, making it the economic and political centre of the island group.

ECONOMY

Fiji has one of the largest economies among Pacific Island Countries (PICs), and is one of the PICs least dependent on foreign aid. The Gross Domestic Product (GDP) of Fiji was US$3.78 billion in 2008, or US$3,900 per person. The GDP grew by 1.2% in 2008 after shrinking by 6.6% in 2007. Even though 70% of the Fijian workforce is in the agricultural sector, agriculture and industry together account for less than 25% of GDP. The rest comes from the service sector, mostly from tourism. Within the agricultural and industry sectors, sugar production and processing are by far the most important economic activities. Sugar processing makes up one-third of all industrial activity, and sugar is the country's primary export product. Other agricultural products produced in the country include coconuts, tapioca, rice, sweet potatoes, and bananas, but these are primarily used for domestic consumption. Apart from sugar, exports include garments, gold, timber, and fish. Imports include manufactured goods, machinery, and petroleum products.

Table 2.1: Socio Economic Indicators

	1999	2007
Population	775,077	837,271
Growth rate (%)	0.8	-0.5%
Gross domestic Product (F$ million)	2616.4	2,871,047
G D P per head of population	3341	5271
Life expectancy (yrs)	73	73
Literacy rate (%)	92.9	92.9

(Source: Fiji Bureau of Statistics)

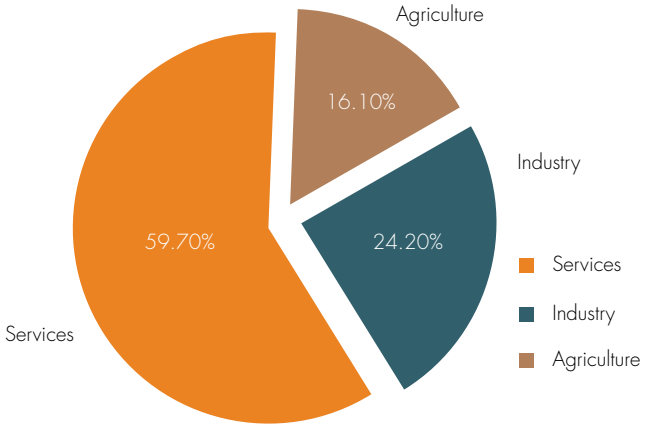


Figure 2.3: shows the GDP by sector, 2011

Table 2.2: Gross Domestic Product Summary (FJD)

Indicator	2005	2006	2007	2008	2009	2010[p]
GDP (per capita) current	5232.5	5475.9	5587.3	5855.1	5770.2	6182.8
GDP (per capita) at constant 2005 prices	5232.5	5310.2	5252.3	5274.9	5176.8	5156.6
GDP Current Prices [FJD million]	4327.3	4545.0	4648.6	4900.7	4858.5	5243.0
GDP Current Prices (Annual Growth Rate %)		4.7	2.0	408	-1.4	7.2
GDP Constant (2005 prices) [FJD million]	4327.3	4407.5	4369.9	4415.1	4358.9	4372.8
GDP Constant (2005 prices) (Annual Growth Rate %)		1.5	-1.1	-0.4	-1.9	-0.4

Source: Fiji Bureau of Statistics

CULTURE AND HERITAGE

Culture plays a pivotal role in Fiji's socio-economic development. Of particular relevance is its potential to address problems of unemployment and poverty faced by women and youth today. Cultural and creative industries can serve as tools for revenue generation and sustainable livelihood. Government recognizes that investing in conservation of cultural resources, promoting cultural activities, traditional knowledge and skills are effective means to strengthen environmental sustainability and the social capital of communities. A National Cultural Policy is currently being developed. The policy will bring together and streamline all culture-related legislation, policies, strategies, institutions and activities at the national level to minimize duplication and set a clear direction for the development of cultural activities. The Fiji Heritage Decree has been drafted to protect key heritage sites in Fiji.

BIODIVERSITY

National Biodiversity Strategy and Action Plan (NBSAP)

The NBSAP was prepared through the Department of Environment which is also the National Focal Point for the United Nation Convention for Bio- Diversity in 1999. After consultation with different stakeholders at different levels from local to national, a strategy was formulated on conserving the genetic, species and ecosystem diversity of the country. It focuses on six focal areas;

- Community support-awareness, involvement and ownership
- Improving knowledge
- Developing protected areas
- Species conservation
- Control of invasive species and
- Capacity building and strengthening

The strategy observes that Fiji has only a rudimentary system of protected areas and that it is time to create "site of national significance program" that would provide legal protection and establish management plans. It also identifies institutional and capacity building as a very vital aspect of the commitment while involving other non-governmental organizations.

More than 80% of Fiji's land and large parts of its marine areas are under communal village ownership; and conservation activities in this country are almost exclusively located in these areas. Accordingly, the NBSAP process and action plan have a strong emphasis on the direct participation and leadership of land- and resource rights- owners in all aspects of conservation planning and management. This diversion from a more conventional top-down approach is key to the success of biodiversity conservation in Fiji.

While the subsistence life styles of many land- and resource rights-owning communities respect biodiversity, there is increasing pressure to privatize land and resource ownership, and to use resources unsustainably (or allow others to do so). In order to gain community support for conservation, to maintain traditional systems of resource ownership, and to allow local communities to play a leadership role in conservation, the following activities were included in Fiji's NBSAP:

- Increase village and community understanding and awareness of the importance and benefits of maintaining diversity, and enhance their technical and organizational abilities, Ensure that natural resource owning communities in particular, and the nation in general, receive fair benefits from the use of genetic material and products,
- Minimize the loss of aquatic resources of importance to local communities, and the loss and fragmentation of community-owned native forests, Encourage and assist traditional fishing rights communities to actively manage their inshore fishing rights and to establish or reinforce protected areas, through appropriate traditional conservation measures.
- While Fiji was already an active member of the Locally Managed Ma-

rine Areas Network (LMMA) hosting and supporting numerous such areas prior to Fiji's signing of the Biodiversity Convention, the development and implementation of the NBSAP provides an important impetus to broaden and strengthen local establishment and management of locally managed conservation areas.

LAND RESOURCES

The first and second National Reports on United Nation Convention to Combat Desertification (UNCCD) Implementation were submitted in 2000 and 2002 respectively, and covers the areas well on plans and strategies prior to the UNCCD but the following plans and strategies have being taken on board since then to supplement all other developments and government commitments.

Fiji's Draft National Action Plan (NAP) on Combating Desertification was completed in 2006. The purpose of the national action plan is to identify the factors contributing to desertification / degradation and practical measures needed to combat it. Further it seeks the commitment of the stakeholders in ensuring the mainstreaming of this into Fiji's strategic plans.

Fiji's NAP provides for the following:

- Long term strategies to combat desertification /degradation and to mitigate the effects of drought, emphasizing implementation and integration into national policies for sustainable development
- Allows for modifications in response to changing circumstances and is sufficiently flexible at the local level to cope with different socio-economic, biological and geo-physical conditions
- Gives particular attention to the implementation of preventative measures affected areas and areas with degradation potential
- Enhancement of national capabilities in national climatologically/ meteorological and hydrological monitoring as a means of providing early warning systems for drought
- Promotion of policies and strengthening of institutional frameworks to promote partnerships, corporation and coordination between the government, donors, local populations and groups and facilitates information and technology access to all
- Provides for effective participation of government, local populations both men and women, nongovernment organizations, particularly resource users and their representative organizations in policy planning, decision-making, implementation, monitoring and evaluation of national action plans.

Land is an important factor in the development of the economy. Previous studies have emphasized the critical role of land tenure system, land use and its management in the development of Fiji's economy. The increasing population over the past 40 years has increased demand for agricultural land and consequently has put a significant amount of pressure on arable land. This has resulted in land degradation, reduced productivity, lower yields, reduced food security and an increase in poverty. Much of Fiji's arable land has been taken up for housing, industrial and commercial developments. With competing demands for limited land resources, the government has endorsed the Rural Land Use policy to provide framework for the land development in the country.

Government recognizes the important role of land and plans to address the following:

1. Environmental Rehabilitation and Degradation.
2. Creating livelihoods through small and micro enterprise development
3. Sustainable community livelihoods through competitive exports and efficient food security
4. Sustainable Land and Water Resources Management.

The system adopted for land use capability classification needs to be reviewed based on the present day land use and land availability problems. Nonetheless, it is being slowly incorporated into all the planning for land development of any sort by any sector or for any land use. As such it has become an ongoing activity of the Land Use Planning Section of Ministry of Agriculture.

The successful implementation of the National Rural Land Use Policy and Plan depends very much on a delivery framework that combines top down and bottom up approach to facilitate communication between communities and government agencies. There is a need for a coordinating mechanism whereby government programs are complemented and strengthened by activities of the groups of stakeholder at community level.

At community levels resources owners and users need to be organized and empowered to plan and manage their resources, in order to provide the bottom up input necessary in the interactive resources management. A mechanism to facilitate this is through the group based concept where the resources owners and users are organized into local resources management groups, widely known internationally as the Landcare Groups.

The Landcare Concept is based on participatory community development approach. Experience has shown that technology alone has not improved the management of natural resources. The emphasis has therefore been placed on institutional strengthening, local decision

making and building the self reliance of the local communities.

Fiji is fortunate that it has a social structure which embraces and enhances the formation of such a movement at settlement, village, district and provincial basis. But for the resources users such as the lease holders, they need a lot of awareness and education to strengthen their participation and supportive role. The need to integrate and work together as a team for the benefit of the country is quite imminent.

Since 1999 the Land Use Section of the Ministry of Agriculture has adopted a participatory land use planning approach as part of all programs. This is done in close consultation and collaboration with the resource owners and the community, and all other stakeholders such as Extension Division of Ministry of Agriculture, Native Land Trust Board, Ministry of Fijian Affairs, Ministry of Fisheries and Forests, various civil societies representative.

This would be the basis of future integrated or holistic approach to land resources planning, development and management programs. It emphasise the importance of a bottom up approach to land use planning and one of its main objective is to establish local land care groups, to empower communities to efficiently and effectively develop and manage their resources and create land stewardship amongst the resources owners and users.

To ensure sound land development, utilization and management, the following strategies are incorporated in the SDP:

- Promotion of the Rural Land Use Policy at provincial Level
- Enforcement of the Land Conservation and Improvement Act
- Ensuring sustainable land utilization & management practices
- Promoting sound land use planning
- Promote the organization of community groups involving all stakeholders in different localities for resource conservation
- Promote strategic partnership
- Develop and enhance land resource information system [GIS]
- Education, training and awareness on Sustainable Land Management

AGRICULTURE AND FORESTRY

Over the past half century, the country has been dominated in output and value by the sugar industry. Recently, the tourism sector has surpassed sugar as the main foreign exchange earner. However, the sugar industry, and by extension, the whole agriculture sector remains a key conduit for the socio-economic empowerment of Fiji's population, in particular those residing in the rural areas. While the performance of the sugar industry has declined over the recent decades due to erosion of markets preferences, declined farm and mill efficiency, and land tenure disputes, there remains optimism over the potential contributions that other agricultural commodities can make towards the economic advancement of the nation.

Fiji's existing agricultural policy is focused on food security and gearing the sector towards export oriented growth. Food security is a growing concern for many nations, more so for small island nations such as Fiji which is susceptible to volatile commodity markets and natural disasters. Since 2010 the Department of Forestry has been mainstreaming food security into its existing policies and programmes under the Forestry Extension Program. Such activities include setting up of community fruit tree nurseries in rural areas around Fiji, and promoting agro forestry to improve soil fertility and agricultural yield.

Government continues its Pest Management programme. Through the project a number of plants and animals have been identified for research to determine effective control and mitigation measures. These include management of Coconut Pest, Taro Beetle, Fruit Flies, Wedelia, African Tulip, Merremia peltata, Rain Tree, and Chilly Anthracnose Disease. Over the past three years, the agriculture sector has had to deal with the outbreaks of termites, brucellosis disease affecting dairy livestock, and the American iguana affecting major dalo production areas. The addressing of these outbreaks has been supported by the new Bio Security Decree.

Value adding continues to be promoted in the agriculture sector. Programmes such as the Coconut Development Programme incorporate a product development component for products such as Virgin Coconut Oil and Soap. Value adding of root crop into chips has also increased.

The forest sector on average accounts for 1.2% of GDP and 4.1% of export earnings. Fiji has a total forest cover of 1,054,459 ha, covering 58% of the total land area. This consists of 899,229ha of native forest, 116,488ha of plantation forest (52,419ha of hardwood plantations and 64,068ha of softwood plantations) and 38,742ha of mangrove forest. The native forest consists of 5,738ha of nature reserves, 16,109ha of forest reserves, and 1,300ha of recreational parks.

The performance of the sector in the past few years has been poor due to the complex institutional environment in which the sector operates, exacerbated by low log production, poor performance of public companies involved in the sector such as Fiji Hardwood Corporation Limited (FHCL) and Fiji Pine Limited (FPL), and the delays in getting Wairiki port into op-

eration. The sector declined by 1.6% in 2007, 3.4% in 2008 and projected to continue to fall sharply in 2009 by 9.1% mainly due to woodchips exports, which, based on current orders, is projected to fall by 43.8%. However, a recovery of 4.3% and 0.9% is currently projected for 2010 and 2011 respectively, as Government puts in place measures to address the current institutional constraints.

The National Forest Inventory and Fiji Forest Policy Statement provide the framework for the sustainable management of Fiji's forest resources. These tools represent a paradigm shift in the management focus away from timber production towards conservation and sustainable management. With emphasis on sustainable forest management, increased landowner aspirations, expansion in nature reserves, afforestation, climate change adaptation and globalization, there is more awareness on the social functions provided by forests to improve water source quality, improve agricultural land and reduce vulnerability to natural disasters especially flood mitigation.

WATER RESOURCES

The consistent supply of clean, safe piped water and efficient sewerage services are crucial for both rural and urban sectors in inducing greater economic activity and commercial developments. Fiji has an abundance of water resources; however, there are persistent problems of supply of piped water. Approximately 75 percent of Fiji's population has access to piped water while the proportion of population having access to sewerage facilities is about 25 percent.

Government recognizes the importance of water and sewerage services in the socio-economic development of the country. As such, Government ensures that inhabitants of some of Fiji's most densely populated areas have access to regular and safe piped water and an environment friendly sewerage system.

The Water Supply and Sewerage Scheme are currently undergoing upgrading and augmentation works to improve the level of service to consumers in terms of reliability, quality and quantity. Investigation to acquire new water source is ongoing since the demand for water is ever increasing especially in the tourism industry. New water and sewerage treatment plants will be in place to improve water quality and sanitation in a few townships.

Government has reformed the Water and Sewerage Department into the Water Authority of Fiji (WAF) which is a commercial statutory authority to pursue reform programmes in the Water and Sewerage Department. The development of a water management policy will safeguard the proper management of Fiji's fresh waters and the marine environment as well. New legislation and regulation will ensure an appropriate framework for sustainable exploitation and environmental protection of fresh water rivers and ground water aquifers.

Mismanagement of land and water resources is gradually resulting in the depletion of the nation's resources. Indiscriminate utilisation of these scarce resources will have serious impacts to the fragile economy as well. These issues need to be addressed with both long and short-term measures to ensure development and management of these resources in a sustainable manner.

The Land and Water Resource Management Division's Plan focuses on the following deliverables:

- efficient and effective drainage infrastructure maintenance works for the improvement and effective utilisation of agricultural land in the Central, Northern and Western Divisions;
- disaster mitigation activities to reduce vulnerability and risk of flooding in Nadi and Labasa;
- watershed management to reduce the impact of flooding in Nadi and Labasa;
- irrigation infrastructure development and maintenance works in irrigation schemes in the Central and Northern Division; and
- water resource development and management for sustainable crop production and drought mitigation in the Western Division.

Fiji's development plans recognize the need for watershed management programs to reduce flood intensity, soil erosion and sedimentation of river systems. The worst affected watersheds are in the Western and Northern Divisions, which have densely populated flood plains and all the major infrastructures including agricultural crops. The soil losses in these watersheds range from 60 to 81 tonnes per hectare.

COASTAL AND MARINE RESOURCES

The coastal areas of island nations are of vital importance since most of the urban centers and vast majority of villages are located on the shore, along with much of the population, agriculture, industry and commerce are located here. The result of rapid coastal development and increasing utilisation of coastal resources has resulted in various impacts on the coastal environment problems which includes; loss of habitat and biodiversity, inappropriate solid waste management, mismanagement of chemical wastes, pollution of air and water ways, land degradation e.t.c.

The fisheries sector accounts on average

for 1.9% of GDP and 9.1% of domestic export earnings. Fish production in Fiji is estimated at around 22,000mt with an average fish production in the last 10 years of 24,000mt. Tuna contributes 67% of total production in the industrial fisheries sector whilst artisanal fisheries contribute 28% and aquaculture contributes 5% of production. Industrial fishery contributes 84% of total export earning while artisanal fisheries contributes 16% of export earnings.

The sector declined sharply by 15.9% in 2007 on the back of soaring industry costs, driven largely by the rise in fuel costs. While there was a slight recovery of 4.5% in 2008, the outlook for 2009 is a decline of 3.4% as the impact of the global recession takes hold, affecting mainly the Japanese sashimi market. The devaluation of the Fiji dollar may boost exports and support growth, but is also expected to adversely affect industry operating costs. A recovery of 4.1% is currently projected for 2010 followed by a decline of 6.7% in 2011. The decline in 2011 was expected to be caused by a more pronounced El Nino impact.

The management of offshore fisheries has been an area of concern, not only nationally, but regionally and globally, particularly in the wake of an invasion of State subsidized Asian fleets. While total catch has increased in the past 2 years from 12,417mt in 2007 to 13,330mt in 2008, catch in domestic waters is declining. This prompted a reduction in licences issued for vessels in the Fiji EEZ from 100 in 2003 to 45 in 2008. There are currently 40 licensed vessels operating in 2009 from a licensing cap of 60. Most of the fish catch is now coming from high seas and neighboring countries. Resource management, therefore, becomes critical and mechanisms such as the Tuna Management and Development Plan need to be followed and enforced at the national level.

Fiji has an expanded value adding industry for tuna, which includes frozen sashimi grade, yellow fin loins, loining and carbon monoxide treated yellow fin for the US market, fish smoking for the niche Japanese market and small scale value adding for the local and export markets. Sustainable development in the fisheries sector will require strengthened policy, institutional and regulatory frameworks which are developed with stakeholder participation. The revision of the Fisheries Act is planned for 2009 with assistance from the Forum Fisheries Agency.

The fishing industry has expanded in recent years to include other fisheries such as aquarium trade, live rock, and live coral. There is an expansion of demand for marine products supported by health oriented consumers as well as for management and conservation as in marine parks and marine protected areas (MPA). Development of other areas such as seaweed farming, aquaculture and recreational fishery for both food security and income generation is also being encouraged.

Aquaculture programmes have not progressed well despite large investment from Government and donors. Total aquaculture production is estimated at 500 mt/20,000pcs valued at about $12 million on the back of the strong results from the pearl industry. Principal types of aquaculture initiatives consisted of eight (8) aquaculture species, namely, Tilapia, Carps, Brackish water shrimps, Prawns, Fancy Carps, Gold Fish, Pearl Oysters and Seaweed. While the objectives were to improve the nutritional status of rural populations, generate supplementary income and diversify activities, create opportunities to stem the flow of migration from rural to urban areas, the strategy was also designed to enhance production for import substitution (prawns, mussels, oysters, fish), and the re-seeding and stocking of our fisheries water ways. However, more research is needed to improve the quality of fries (babies) and feed which are key obstacles to commercialization. The current average yield of 1.2mt of fish per hectare needs to be increased to 26mt in order to sustain a viable industry.

Seaweed farming engages the family, community, Government and the private sector, and offers an alternative livelihood to isolated rural areas, especially in maritime zones where shipping services is irregular and unreliable. In Ono-i-Lau, this commodity has provided employment, raised the standard of living and contributed to the drift to urban areas. There are 198 active farmers producing an average of 60mt of dried seaweed per year around Fiji. The demand by the current market for Fiji seaweed is 2,000mt per month with projected export earnings of $36 million per year.

The pearl industry is another potential growth industry with Government working in partnership with the private sector. This partnership has supported the operation of 11 pearl farms which have produced an average of 50,000 pieces over the past 2 years valued at around $1.6million. The industry is worth $7.5 million and government is aiming at increasing the value to $50 million by 2015. However, increased technical is needed to develop the industry.

TOURISM

Tourism in Fiji is a myriad of partnerships between a diverse range of private sector businesses, the communities and government. It has grown steadily over the past few years; it has recovered from a significant decline following the 2000 coup with growth in visitor numbers and economic contribution and strong invest-

ment in infrastructure.

However, the tourism industry has had to face a number of challenges since 2006 to remain globally competitive. These include the advent of the Hotel Turnover Tax in 2006, loss of price competitiveness, global financial crisis and adverse publicity in the major source markets.

Against this backdrop, the tourism sector recorded the highest number of visitor arrivals of 585,031 visitors in 2008, an increase of 6.6% compared to 2006 visitor arrivals. The increased numbers were primarily driven by lucrative packages offered by the industry, with prices reduced by as much as 40%.

The strong performance is expected to continue into 2009 with Tourism Fiji projecting 600,000 visitor arrivals (provisional still). However, the destruction caused by the floods in early 2009 severely affected arrivals for the first quarter with Tourism Fiji revising the visitor arrivals to 540,000.

The 2007 census recorded that 21,460 people or 2.6% of the total population are working in the tourism industry. The industry contributes around 18.4 % of GDP, with $741.7 million earnings in 2006 having estimated tax revenue to government of $140million.

The Tourism Development Plan 2007-2016 was prepared on the basis of two phases: a recovery period in 2007-2009 in which visitor numbers will recover to at least 550,000 annually. Development of Eco- Tourism will be targeted through various programs and initiatives within Government.

MINING

Mining and exploration in Fiji has been dominated by gold production from Vatukoula mine in the past, although significant other sector revenues come from industrial minerals such as sand and gravel, quarried stone and coral sand.

The mining and quarrying sector on average accounts for 1.5% of GDP generates on average 8.5% of total domestic exports and at its peak supported a workforce of over 1,700 personnel as well as 350 directly related contractors. The Vatukoula mine shut down in 2006 because of rising operational costs and low output which severely affected the viability of its operations. After placing the mine up for sale, an Australian company, Westech Gold purchased EGM's operations and tenements in Fiji. Production in 2007 was a mere 932 ounces. In 2008, a UK-based company, River Diamonds, acquired the Vatukoula operation from Westech. With Vatukoula mine under new management, mining operations gained some momentum with gold production increasing to 22,496 ounces. For 2009 gold production had increased to 35,000 ounces, an estimated increase of 60% from 2008. With the increase in interest shown by investors and number of forecasted mining activities, the sector is expected to further grow by 38.9% in 2010 and 20% in 2011 respectively.

Fiji has good prospects with regard to epithermal gold (associated with volcanic centres), porphyry coppergold (Namosi), and smaller base-metal deposits (Udu, Wainivesi). Mining and exploration in Fiji has been dominated by gold production from Vatukoula mine however the existence of several mining prospects such as Tuvatu (gold mine), Wainivesi (copper mine), Mount Kasi (gold mine) Namosi (copper) and other solid mineral deposits could mean more revenue, foreign exchange, and employment from this sector than from Vatukoula alone. The potential of Fiji's mining industry is enormous given the number of exploration licences issued and the various types of activities undertaken by each sectors. From 2007 to 2008, a total of 16 exploration licences were issued, with an additional 7 licences issued in 2009. The potential conversion of these exploration licences to mining leases provides the impetus for growth and development of the mining industry as a whole.

Recent studies have indicated that Fiji has a huge potential in geothermal energy. However, this has yet to be firmly established. In 2008 exploration was carried out in Labasa by Asia Pacific Resources Ltd, an Australian company. However, more exploration is needed to ascertain the viability of the resource.

In addition to geothermal energy, offshore mining has attracted a lot of interest by prospective investors. Government has, therefore, seen the need to put in place a legislative framework for offshore mining, given that this is a totally new area for the Fiji mining industry. Offshore exploration and mining in Fiji has, therefore, been placed under moratorium until the Offshore Mineral Policy is approved by Cabinet.

There has been a lot of focus on mining operations with little attention paid to the potential economic activity generated through exploration. In order to tap into this segment, the current fiscal regime needs to be reviewed to be sufficiently attractive for small exploration companies. In order to develop new mines, an effective exploration industry is required.

ENERGY

The provision of a regular energy supply is critical to the functioning of any economy. Availability, reliability and affordability of appropriate forms of energy are necessary as a basis for viable investments needed to attract private in-

vestment to create employment, alleviate poverty and increase exports.

Fiji, like any other country in the region, is heavily dependent on imported fuel to meet a major component of its energy demand. As such, Fiji is vulnerable to the continuous fluctuation of world crude oil prices. For the past few years, demand in Fiji has increased from around $FJ400 million in 2004 to $1.25 billion in 2008.

The contribution of the electricity industry to GDP was 4.0% in 2007 and had fallen to 3.6% in 2009.The decline is due to the current political situation, large investments in Tourism Sector and Construction Sector are put on hold and lastly a decline in the Manufacturing sector.

The development and approval in 2006 of the National Energy Policy (NEP) by Cabinet has provided a common framework for both the public and private sector to work towards the optimum utilisation of energy resources for the overall growth and development of the economy. The policy focuses on four key strategic areas:

i) National Energy Planning,
ii) Energy Security,
iii) Power Sector and
iv) Renewable Energy Development.

Around 66.8% of the country's electricity requirements are met from renewable energy sources which include; 62.1% hydro, 0.6% wind and other renewable resource 4.1% biomass. This is provided largely through the FEA's grid network on the two main islands and Ovalau. Imported petroleum for thermal generation provides the remaining 33.2 %. The Department of Energy (FDoE) has also installed about 600 diesel based systems in various rural communities.

The amount of electricity generated and sold by FEA reflects the level of economic activity in the country. Currently, the contribution of the electricity sector to GDP as mentioned above about was 3.6% in 2009. This is projected to increase as a result of greater access to electricity in rural areas under the Government's Rural Electrification Programme which, apart from the extension of the grid networks and diesel schemes, also encourages the utilization of solar home systems in rural communities.

In terms of final energy consumption, the Transport sector has continually consumed a little over 40% of the total energy supplied. This is followed by the Commercial sector, Industrial and Domestic sector. Some of the important measures that have been identified to address the situation are outlined;

i) addressing consumption of our transport sector through the development and use of bio-fuels locally and other legislative measures;
ii) diversifying the current energy mix through the use of LPG in the industrial, transport and domestic sectors; and
iii) Improving the efficiency of energy use in all sectors of our economy.

To facilitate an enabling environment for a sustainable energy sector, Government will do the following:

i. continue with its renewable energy investments and assist in securing financing of the construction of an additional hydro-power facility in Nadarivatu and other identified feasible sites;
ii. At the same time, Government will work closely with the Donor Agencies to identify and implement small renewable energy projects around the country, particularly in the Northern division where off-grid schemes are more viable at this stage; and
iii. Government will push ahead aggressively with investments on power co-generation and Biofuel production.

TRANSPORT

Transport plays a critical role in our economy contributing around 10.2% of GDP in the last three years, (2007-2009). It also employs considerable amount of people in both formal and informal sectors with the latter most vibrant in the land transport industry. It also links key social and economic sectors of the economy including resources based industries, education and health. The sector's contribution to GDP is expected to expand to 20% by 2014 once the impact on the economy of the support from EXIM Bank China and EXIM Bank Malaysia comes through.

In the next five years, government will pursue vigorously its transport financing with the private sector especially in the area of land transport. In the next year or so, government will be engaging the private sector to go into financing rehabilitation works for existing roads.

Asian Development Bank (ADB) is also assisting government in the establishment of the multi sector regulator to be adopted soon aimed at promoting competition and minimizing externalities

Transport subsidies need to be carefully analysed in light of the pollution cost. There is strong growth in the use of bio-fuels. Fiji has wealth of natural raw materials for bio-fuel. Coconut Oil in transport has been applied successfully in blends with kerosene and diesel in the region during the past years, in vehicles as well as generators. We must now reassess our options, realign our priorities and double our efforts to drastically cut down on hazardous gas emissions, and through concerted efforts with the com-

munity and stakeholders, improve the air quality in the transport sector.

Some progresses that have been made for this sector over the years include:

- Advocate and facilitate an enabling environment that promotes the use of mass transportation such as public transportation, car pooling, dedicated traffic lane and shared ridership.
- Monitor effective methods introduced to reduce transport related fatalities on roads, and mishap at sea through effective and enabling safety and enforcement strategies such as self assessment on compliance & quality standards, and minimal regulatory enforcement.
- Review of Government subsidy on the transport sector particularly on Road and Sea Transport to enhance efficient use of resource.
- Ensure provision of access to all remote and rural areas of various transportation systems.
- Rural and remote areas have improved road conditions, and transport to market and social services to improve livelihood in the communities from subsistence lifestyle e.g. opening of Rotuma International Port of Entry 1st quarter 2010.
- Initiate stakeholder consultations for appropriate infrastructure and review of regulation in regard to Alternate mode of transportation e.g. Special Lanes for Cycling/Walking.
- Encourage and facilitate the use of fuel efficient vehicles such as LPG for all Public Service vehicles with PSV operators. This will reduce our dependence on fossil fuel and reduce emission.
- Undertake a wider study in the transportation system in the Suva-Nausori Corridor including study of intermodal and peak hour variability, and implement appropriate decision on the recommendation.

WASTE

Environmentalism promotes just and equitable access to resources. The natural environment is an integral part of Fiji's products and services and the quality of nature plays a significant role in the success of any socio-economic development. As such, the generation and disposal of wastes does have direct and indirect impact on the socioeconomic development of our nation. The Government has taken steps to support sustainable resource management and encourage environment conservation through the Environment Management Act (EMA) 2005. The Act sets guidelines and policies for environmental impact assessments, waste management, pollution control and penalties.

Waste material present wasted money in-terms of original cost of materials, cost of materials; cost of disposal and also potential value of the material as a recyclable and reusable resource. Poorly managed wastes can have negative effects on tourist destination image and by association with health warnings about infectious and vector-borne diseases.

Waste cannot be reduced without a system that manages waste from the point of generation through to disposal. There are various programs/projects currently being implemented by the Department of Environment in the effort to minimize waste at a National level.

Part 5 of the Environment Management Act 2005 sets out the framework for waste management and pollution control in the Fiji Islands. It prohibits any commercial or industrial facility from discharging any waste or pollutant into the environment or handling or storing hazardous materials without a permit and gives the Waste and Pollution Control Administrator power to issue permits. The Act came into force on 1st January 2009 and the Department of Environment has been to date encouraging commercial and industrial facilities to submit in their application for a permit.

The National Solid Waste Management Strategy for Fiji (NSWMS) 2006 details the current waste management practices and outlines the inadequacies that exist in the institutions, it provides a platform from which future waste management activities can be developed and the mechanisms for coordinating the programs. It provides implementation at national, municipality, local and community level.

Other strategies implemented by the Department is the National Liquid Waste Management Strategy (NLWMS), National Air Pollution Strategy, National Plan for the Implementation of the Stockholm Convention on POP's in Fiji, Rural Waste Policy, Chemical Management Plan.

HEALTH

Health continues to be a growing and increasingly complex field of competing priorities from all perspectives - from the individuals to governments, businesses, health professionals and the health services system. A healthy and productive population is a key for sustainable economic development. Despite consuming a major portion of governments budget (>3% of GDP and 9% of total budget), health care funding continues to be lower as compared to other countries in the region while Fiji's population tends to be increasing every year.

Fiji's progress towards Millennium Development Goals (MDGs) such as reduction in child mortality, maternal mortality and HIV/AIDS, have not been achieving the impacts on the health of citizens which Government intends. Fiji's life expectancy for males and females is on a declining path (2007 population census). The performance against the three health MDGs is disappointing as compared to baseline data of 1990 and 2015 target. The current statistics show a slow progress in improving the infant and maternal mortality rates, immunization coverage and the prevalence of HIV/AIDS.

The progress towards MDGs suggests that the substantial and increased input of resources by Government is not achieving the impacts on the health of citizens which Government intends. Increasing annual budget allocations in itself is healthy and positive but if it is still below a critical level of less than 5% of GDP (Fiji averages less than 3%), then maybe it is not sufficient to adequately fund important interventions that would specifically address the MDG targets.

In addition to the continuing incidence of communicable diseases, there is an increasing prevalence of Non Communicable Diseases (NCDs) such as diabetes and hypertension, due to lifestyle changes, poor diet, smoking, changing patterns of physical activity, continuing malnutrition problems, particularly in school children and women. On disease conditions and status, NCD continues to be the major cause of morbidity and mortality. Controlling diabetes and cardiovascular disease remains a priority focus of the Ministry of Health (MOH). With the re-emergence of infectious diseases such as typhoid, which were thought to have been controlled, an extra burden will now be placed on the already incapacitated health system. This is termed the double burden of disease, where high rates of infectious disease and NCD co-exist.

NATIONAL GREENHOUSE GAS INVENTORY | 3

INTRODUCTION

Fiji's first Greenhouse Gas Inventory was reported in the Initial National Communication (2005). This second inventory has been prepared in accordance with the requirements for non-Annex I PARTIES decision as laid out in UNFCCC decision 17/CP.8 (paragraphs 2, 6 through 24). In particular, estimates have been made for emissions for years other than 2000 (paragraph 7) in order to provide context for the 2000 emission estimates; revised 1996 guidelines have been employed (paragraph 8); where appropriate and possible country-specific emission factors have been employed (paragraph 10); a selected number of key source and sink analyses have been undertaken (paragraphs 12 and 14).

OVERVIEW AND NATIONAL EMISSIONS

Summary of inventory results

The table below summaries the greenhouse gas emissions and removals from different sectors compared with the 1994 inventory (carbon dioxide equivalent factors are 21 for methane & 310 for nitrous oxide)

Table 3.1 Calculated greenhouse gas emissions for Year 2004 and comparison of results with Year 1994.

Sector	Year 2004 Carbon Dioxide emission (Gg)	Year 2004 Carbon Dioxide removal (Gg)	Year 2004 Methane (Gg)	Year 2004 Nitrous Oxide (Gg)	Year 2004 Carbon Dioxide equivalent emission/ removal(Gg)	Year 1994 Carbon Dioxide equivalent emission/ removal(Gg)
Energy	1567	0	3	0	1570	776
Industrial process	0	0	0	0	0	45
Solvents	0	0	0		Not calculated	0
Agriculture	0	0	17	2	977	494.10
Land use change & forestry	0	-7988	0	0	-7988	-7701.60
Waste	0	0	4	0	84	76.23
Total	1567	-7988	24	2	-5357	-6310.27

*(CO_2 eqv = CO_2+ (CH_4 emission *21)+(N_2O emission *310)*

Emissions By Gas

Carbon Dioxide

The main source of carbon dioxide emissions is from fuel combustion especially in the **transport** sector accounting for approximately 47% of total emissions. The second largest contributor is **other sectors** which includes emissions from the commercial/ institutional, residential, agricultural/ forest/ fishing as represented in the pie chart below.

Table 3.2: The table below shows the emission of CO_2 from different sector

Greenhouse Gas Source Categories	CO_2 Emissions
Total National Emissions	1566.56
1 Energy	1566.56
A Fuel Combustion	1566.56
1 Energy Industries	186.05
2 Manufacturing Industries and Construction	10.76
3 Transport	728.86
4 Other Sectors	549.15
5 Other (mining & quarrying)	91.75
International Bunkers	92.50
Aviation	20.47
Marine	72.03

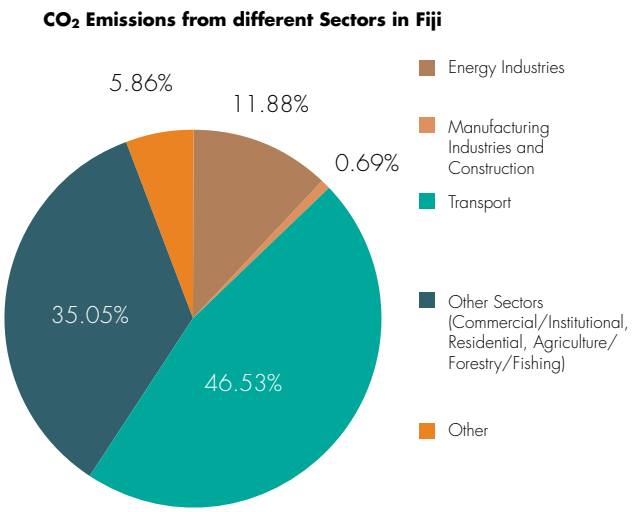


Figure 3.1: The pie graph above shows the CO_2 emission by sectors

Methane

The main source of methane is from agriculture which accounts for approximately 69% emissions.

Table 3.3: The table below shows methane emission from different sectors

Greenhouse Gas Source Categories		CH_4 (Gg)
Total National Emissions		24.61
1 Energy	Reference Approach[1]	
	Sectoral Approach[1]	3.47
A Fuel Combustion		3.47
B Fugitive Emissions from Fuels		0.00
2 Industrial Processes		0.00
3 Solvent and Other Product Use		
4 Agriculture		16.93
5 Land-Use Change & Forestry		0.00
6 Waste		4.21
7 Other (please specify)		0.00

Methane Emission from different Sectors in Fiji

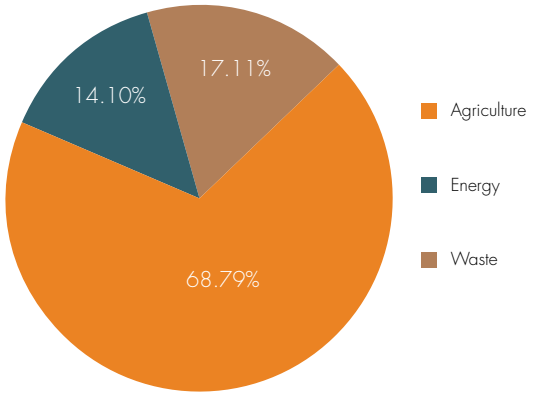


Figure 3.2 The pie graph above show the methane emission from different sectors in Fiji

Nitrous Oxide

The main source of Nitrous Oxide is from agriculture which accounts for approximately 96% emissions.

Table 3.4: Nitrous Oxide emission from different sectors

GREENHOUSE GAS SOURCE CATEGORIES		N_2O (Gg)
Total National Emissions and Removals		2.06
1 Energy	Reference Approach[1]	
	Sectoral Approach[1]	0.06
A Fuel Combustion		0.06
B Fugitive Emissions from Fuels		
2 Industrial Processes		0.00
3 Solvent and Other Product Use		0.00
4 Agriculture		1.99
5 Land-Use Change & Forestry		0.00
6 Waste		0.02
7 Other (please specify)		0.00
Memo Items:		
International Bunkers		0.00
Aviation		0.00
Marine		0.00
CO_2 Emissions from Biomass		-

Nitrous Oxide emission from different sectors in Fiji

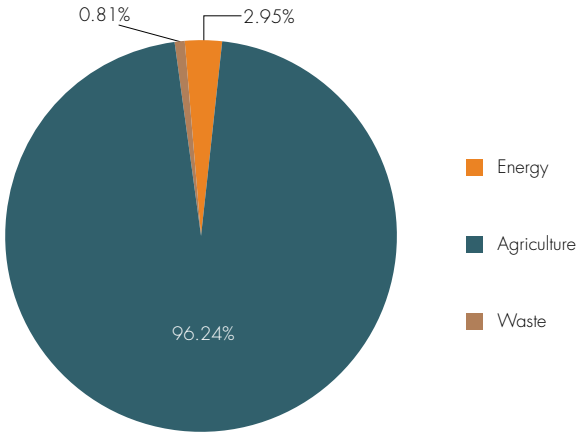


Figure 3.3 Nitrous Oxide emission from different sectors in Fiji

Sectoral Breakdown

Energy

Fiji is an energy importing country, although it also harvests substantial local renewable energy sources. While energy use, and its associated cost, is important for Fiji's economic and social development, in global terms this consumption is very small. As a result, Fiji's greenhouse gas inventory shows the country is not a significant contributor to climate change.

Fiji's energy intensity in 2009 was 8.4 MJ/USD. This is higher, relatively speaking, than other Pacific islands, for example the average of the 14 Forum Island Countries is 7.0 MJ/USD. This may be due to more energy-intensive industries than other countries, such as mining, manufacturing, and other industries. Fiji also has a much lower electricity price than other countries in the region, with commercial and industrial rates of $US 0.19/kWh, while the Forum Island Countries' average electricity price was $US 0.35/kWh; together with a 24-hour supply and a location as a Pacific transport hub, this may encourage such industry[1].

Energy sources

Fiji's electricity supply is provided by the Fiji Electricity Authority (FEA), the sole state-owned electricity utility. The Public Works Department (PWD) has also historically supported local grids on Nabouwalu, Lakeba, Vunisea, Taveuni and other locations outside the FEA network. In 2002, it was estimated that 57% of the population had direct access to electricity, 87% of urban households and 49% of rural households. This increased through various programs, bringing the electrification rate to 75% (est.) by 2009[2]. Electricity in Taveuni has more recently been provided by a private supplier, at around $FJ 2/kWh. In 2004, liquid fuels were imported and sold by Mobil, BP and Shell. Since this time, BP has sold its Pacific operations to Pacific Energy, and Shell has sold its retail operations to Total, while retaining its wholesale activities. Mobil continues their operations. Liquid fuels in Fiji include diesel, petrol and kerosene. Use of imported LPG is also common, with Fiji Gas and Blue Gas the two suppliers. Cooking with LPG is widespread, however many households choose to cook with both LPG and kerosene, with some also using fuelwood, choosing different fuels for different tasks. With respect to solid fuels, only 1.4 tonnes of coal import were identified through customs data.

Fiji also benefits from having substantial renewable energy resources. The largest and oldest is the 80MW Monasavu Dam, providing up to 50% of the electricity supply in Viti Levu. Other hydro power facilities also generate electricity for the network, on Viti Levu and Vanua Levu, with a number having been commissioned since 2004. Wind energy is a smaller contributor, with the 10 MW Butoni wind farm also on Viti Levu. Solar PV is now widely used, but especially in rural and remote locations, due in large part to support through the Fiji Department of Energy's rural electrification projects. Use of ethanol and biodiesel has recently been encouraged through the Biofuel Standard (2011), and projects in biofuel generation on the islands of Koro, Rotuma and Cicia. Use of fuelwood for cooking is widespread, even in urban areas, and many households use multiple fuels for cooking.

Energy consumption

Economically important sectors of Fiji's economy are agriculture; textiles, clothing and footwear (primarily garments); tourism; forestry; fishing; mining and industrial services. Remittances are also a noteworthy contributor. Sugar is the most significant agricultural product, with one-third of industrial activity being sugarcane processing[3]. Other products are coconuts, and root crops such as cassava and taro.

The economic value of different sectors cannot easily be compared to energy consumption statistics, as categories are slightly different. In the case of primary industries (agriculture, forestry and fisheries) no fossil fuel energy consumption was recorded, despite the extensive activities in this sector.

Methodology

In preparing Fiji's greenhouse gas inventory for the SNC, it is important to note that Fiji does not have any indigenous fossil fuel energy sources. As an island nation, all fossil fuels are imported, which makes the Reference Approach very suitable. The Sectoral Approach was also applied, taking source data from the energy balance developed by the Fiji Department of Energy (FDoE) in the Energy statistics year book 2000-2004. Discussion with FDoE suggested that the data

[1]Fiji Country Energy Security Indicator Profile 2009, SPC (2012)
[2]REEGLE Country Profile, Fiji: *http://www.reegle.info/policy-and-regulatory-overviews/FJ* last accessed on 25 April, 2013, from REEEP Policy Database
[3]Source: CIA Factbook, *https://www.cia.gov/library/publications/the-world-factbook/geos/fj.html* last accessed 25 April, 2013.

was suitable to apply a top-down, Tier 1 approach.

The Reference Approach and Sectoral Approach were developed with few overlaps, and hence are reported separately. Calculations were undertaken using the IPCC worksheets, version 1.3.2.

Fiji is an important transhipment hub in the South Pacific, as well as a transport hub with a substantial use of bunker fuels. Data on imports, exports and re-exports of fuels is collected by the Fiji Revenue and Customs Authority (FRCA) and held by the Fiji Bureau of Statistics (FBS), who provided it for the inventory. Fiji uses the international Harmonised System of tariff codes, and data under these categories were compared against the descriptions in the Customs Tariff Act, for 2000 through to 2004. Fuel stock is kept by private companies, and records on stock change were not collected or reported in 2004.

For the period 2000-2004, the Fiji Department of Energy (FDoE) collected available data and developed an energy balance, showing the energy generation, transfers, and sectoral consumption for Fiji. The FDoE identified that, The Energy Statistics Year Book 2000-2004, (referred to as 'the Yearbook) provides sectoral energy consumption, and data for oil products was sourced from the oil companies. It is the only source of data on energy from renewable sources. Calculations for energy from renewable sources are therefore based on the same data for the Reference Approach and Sectoral Approach, and give the same results

For the reference approach, calculations were made in accordance with the IPCC guidelines, using default values for emission factors, oxidation rates, and other factors. The energy content of the fuels was calculated using Fiji-specific data, provided in the Energy Statistics Year Book 2000-2004. Default data from the IPCC guidelines were used.

Based on the sectoral energy balance prepared by the FDoE, a Tier 1 inventory was prepared. Energy data was entered into the workbooks provided as part of the IPCC reporting software.

IPCC defaults were used for carbon emission factors and fraction of carbon oxidised. No significant uses of petroleum products as feedstock could be identified, and therefore carbon stored was assumed to be nil for all sectors and all fuel types.

Following the data collection and calculation stages, an analysis and verification stage was undertaken, to compare the results with expectations based on the known activities in Fiji.

Additional calculations were then required to calculate non-CO_2 emissions. Methane, nitrous oxide, oxides of nitrogen, carbon monoxide and NMVOCs were estimated in accordance with IPCC guidelines, except for bunker activities and for mining and quarrying. Sulphur dioxide was not estimated, due to limited information about sulphur content in fuels. It should be noted that LPG, as a liquid fossil fuel, is included under 'oil' in these calculations.

For bunker activities, the estimation method for non-CO_2 emissions is not specified. For marine bunkers, the default emission factors for national navigation were used. For aviation bunkers, the default emission factors for domestic aviation were used. While acknowledging that the usage characteristics are slightly different, this provides at least some information on the general scale of emissions from these sources.

Mining and quarrying was identified as a sub-sector in the Yearbook, and is separated out in the 'other' subcategory in this report, to enable ease of comparison in future reporting. Mining and quarrying is a subcategory of manufacturing in the 2006 IPCC guidelines (subcategory 1A2i).

In comparing data inputs, factors and results from the reference and sectoral approach, some discrepancies were noted. Data quality was therefore marked as low.
Once the sectoral estimates of fuel use were prepared, carbon dioxide, methane, and nitrous oxide were calculated in accordance with IPCC guidelines except where otherwise noted. No information was available on the detailed used of the fuel, for example if used in controlled or uncontrolled engines, proportion of 2-stroke or 4-stroke engines, level and type of catalytic converters in vehicles, age and maintenance of engines, proportion used in facilities that have air-pollution controls, etc. Without this information, the defaults were used.

Future National Communications may benefit from the introduction of the Environment Management Act in 2005, and the Environment Management (Waste Disposal and Recycling) Regulation in 2007. Progressively implementation will see, major air-polluting activities recorded, including combustion-related and industrial activities. Some discussions may improve reporting by aligning the requirements of both programmes while minimising the burden on businesses.

Reference Approach

Primary fuels

Fiji does not produce any primary fuels, nor does it have facilities such as refineries to process primary fuels.

Secondary fuels

Gasoline

In Fiji, gasoline is widely known as petrol, benzene, super or unleaded; the names mogas and motor spirit are not widely used. In 2004, biofuels (e.g. ethanol blends) were not part of the fuel mix. Common fuel types were unleaded petrol (ULP) and leaded petrol (only 0.25% of net imports), as well as aviation gasoline (1.9% of net imports). Petrol is used for transport as well as for electricity generation, such as gensets for households and small business. This fuel is responsible for 7.3% of Fiji's carbon dioxide emissions.

Kerosene

As a SIDS, air transport is very important, and Fiji is a significant Pacific hub for air travel, with Nadi airport as the primary airport for international flights; Suva (Nausori) airport also caters for international flights by smaller aircraft. The flag carrier, Air Pacific (Fiji Airways from 2013), bought out Sun Air (formerly Sunflower Airlines) in 2007, and now operates domestic flights under the name Pacific Sun. In 2004 a number of other operators also provided scheduled domestic flights, such as Island Hoppers; Pacific Island Seaplanes; Turtle Airways. Nausori-based Air Fiji went out of business in 2009. Since 2004, new operators are Northern Air, and Inter Island Airways (due to commence operations in June/July 2013).

This corresponds with the reported fuel use for aviation, including substantial re-exports of jet kerosene (108,269 kL), as bunker fuel. Kerosene is also widely used for cooking and lighting, and is often referred to as dual-purpose kerosene (DPK). It is probable that there is some flexibility in recording the type or use of kerosene, but the total should be correct. Kersone, both jet and other, contributes 19% to Fiji's carbon dioxide emissions.

Diesel

Referred to as Gas/Diesel Oil under the IPCC guidelines, this encompasses 'Industrial Diesel Oil' (IDO), and 'Automotive Diesel Oil' (ADO, the diesel sold in service stations).

Diesel is widely used in Fiji for transport, both road and marine, as well as for electricity generation. Natural hazards such as cyclones, occasional power cuts, together with only partial electrification of the main islands, and no electrification of smaller islands, have provided sufficient drivers for widespread uptake of generators. Generators are commonly used, from rural households and businesses through to major energy consumers such as resorts and Emperor Gold Mine (EGM). EGM is reported to have exported 190MWh of surplus electricity to the grid in 2004, from on-site production[4]. Diesel is the source of 70% of carbon dioxide emissions in Fiji

Residual Fuel Oil

Residual fuel oil (RFO) is also known as heavy fuel oil (HFO) and fuel oil (FO). The only identified use is by the Fiji Electricity Authority (FEA), for power generation. RFO contributes less than 0.05% to Fiji's carbon dioxide emissions

LPG

Liquefied petroleum gas (LPG) is widely used throughout Fiji for domestic and institutional cooking, as well as for transport (LPG vehicles, particularly taxis). Use for power generation is a minor component of use.

Fiji's LPG is primarily butane, although LPG is typically a mix of both propane and butane. LPG comprises 2.5% of Fiji's carbon dioxide emissions.

Bitumen

All bitumen was considered to have carbon storage of 100%, that is, use in such activities as road building where the bitumen is not combusted. This aligns with the default assumptions under the IPCC guidelines. Therefore, bitumen is considered under industrial processes, not as a fuel source.

Lubricants

Emissions from lubricants were estimated, to provide some idea of the relative importance of this sector, however the customs category HS 2710.19.10, 'lubricating oils and mineral turpentine', combines two different items. The quantity is so small, that even if the entire amount were lubricants, this would still be less than 0.4% of Fiji's emissions, and was not considered material to the inventory.

Waste oils

One industrial facility was identified as using waste oils for process heat in their factory, collecting used oil from car

[4]Data provided during meeting with FEA on 28 September, 2012

yards and marine facilities around the Greater Suva area. This fuel consumption was directly reported by the facility, as 2,300 kL. Consumption of the waste oil was entered in the worksheet as a stock change under 'other oil' for clarity. As it is sourced from car yards, ship yards and other waste oils, it is calculated as diesel, the dominant fuel type for these sectors. This comprises less than 0.4% of Fiji's carbon dioxide emissions, and is identified for completeness.

Solid fossil fuels

There were four categories of solid fuels for which imports were reported in 2004, bituminous coal, sub-bituminous coal, brown coal briquettes and patent fuel, and peat.

While the use of these solid fossil fuels in Fiji could not be determined, the relatively small quantities suggest either the number of users, the scale of activity, or the period of use, is small.

Biomass

In Fiji's energy sector, only solid biomass was recorded in 2004. The capacity to produce liquid biomass, such as coconut-oil biodiesel and ethanol supplemented petrol, has been developed since this base year.

Biomass is known to be used for electricity generation, with co-generation by Fiji Sugar Corporation (FSC) using bagasse, and by Tropik Wood using wood waste; these are the only relevant approved Independent Power Producers (IPPs), as EGM's electricity generation and export is fossil fuel based. Use of wood fuel for cooking is also common, both in rural and urban areas. As is common throughout non-Annex I countries, obtaining accurate information on household fuel use is challenging, and the quality of the estimate is also difficult to assess. In summary, Fiji's biomass usage for fuel comprises bagasse, coconut husks and residues, pine chips and sawmill residues, mangroves and other wood (reported as fuel wood).

Bunker fuels

As a regional transport hub, Fiji provides fuel to international aircraft, foreign fishing vessels, cruise liners and superyachts, and other vessels. Bunker fuels are reported separately as a memo item.

Results

The Reference Approach is only estimates CO_2 emissions. Table 3.5 below shows the fuel movements, energy, and estimated emissions for Fiji.

The largest energy source was diesel, with net imports of 468,849 kL, providing 15,184 TJ of Fiji's needs. Biomass was second, including formal harvesting (sugar cane bagasse and wood chips) as well as semi-formal and informal domestic firewood consumption, contributing 6,159 TJ. Biomass use is estimated, and is only reported for emissions of non-carbon dioxide gases.

Substantial bunker fuel use (re-exports) was recorded for diesel (171,205 kL), jet kerosene (108,269 kL), and to a lesser extent, petrol (gasoline) (32,277 kL). This reflects Fiji's position as a hub for international shipping, international flights particularly in the Pacific, and also activities such as off-shore fishing.

Estimated emissions of 1,591 Gg of CO_2 for the energy sector in 2004 compare with emissions of 776 Gg of CO_2 in 1994. Fiji's Initial National Communication only estimates emissions using the sectoral approach, therefore no comparison can be done of changes to trade in fuel as revealed through customs data.

Results for the energy sector, using the reference approach, are shown in Table 3.5 below.

Table 3.5: Carbon dioxide emissions from energy sources using Reference Approach

FUEL TYPES			Production	Imports	Exports	International Bunkers	Stock Change	Apparent Consumption	Apparent Consumption (TJ)	Actual CO_2 Emissions ($GgCO_2$)
Liquid Fossil	Primary Fuels	Crude Oil	0	0.03	0		0	0.03	0.00	0.00
		Orimulsion	0	0	0		0	0.00	0.00	0.00
		Natural Gas Liquids	0	0.011	0		0	0.01	0.00	0.00
	Secondary Fuels	Gasoline		98833.87	0.03	32276.93	0	66,556.91	1,684.42	115.56
		Jet Kerosene		248066.91	13	108269.13	0	139,784.78	4,146.13	293.48
		Other Kerosene		7502.81	0.01459	0.16	0	7,502.64	222.53	15.83
		Shale Oil					0	0.00	0.00	0.00
		Gas / Diesel Oil		640055.23	1	171205.73	0	468,848.50	15,183.85	1,113.37
		Residual Fuel Oil		658.06		461.01	0	197.06	7.42	0.57
		LPG		13652.72	42.6695		0	13,610.05	643.89	40.41
		Ethane					0	0.00	0.00	0.00
		Naphtha					0	0.00	0.00	0.00
		Bitumen		7266.96	685.66894		0	6,581.29	264.50	0.00
		Lubricants		4888.64	0.116	27.42	0	4,861.11	169.77	6.16
		Petroleum Coke					0	0.00	0.00	0.00
		Refinery Feedstocks					0	0.00	0.00	0.00
		Other Oil					-2300	2,300.00	74.49	5.41
Liquid Fossil Totals									22,397.01	1,590.79
Solid Fossil	Primary Fuels	Anthracite[a]	0				0	0.00	0.00	0.00
		Coking Coal	0				0	0.00	0.00	0.00
		Other Bit. Coal	0	19.80			0	19.80	0.59	0.05
		Sub-bit. Coal	0	1.54		0.052	0	1.48	0.04	0.00
		Lignite	0				0	0.00	0.00	0.00
		Oil Shale	0				0	0.00	0.00	0.00
		Peat	0	16.583	0		0	16.58	0.28	0.03

FUEL TYPES		Production	Imports	Exports	International Bunkers	Stock Change	Apparent Consumption	Apparent Consumption (TJ)	Actual CO_2 Emissions ($GgCO_2$)
Secondary Fuels	BKB & Patent Fuel		7.376	0		0	7.38	0.15	0.01
	Coke Oven/ Gas Coke		0	0		0	0.00	0.00	0.00
Solid Fuel Totals								1.07	0.10
Gaseous Fossil	Natural Gas (Dry)					0	0.00	0.00	0.00
Total						0		22,398.08	1,590.90
Biomass total		340999						6,159.30	668.51
	Solid Biomass	340999	0	0		0	340,999.00	6,159.30	668.51

(a) Other bituminous coal, i.e. not anthracite or lignite

Summary

The Reference Approach provides a country-level estimate of emissions, and is most effective in estimating emissions associated with imported fuels. For Fiji, all fossil fuels are imported; therefore customs data can provide the necessary information. . Further emissions from domestic activities, particularly household bioenergy use, are provided to give a general picture of these activities. Such information is less certain, being part of the informal, subsistence economy.

Emissions for the energy sector under the reference approach are estimated at 1,591 Gg CO_2.

Sectoral Approach

Energy industries

The Fiji Electricity Authority is the only government-owned utility, and operates on the three largest islands, Viti Levu, Vanua Levu and Ovalau. It operates both renewable and thermal generation, and is the major generator of emissions in this category.

Generation by FEA has been increasing, from 33.5 GWh in 1995, to 282 GWh in 2004. Much of this increase is from additional thermal generation, as few new renewable energy projects have come on line in this period. In particular, the FEA has expanded generation based on HFO, from their Kinoya plant. With the strong dependence on hydro power, rainfall is a key factor in the annual power generation from renewables. The growth in FEA generation, categorized by energy source, is shown in Figure 3.4 below. 2004 experienced the lowest rainfall figure since 1980 when the hydro power commenced operation, however this was not the case in the surrounding years, suggesting that rainfall timing, as well as management of the hydro and accuracy of forecasting may play a role. As a result, fossil-fuel based supply increased.

Energy generated by renewables, particularly hydro, varies seasonally and year-on-year and makes a valuable contribution to avoided fuel costs and avoided emissions. As generation grows, the proportion has declined from 97% of Fiji's electricity needs in 1991[5].

Two other sources of generation may be included in this category. Many households and businesses also generate their own electricity, particularly in rural areas or as a backup, such as tourism facilities. A PWD scheme (now part of the rural electrification unit of the Department of Energy) assisted households to install small gensets, and this was later expanded to include facilitation of

FEA Electricity generation 1993-2011

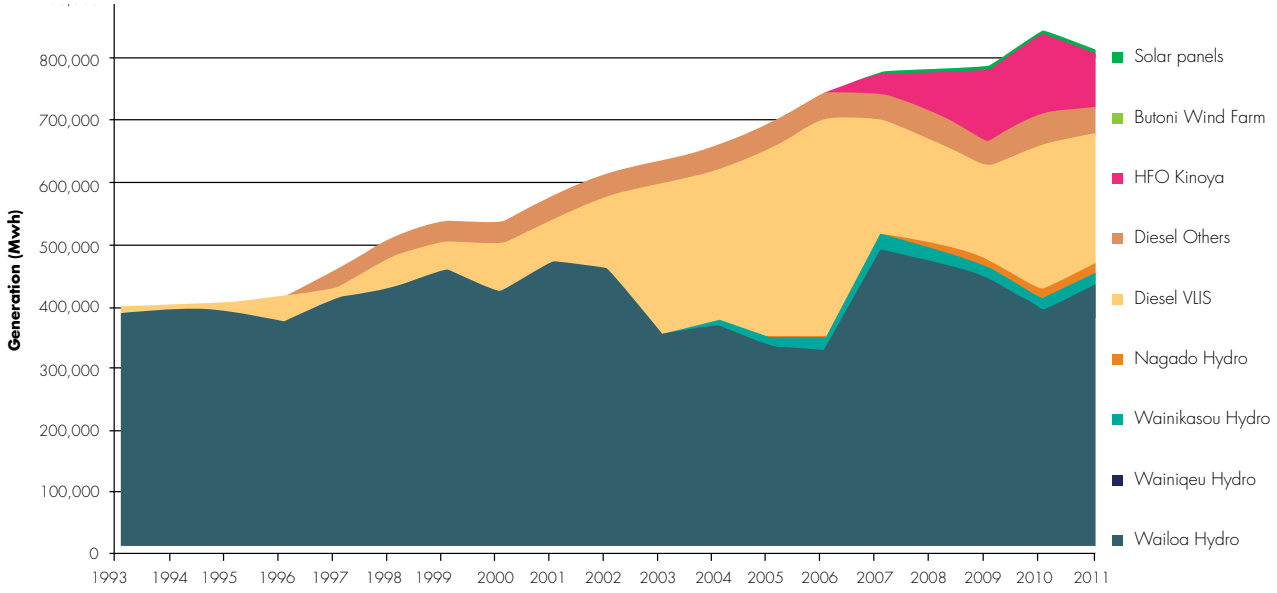


Figure 3.4 Electricity generation by FEA, 1993-2011, by energy source (IPPs excluded)

grid connection, and renewable energy powered systems. Secondly, the PWD for some time supported a local network on the island of Taveuni; which has since been taken over by a private operator. PWD and other local networks were also operating in the rural centres of Ahau in Rotuma, Vunisea in Kadavu, Tubou in Lakeba, Dreketi Agricultural Station in Macuata, Lomaloma in Vanua Balavu and Nabouwalu in Bua.

Fiji also has three organisations who generate electricity for their own use and export the surplus to the grid as Independent Power Producers. In 2004 the three sources were co-generation by Fiji Sugar Corporation (FSC), using bagasse; co-generation by Tropikwood using wood waste, primarily pine; thermal generation by Emperor Gold Mine (EGM). Since this time, EGM ceased mining in 2006, although water pumping continued; following a period of ownership by Westech Gold, it was then bought by Vatukoula Gold Mines who re-opened operations in 2008[6].

Electricity generation from fuelwood and wood waste is assumed to be the electricity generation by Tropik Wood, and is therefore reported under autogeneration[7] for the agriculture, forestry and fisheries sector.

Fiji's indigenous energy production comprises only renewable sources, most notably hydroelectricity from the 80MW Monosavu scheme[8]. Other sources include smaller hydropower generators; the 10 MW Butoni wind farm[9]; solar photovoltaic power, primarily in rural households; and biomass, from bagasse processed by Fiji Sugar Corporation, woodchips from the operations of Tropikwood, and domestic firewood. The FDoE has been piloting biogas from piggery waste, but this was not commercially available or widespread in 2004 and was not included in this GHGI.

Manufacturing industries and construction

In general, Fiji has a relatively large manufacturing sector, producing numerous products for export both in the Pacific and around the world. There are a number of industries where Fiji has comparative advantage such as textiles,

[5] INC, p14, op cit
[6] Sourced from Vatukoula Gold Mines' website, *http://www.vgmplc.com/about/* last accessed 10 July 2013
[7] Autogeneration and autoproduction are both used in IPCC literature. In this report, autogeneration is used.
[8] Fiji Electricity Authority, *http://www.fea.com.fj/pages.cfm/major-projects/renewable-projects/hydro/* viewed 15 Jan 2013
[9] Fiji Electricity Authority, *http://www.fea.com.fj/pages.cfm/major-projects/renewable-projects/windfarm.html* viewed 15 Jan 2013

clothing and footwear; others where Fiji adds value to local products such as Pure Fiji for local coconut oils; and regionally and internationally well-known brands, such as Fiji Water, FMF and Punjas for consumables.

Many of these manufacturers use energy directly, such as in boilers, ovens, and kilns, for process heat. With the annual challenge of cyclone season and other occasional black-outs, it is common for businesses to operate generators, either full-time or as backup. One industrial premises is known to collect a modest amount of waste oil from vehicles and ships for combustion in their kiln
In this sub-sector, energy consumption is only reported for LPG, waste oil and a negligible amount of coal; no diesel or petrol use is reported. Manufacturing industries and construction are therefore estimated at less than 1% of Fiji's carbon dioxide, and it seems likely this sector is underreported. Note that mining and quarrying are reported separately. It is strongly recommended that efforts are made to improve the documentation of data recording processes, and due consideration is given to the likely uses of the data, so that it is suitably classified and presented.

Domestic Transport

Transport in Fiji comprises the following activities:

- Road transport includes passenger, commercial and freight activities, with the larger islands have a more extensive road network, and some smaller islands having only partial road connections. The road transport subsector is the second largest user of fossil fuel in Fiji, at 4,622 TJ, second only to the Commercial and Institutional subsector. Emissions are therefore high, 21% of Fiji's national emissions of carbon dioxide.

- Rail transport is limited to the sugar trains operating near FSC's mills in western Viti Levu and in Vanua Levu. There were no public or commercial train systems operating in 2004 and none has started since.

- Air transport plays an important social and economic role, and is expected to be a substantial user of fuel for the future. There are– two international airports (Nadi and Suva/Nausori), and numerous domestic airports for scheduled flights and multiple smaller airports and landing strips for private and charter operators. All international aircraft are turbine engine aircraft, using jet fuel (jet kerosene/avtur), while domestic flights use both piston and turbine engine aircraft, consuming avgas (aviation gasoline) and jet fuel respectively. As Fiji is a hub with flights to other Pacific islands, and operates fuelling and other services, international usage is expected to be high. The Yearbook notes a 'statistical discrepancy' for this subsector of 978 TJ, roughly equivalent to the 980 TJ for domestic flights, and more than three times the international bunker fuel recorded. Therefore, while this sector is known to be a significant contributor to Fiji's emissions, there is a high degree of uncertainty as to how significant air travel is.

- National navigation (sea transport) comprises a range of vessels, from on-shore and off-shore fishing fleets, including foreign flagged vessels and those that operate in the high seas (areas beyond national jurisdiction), scheduled ferries, and smaller vessels, such as 'fibre' (fiberglass boats). These are important transport links for many islands, with some having few roads and instead relying on small watercraft. It is likely that fuel recorded under 'sea transport' refers only to the larger, formal transport such as ferries and fishing fleets (sold from separate terminals), while small watercraft may be recorded under road transport together with other small retail users who obtain fuel from service stations. Despite this potential under-reporting, national navigation is a substantial user of diesel, at 2,858 TJ, and correspondingly is 13.5% of Fiji's carbon dioxide emissions.

Combined, transport is the most significant of all the energy using sectors in Fiji, contributing 729 Gg of CO_2 (47%). Although some additional emissions from lubricants and LPG would be expected, and some transport may be more appropriately considered part of other sectors, overall, the results show what has long been stated in the Pacific Islands – that transport is the major energy use.

This inventory is based on the 1996 IPCC guidelines; however in the 2006 guidelines, to be used for the Third National Communication, transport is in itself a sector (together with stationary energy, which together make energy). While a Tier 1 top-down approach has been used, it may be appropriate to consider the assumptions this makes, and how best to prepare for future reporting.

One area that is difficult to assess from a top-down perspective, is use of fuel from service stations. At least four uses can be readily identified for fuel sold at retail outlets:

1. road vehicles, including agricultural plant and equipment;
2. to fuel outboard motors in watercraft;
3. for small generators, such as in homes;
4. Equipment such as brush cutters (also known as string trimmers or strimmers), chainsaws, compressors, etc.

Discussions with FDoE suggest that fuel sold from service stations, village outlets and other small retail is recorded together, and presumably this is documented under Road Transport. Additional techniques may be required, such as surveys of retailers, of householders, or comparison against other activity data such as vehicle registration. Further, engine characteristics play a significant role in efficient combustion and fuel use; engine capacity and fleet age data from the Land Transport Authority may be useful in further developing a transport model. The effort required for such an effort should be assessed against the benefit that can be gained by better understanding opportunities for mitigation in this subsector.

Commercial and institutional

Fiji has an active retail sector, from department stores in urban areas, to small canteens and village shops. A range of other secondary and tertiary industries also operate, with Fiji selling services to other Pacific island countries. As with many SIDS, the government is a substantial employer and service-provider, and therefore is a substantial energy user. The main Laucala campus of the University of the South Pacific is in Fiji, providing tertiary education for its 12 member countries, serving a population of 1.3 million people, as well as supporting distance and flexible learning. Together with multiple boarding schools throughout Fiji (such as Adi Cakobau School, Queen Victoria School, Ratu Kadavulevu School), education is expected to be a significant part of the commercial and institutional sector. Tourism is a major part of Fiji's economy, and can be energy-intensive due to the range of services provided, particularly hot water and air-conditioning which are uncommon in Fiji households, and even desalination for water provision. Figure 3.5 illustratesvisitor arrivals over recent years.

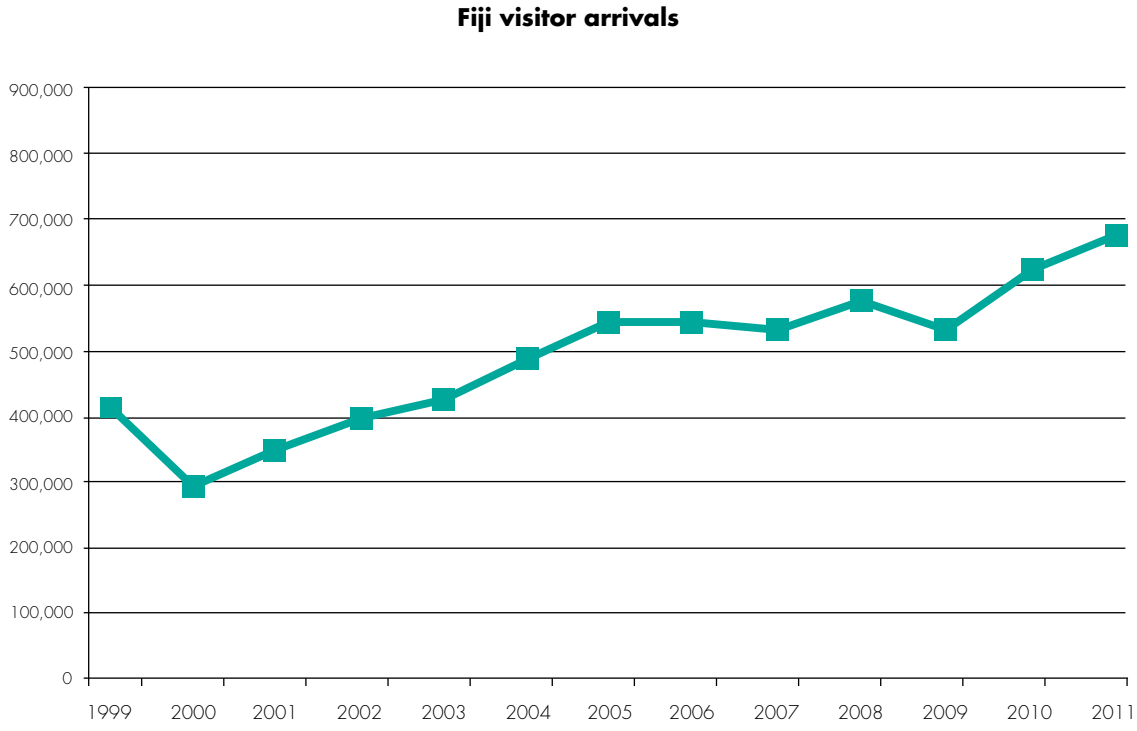


Figure 3.5 Visitor arrivals data, 1999-2011[10]

[10] Visitor arrivals data is prepared from Fiji Bureau of Statistics information, made available through SPC's website: *http://www.spc.int/prism/fjtest/Tourism/Visitor_Arrivals.htm* (accessed 1 July, 2013), which states data is sourced from Embarkation and Disembarkation Cards - Department of Immigration.

The commercial and institutional sector is the largest energy consumer, and the largest user of ADO (4,899 TJ, 43% of ADO, 39% of total diesel); of gasoline/ petrol (1,679 TJ, 54% of total); and of electricity (964 TJ, 52% of total). It also has substantial usage of kerosene and LPG.

Residential

The IPCC worksheets provide only for direct fuel uses by the residential sector, and do not separately consider autogeneration, despite the widespread use of small generators by households. Therefore, all data for the residential sector was combined in the worksheet.

While there are no records of charcoal making, some anecdotal evidence suggests there is a small-scale industry in a few areas of Fiji. It has a high methane-generation rate, and should information become available, such as applications for waste permit under the Department of Environment, this could be added to the inventory.

The largest energy use recorded by the residential sector was from biomass, reflecting the importance of solid fuels for cooking, particularly in the rural areas. Fuelwood and wood waste accounted for 4,366 TJ, and coconut (and palm oil residues) accounted for a further 1,431 TJ. Emissions of carbon dioxide are reported only as memo items, however emissions of methane and nitrous oxide

The residential energy sub-sector has the highest contribution to non-carbon dioxide emissions within the energy sector. This is due to the emissions from presumed poor combustion of biomass (wood and coconut fuels) in open fires, reflected in the emissions being over half of the national total for four of the five gases estimated: methane (3.05 Gg, 90%); carbon monoxide (50.82 Gg, 70%); nitrous oxide (0.04 Gg, 69%), and NMVOCs (6.10 Gg, 61%). Further, the use of biomass is not considered to contribute to anthropocentric (human caused) emissions of carbon dioxide, as these are part of a cycle and recaptured in forest growth. Therefore, the residential sub-sector's most significant feature is its major role in non-carbon dioxide emissions and overall national energy use.

Agriculture, Forestry and Fisheries

Sugar is a priority industry in Fiji, and even has a Ministry of Sugar to oversee it. While export earnings arenotable but modest (7% of GDP and $250-$300m in revenue annually[11] from information available in 2004), as a labour-intensive industry it is highly significant in a social sense, with estimates that 25% of the active labour force are involved, or that 31% of the population are reliant on sugar[12].

Forestry is also a significant industry: in 2004, Fiji was "the location of the world's largest mature mahogany plantation"[13], and also had large plantations of pine, thanks to Fiji Pine Limited, a government venture[14]. Other forestry activity comprises both export and domestic uses, from native hardwoods such as vesi, yasi (sandalwood), raintree and others, and the use of various species of mangroves (dogo, tiri) for traditional uses ranging from firewood to medicinal purposes.

As Fiji is an island nation, fishing provides important dietary protein as well as a source of income. Artisanal fishers, near-shore commercial fishers, and deep-sea fishing fleets can all be found in Fiji waters. The sectoral breakdown provides an estimate of bunker fuel for the marine sector, which presumably includes deep-sea fleets. It is unknown if national navigation captures all these uses, particularly artisanal fishers who purchase petrol in small quantities from service stations.

The sectoral breakdown reports on use of fuel by this subsector. However, agriculture, forestry and fishing are important for exports, the domestic economy, and at subsistence level. Sugar alone was estimated to involve 25% of the active labour force in 2004.From discussions with stakeholders, the most likely explanation is that the fuel use has been misallocated, but not left out, so that the energy sector total will be. It appears likely that there are differences in definition of categories between the source data and the 1996 IPCC Guidelines, for example fuel for transport in this subsector may be captured instead under transport, although rail transport is only used for carting sugar cane. Major agricultural processing could potentially be captured under industrial or manufacturing, such as wood chipping operations.

Biomass use is reported, being co-generation from bagasse and woodchips.

[11] From Fiji: Preparing for the end of preferences (Stoler, A.) as Managing the Challenges of WTO Participation: Case Study 13, http://www.wto.org/english/res_e/booksp_e/casestudies_e/case13_e.htm#fntext4, last accessed 10 July 2013.

[12] p9, Deverall, E & Lennon, S; The Fijian sugar industry: investing in sustainable technology (2005), http://archives.pireport.org/archive/ 2005/ October/FIJI%20SUGAR%20INDUSTRY%20REPORT%20%20OXFAM.pdf an Oxfam Briefing Paper, last accessed 10 July 2013.

[13] Stoler, A op. cit.

[14] p62, FAO, (2000) Asia and the Pacific national forestry programmes: update 34; Chapter 8: Fiji last accessed 10 July, 2013, from http://www.fao.org/docrep/003/x6900e/x6900e.pdf which stated that in 2000, Fiji Pine Limited was 99.8% government owned.

Mining and Quarrying

Separate information is available on mining and quarrying. Gold is economically important, and in 2004 there was one gold mine (Emperor GoldMine (EGM), in Vatukoula). Quarrying is locally significant to provide for the building industry; discussions revealed that hard rock quarrying was previously the dominant gravel source, but around 2005 there was a major shift to river gravel.

Activities that would consume energy and release greenhouse gas emissions include use of heavy plant and equipment, explosives, processing, and transportation. Discussions with the FEA also identified EGM as running significant generation capacity, and on occasions exporting this to the grid. Therefore, it was presumed that the diesel consumption recorded under this sub-sector was primarily for the gensets, while transport was recorded under the road transport sector.

EGM's successor, Vatukoula Gold Mine , it noted that gold ore from the mine is pyritic, and historical roasting processes often added elemental sulphur for extra energy, leading to direct release of sulphuric compounds such as sulphur dioxide. Sulphur dioxide emissions (which would be for both energy or industrial processes) were not estimated from this activity. It is recommended that liaison with Vatukoula Gold Mine and the DoE be used to align waste permit reporting (for air pollution) with data collection for future National Communications. The use of elemental sulphur for roasting has been discontinued by Vatukoula Gold Mine; however concentrating of the pyritic ore is still required.

Fugitive Emissions from Fuel

Fugitive emissions from fuel are recorded as NO (Not Occurring) for solid fuels and NE (Not Estimated) for liquid fuels. As Fiji does not produce or refine fossil fuels, the only potential emissions are under categories 1 B 2 v Distribution of Oil Products and 1 B 2 iii (Natural Gas) Other leakage for leaks during import/offloading, fuel transport, transfers and other handling. This was not considered further, as it is expected to be negligible, and also to be already included in fuel import/export data.

Results

The sectoral approach estimates CO_2 and also CH_4 and N_2O the other two Kyoto Protocol gases resulting from fossil fuels. Further estimates then enable assessment of emissions from a range of non-Kyoto protocol gases which may assist climate modellers and others to understand and predict subsequent impacts – however these should be used with caution as they represent an indication only, given the challenges in preparing the data. Fuel consumption and CO_2 emissions are presented by sector in Table 3.6 below.

As the table shows, the greatest consumption of energy was 4,899 TJ (22% of national fossil fuel energy) in the commercial and institutional sector in the form of diesel. Energy was predominantly provided from diesel, at 14,886 TJ (68% of national fossil fuel energy), while the highest consuming sector is recorded as the commercial and institutional sector, with 7,141 TJ (33% of national fossil fuel energy). The total energy use recorded is 21,805 TJ, excluding biomass.

Emissions were broadly in line with energy consumption. The largest single emission was 359 Gg CO_2 (23% of national energy emissions) for the commercial and institutional sector's diesel fuel, with diesel responsible for 1,092 Gg CO_2 (69% of national energy emissions). Diesel was the most significant source of energy-related CO_2 emissions, while the commercial and institutional sector had the most emissions at 512 Gg CO_2, with road transport the second most emitting sector, with 332 Gg CO_2.

Two sets of emissions are reported as memo items. International marine and aviation bunkers were estimated to consume an 987 TJ and 289 TJ, respectively, of liquid fossil fuels, and therefore emit 72 Gg CO_2 and 20 Gg CO_2. Biologically sourced fuels, such as wood waste, or solid, liquid or gaseous fuels sourced from biomass, are recorded separately as they are not considered to contribute to anthropogenic CO_2 emissions, only other gases. In Fiji, these provided 6,438 TJ of renewable energy.

Note that all results should be received cautiously, given the limitations on data completeness and quality identified.

Table 3.6 Carbon dioxide emissions from energy sources, using Sectoral Approach

		CO_2 FROM FUEL COMBUSTION BY SOURCE CATEGORIES (TIER 1) , FIJI, 2004													
		Total Liquid Fossil	Total Solid Fossil	Total Gaseous Fossil	Total Other Liquid Fuels (c)	Total Other Solid Fuels(c)	Total Other Gaseous Fuels(c)	Total (d)	Wood / Wood Waste	Charcoal	Other Solid Biomass	Liquid Bio-mass	Gaseous Biomass	Total Bio-mass	
FUEL CONSUMPTION (TJ)															
Energy Industries		2,536.90	0.00	0.00				2,536.90	0.00	0.00	0.00		0.00	0.00	0.00
Manufacturing Industries and Construction		76.40	1.40	0.00	80.33			158.13	0.00	0.00	0.00		0.00	0.00	0.00
Trans-port	Domestic Aviation (a)	2,585.50	0.00					2,585.50							0.00
	Road	4,621.90	0.00	0.00				4,621.90				(b)	0.00		0.00
	Railways	75.50	0.00					75.50							0.00
	National Naviga-tion (a)	2,880.40	0.00					2,880.40							0.00
	Pipeline Transport	0.00	0.00	0.00				0.00							
Other Sectors	Commercial/Institu-tional	7,141.90	0.00	0.00				7,141.90	0.00	0.00	0.00		0.00	0.00	0.00
	Residential	554.00	0.00	0.00				554.00	4,365.60	0.00	1,430.80		0.00	0.00	5,796.40
	Agriculture / Forestry / Fishing Station-ary	0.00	0.00	0.00				0.00	238.70	0.00	402.90		0.00	0.00	641.60
	Mobile	0.00	0.00					0.00					0.00		0.00
Other (not elsewhere specified)		1,251.20	0.00	0.00				1,251.20	0.00	0.00	0.00		0.00	0.00	0.00
Total (a)		21,723.70	1.40	0.00	80.33	0.00	0.00	21,805.43	4,604.30	0.00	1,833.70		0.00	0.00	6,438.00
Memo: International Marine Bunkers		986.90	0.00					986.90							0.00
Memo: International Aviation Bunkers		289.20	0.00					289.20							0.00
CO_2 EMISSIONS (Gg)															
Energy Industries		186.05	0.00	0.00				186.05	0.00	0.00	0.00		0.00	0.00	0.00
Manufacturing Industries and Construction		4.79	0.13	0.00	5.83			10.76	0.00	0.00	0.00		0.00	0.00	0.00

		CO_2 FROM FUEL COMBUSTION BY SOURCE CATEGORIES (TIER 1) , FIJI, 2004													
		Total Liquid Fossil	Total Solid Fossil	Total Gaseous Fossil	Total Other Liquid Fuels (c)	Total Other Solid Fuels(c)	Total Other Gaseous Fuels(c)	Total (d)	Wood / Wood Waste	Charcoal	Other Solid Biomass	Liquid Biomass	Gaseous Biomass	Total Biomass	
Transport	Domestic Aviation [a]	179.52	0.00					179.52							0.00
	Road	332.28	0.00	0.00				332.28				(b)	0.00		0.00
	Railways	5.78	0.00					5.78							0.00
	National Navigation [a]	211.28	0.00					211.28							0.00
	Pipeline Transport	0.00	0.00	0.00				0.00							
Other Sectors	Commercial/ Institutional	512.45	0.00	0.00				512.45	0.00	0.00	0.00		0.00	0.00	0.00
	Residential	36.70	0.00	0.00				36.70	0.00	0.00	0.00		0.00	0.00	0.00
	Agriculture / Forestry / Fishing — Stationary	0.00	0.00	0.00				0.00	0.00	0.00	0.00		0.00	0.00	0.00
	Agriculture / Forestry / Fishing — Mobile	0.00	0.00					0.00					0.00		0.00
Other (not elsewhere specified)															
Total [a]															
Memo: International Marine Bunkers		72.03	0.00					72.03							0.00
Memo: International Aviation Bunkers		20.47	0.00					20.47							0.00

Estimates to emissions of methane, nitrous oxides, oxides of nitrogen, carbon monoxide and non-methane volatile organic compounds are shown in Table 3.7, together with the relevant estimate of energy consumption and carbon dioxide emissions for each subsector.

Table 3.7 Emissions from fuel combustion, Sectoral Approach, for 2004

Activities			Energy and Emissions Summary from Fuel Combustion, By source Categories (Tier I) Fiji, 2004. Gases in Gg						
Energy Industries			2,537	186.05	0.01	0.00	0.51	0.04	0.01
Manufacturing industries and Construction			152	10.33	0.00	0.00	0.03	0.00	0.00
Transport	Domestic Aviation [a]		2,586	179.52	00	0.01	0.78	0.26	0.13
	Road		4,622	332.28	0.04	0.00	3.42	14.45	2.75
	Railway		76	5.78	0.00	0.00	0.09	0.08	0.02
	National Navigation (a)		2,880	211.28	0.01	0.00	4.32	2.88	0.58
Other	Commercial / Institutional		7,142	512.45	0.07	0.00	0.71	0.14	0.04
	Residential		6,350	36.70	3.05	0.04	1.07	50.82	6.10
	Agriculture/ Forestry/ fishing	Stationary	363	0.00	0.18	0.00	0.06	3.01	0.36
		Mobile	0	0.00	0.00	0.00	0.00	0.00	0.00
	Mining & quarry		1,251	91.75	0.00	0.00	0.50	0.43	0.09
Total (a)			27,959	1,566.14	3.38	0.06	11.49	72.11	10.07
Memo: International Marine Bunkers			987	72.03	.00	0.00	1.48	0.99	0.20
Memo: International Aviation Bunkers			289	20.47	0.00	0.00	0.09	0.03	0.01

Notes: (a) excludes international bunkers

The residential sub-sector is the highest contributor to non-carbon dioxide emissions in the energy sector, due to the use of biomass in cooking. The exception is oxides of nitrogen (NOx), where national navigation is the largest emitter, at 4.32 Gg (38% of energy emissions). National navigation emissions of NOx have a factor five times higher than other sectors, which highlights the potential for improving air quality through action in this sector.

The data provided for the mining and quarrying sector shows that it is a sufficiently large source of emissions to be reported as a separate sub-sector. It is responsible for 5.7% of Fiji's energy use, and similarly for 5.9% of carbon dioxide emissions (91.75 Gg), which may rise if further activities are approved.

The estimated emissions of 1,566 Gg of CO_2 for the energy sector in 2004 – using the sectoral approach – compares with emissions of 776 Gg of CO_2 in 1994 . Using the sectoral approach, it is unclear if the breakdown into sectors is consistent between the two periods, therefore care should be taken in any comparison.

Emissions of methane and nitrous oxides from the energy sector are minor contributors to Fiji's overall emissions, even using a GWP-weighted approach. For both gases, the GWP-weighted total is less than 5% of the CO_2 contribution: methane emissions of 3.38 Gg are 70.95 Gg CO_2-e, while nitrous oxide emissions of 0.04 Gg are 18.52 Gg CO_2-e.

Summary

The sectoral approach provides a more detailed breakdown than the reference approach of the source of emissions in Fiji, however must be treated with care as there is very little supporting information available. It suggests that diesel use, particularly in the commercial and institutional sector, is the primary source of carbon dioxide-related emissions, while open burning of biomass in the residential sector is the primary source of methane and nitrous oxide. For the non-Kyoto gases that are reported, the residential and national navigation sectors are the major contributors.

Considerable care must be exercise in using these figures. For example, the

agriculture, forestry and fisheries sector shows energy use and emissions are below the reporting thresholds. However, the structure of the economy and importance of primary industries in Fiji suggests that these uses of energy have not been clearly identified in the energy reporting. As a result, it is probable there is a need to improve the data in the sectoral breakdown, to provide higher quality results in future reporting.

Results

The results reported for the RA and SA were compared, as were the results from the initial national communication. These two sets of comparisons were undertaken to assess Fiji's emissions, both for verification and to illustrate the apparent change in emissions since 1994 of Fiji's contribution to the issue of climate change.

Comparison Between Approaches

The results from the reference approach and sectoral approach are compared in Table 3.8. As both use same factors other assumptions, the difference in estimates is due to the underlying data used.

Liquid fossil fuels form the largest source of energy for Fiji at 21,800 TJ, while solid biomass (for both the formal and informal sectors) contributes a further 6,159 TJ. Solid fossil fuels are negligible, at <2 TJ. No liquid or gaseous biofuels were reported, although their use is expected to increase due to the support of the Department of Energy for biofuel production in small islands, and through publication of a Biofuel Standard. Biogas has also been promoted, but has met with only limited uptake to date.

The two approaches report similar fossil fuel consumption values for Fiji, at ~22,400 TJ compare to 21,800 TJ, an overall difference of ~600TJ or 3%. At a more detailed level, consumption by fuel types, when totaled over the sub-sectors, have substantial variation, over and above the allowance for 'statistical discrepancy' in the energy balance. Consequently, carbon dioxide emissions estimated by the two approaches are similar, at 1,591 Gg CO_2 or 1,566 Gg CO_2 , a difference of only 1.5%; however, if all the individual variations are summed, then the difference is 33%. In addition, the 'statistical discrepancy' in the data added an uncertainty of 14.8%, Therefore, while some general conclusions can be drawn, particularly about the relative importance of different fuels and sectors, care must be taken when using this to inform decisions.

Comparison with 1994 inventory

Comparing the energy sector results for 2004 with those of 1994 can provide some insight into the changes in Fiji's emissions profile over the last decade. However, two other issues must be taken into account

- Similarity of methodology – while both National Communications use the 1996 IPCC guidelines, it does not appear that the same methods have been used to gather the data or define the sectors, nor is this documented in a way that allows appropriate adjustments to be made; hence the data may not be comparable.
- Changes in Fiji's national situation – Fiji's emissions profile will reflect the activities that are being undertaken in Fiji, for example both the amount of electricity generated, and the methods used to generate it. However, Fiji is vulnerable to many unplanned circumstances, such as cyclones, which are not part of the broader trend of national change and must also be considered.

Fiji's energy-related emissions for 1994 and 2004 are compared in Table 3.9 below. Only carbon dioxide emissions are shown, as emissions of other gases were not estimated in the Initial National Communication. Further, for 2004, carbon dioxide emissions were only estimated for the energy and industrial processes sectors, with land-use change and forestry identified as providing a greater sink (removal) than Fiji's entire emissions.

Table 3.8 Energy consumption and CO_2 emissions, Reference and Sectoral Approaches

CO_2 From Energy Sources, Fiji, 2004										
			Reference Approach			Sectoral Approach			Comparison	
			Consumption (KL or tones)	Consumption (TJ)	CO_2 Emissions (Gg CO_2)	Statistical discrepency1 (TJ)	Consumption (TJ)	CO_2 Emissions (Gg CO_2)	Difference (TJ)	Difference (%)
Liquid Fossil	Primary fuels	Crude oil	0.03	0.00	0.00		0.00	0.00	0.00	
		Natural gas liquids	0.01	0.00	0.00		0.00	0.00	0.00	
	Secondary fuels	Gasoline	66,556.91	1,684.42	115.56	231.60	4,691.70	321.88	3,007.28	94%
		Jet Kerosene	139,784.78	4,146.13	293.48	978.30	980.30	69.39	3,165.83	124%
		Other Kerosene	7,502.64	222.53	15.83		360.70	25.66	138.17	47%
		Gas / diesel oil	468,848.50	15,183.85	1,113.37	2,015.90	14,885.60	1,091.50	298.25	2%
		Residual fuel oil	197.06	7.42	0.57	0.00	117.00	8.96	109.58	176%
		LPG	13,610.05	643.89	40.41	10.70	688.40	43.20	44.51	7%
		Bitumen	6,581.29	264.50	0.00	0				
		Lubricant	4,861.11	169.77	6.16	0	0	0		
		Waste oil	2,300.00	74.49	5.41		74.49	5.83	0.00	0%
Liquid fossil totals				22,397.01	1,590.79	3,236.50	21,798.19	1,566.43	6,763.61	31%
Solid	Primary fuels	Other Bit Coal [a]	19.80	0.59	0.05		1.40	0.13	0.81	82%
		Sub-bit Coal	1.48	0.04	0.00		0	0	0.04	200%
		Peat	16.58	0.28	0.03		0	0	0.28	200%
	Secondary	BKB & Patent Fuel	7.38	0.15	0.01		0	0	0.15	200%
Solid Fuel Totals						0.00	1.40	0.13	1.29	105%
Total						3,236.50	21,799.59	1,566.56	6,764.90	31%
Biomass total			340,999.00	6,159.30	668.51		6,159.30	668.51	0.00	0%
		Solid Biomass	340,999.00	6,159.30	668.51		6,159.30	668.51	0.00	0%

Table 3.9 Carbon dioxide emissions from energy, Initial and Second National Communications

Item		National communication		Change	
		Initial, 1994 (Gg CO_2)	Second, 2004 (Gg CO_2)	Gg	%
Energy					
A.	Fuel combustion activities	776	1,566	+790	+102%
1.	Energy Industries	36	186	+150	+417%
2.	Manufacturing & construction	125	10	-115	-92%
3.	Transport [1]	528	729	+201	+38%
A.	Domestic aviation	12	180	+168	+1400%
B.	Road transport	516	332	-184	-36%
C.	Rail	-	6	+6	-
D.	National navigation	-	211	+211	-
4.	Other sectors [2]	87	641	+554	+637%
5.	Others	Nil	Nil	-	-

Notes:

1. Transport is listed in the INC table for the GHGI, with the breakdown into domestic aviation and road transport detailed in the text; rail and national navigation are not mentioned and hence no comparison can be made
2. Fiji's INC provides a GHGI providing only a breakdown to this level. The text states 'the residential/commercial sectors, herein categorised as Other Sectors'[15]. These two sectors are listed separately in the current GHGI, at 36.70 Gg CO_2 for residential and 512.45 Gg CO_2 for commercial/industrial, the remaining 91.75 Gg CO_2 being from the mining and quarrying sector. Merging these sectors in the INC makes comparison difficult, however even if only the commercial/industrial sector is compared with 'other sectors', an increase of 489% from the INC is shown.

Overall, Fiji's energy sector showed a 102% increase in the years between the two inventories, or 790Gg CO_2, averaging a growth rate of 7.28%p.a. This compares to an average growth in GDP over the same period of 4.10% p.a. for the same period[16].

Road transport is a sector that has shown substantial growth in registered vehicles over the decade. Figure 3.7 shows the growth in vehicle registrations 45, which are dominated by private cars. Vehicle registrations have grown steadily from 1994-2004, with average growth of 3.62% p.a. and a peak of 5.37% in 2004; private car registrations grew even faster, with average growth of 5.15% p.a. and highest growth of 7.8% in 2003. Private cars made up over 50% of total vehicles for the first time in 2004, a trend that continues, reaching 52.4% in 2011.

In contrast, carbon dioxide emissions declined by 36% over the same period. Although efficiency gains and changes to lower-carbon options (such as LPG) may improve the emissions profile, an increase in emissions is still expected due to the 43% growth in vehicle numbers. The apparent reduction in emissions suggests instead that the underlying data may not be comparable.

[15] p15, INC, op cit

[16] Calculated based on GDP of $US 1.8253 in 1994 and GDP of $US 2.7275 in 2004, from Google's public data –world development indicators collection, sourced from World Bank data

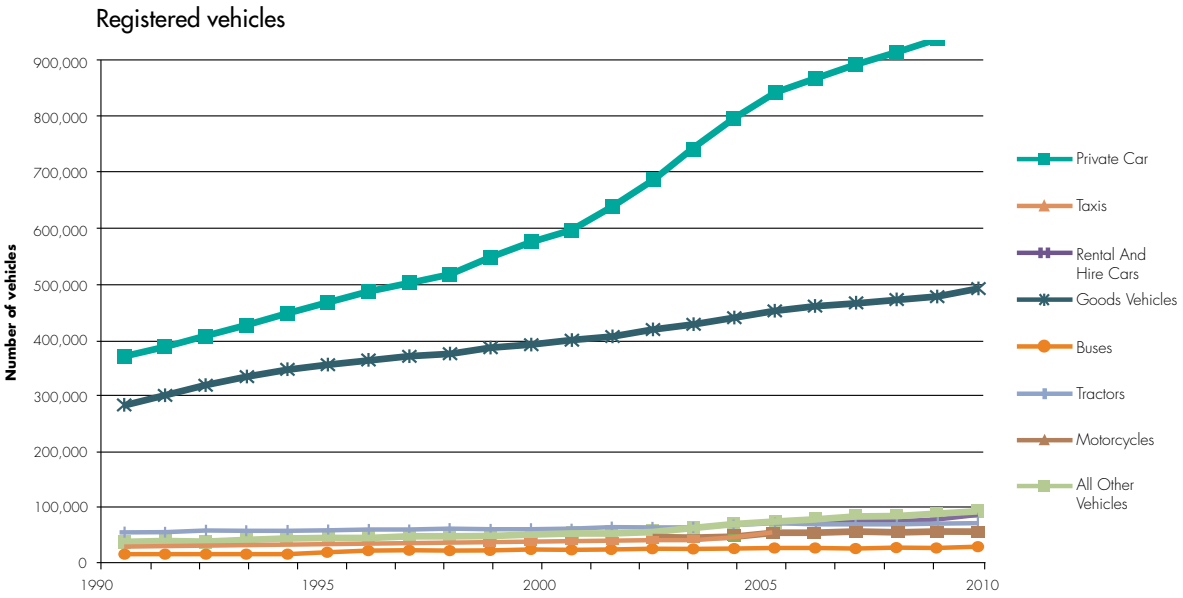


Figure 3.6 Vehicle registrations, by category, 1990-2011

Verification

One particular challenge for verification was the lack of independent data for comparison. Fiji's size is such that little benefit is gained from having multiple reporting processes and instead data used is collected nationally in one centralised process. Regional organisations and databases rely on this primary data from the country. It is also difficult to find suitable countries for comparison. Fiji is the second largest country in the Pacific, but cannot be reasonably be compared with either Papua New Guinea or Solomon Islands, the countries with the nearest population sizes and GDP, as they have electrification rates below 25% and different economic activities.

Bunker fuel is an area where comparison between the two approaches should have yielded similar results, being based on re-export data, but did not. There are large differences in all categories, with the Reference Approach providing a total of 9,591 TJ compared with 1,276 TJ for the Sectoral Approach, therefore this data is considered unreliable. The difference in definition between re-exports and bunkers may need further clarification with customs, and potentially even changes to data collection and reporting arrangements. Bunker fuel data is presented in Table 3.10. Although considered unreliable, in the overall picture of international travel and transport, it is unlikely that bunker fuel use from Fiji is significant for global reporting and management efforts.

Efforts to compare the two approaches against each other, and to the Initial National Communication (for which only the sectoral approach was included), only confirmed the variability of the data could not be accounted for. As a result, data quality was considered low in all cases.

Discussions with key stakeholders in data collection and management, FRCA, FBS, and FDoE, reinforced the challenge and resource constraints in collecting and compiling this data, much less more detailed data required for a Tier 2 inventory. Therefore, the data can be used to provide general estimates, order of magnitude and relative comparisons, but is not recommend for detailed technical use.

Table 3.10 Bunker fuel and emissions estimates for Reference and Sectoral Approaches

CO_2 FROM ENERGY SOURCES, FIJI BUNKERS, 2004						
FUEL TYPES			REFERENCE APPROACH		SECTORAL APPROACH	
FUEL TYPES			International Bunkers (TJ)	Bunker emissions (Gg CO_2)	International Bunkers (TJ)	Bunker Emissions (Gg CO_2)
Liquid Fossil	Secondary Fuels	Gasoline	816.86	56.04	70.80	4.86
		Jet Kerosene	3,211.35	227.32	289.20	20.47
		Other Kerosene	0.00	0.00	0.00	0.00
		Gas / Diesel Oil	5,544.57	406.56	916.10	67.17
		Residual Fuel Oil	17.36	1.33	0.00	0.00
		Lubricants-	0.96	0.03	0	0
Liquid Fossil Totals			9,591.10	691.28	1276.10	92.50
Solid Fossil	Primary Fuels	Other Bit. Coal(a)	0.00	0.00	0	0
		Sub-bit. Coal	0.00	0.00	0	0
Solid Fuel Totals			0.00	0.00	0.00	0.00
Total			9,591.10	691.28	1276.10	92.50
Biomass total						

Key Source Categories

In accordance with good practice the energy source categories have been assessed qualitatively to determine which categories are key source categories and should have higher priority in future inventories

The criteria used for the key source category assessment, and their relevance to this inventory, are briefly summarised as:

- *Trends*: although a source category may not be large, if it is expected to change substantially, good quality data will help to provide a reliable baseline for future trends. This can be determined through a trends analysis, if available. In Fiji, the limited number of data points has not enabled a quantitative trends analysis specifically for energy, although the Climate Change Unit may be able to undertake such an assessment in the future using the entire inventory data and the software.

- *Mitigation techniques and technologies:* where emissions are significantly reduced through mitigation (as opposed to being intrinsically low), it is good practice to identify these source categories as key, to ensure transparent methodologies used for assessing mitigation and the resultant inventory will be of good quality. Mitigation techniques and technologies were not specifically assessed for Fiji – instead relying on IPCC defaults – and limited information is currently available. As a result, this criteria is of limited relevance to the selection of key source categories for Fiji, although can be considered again should it become relevant. As emissions are primarily calculated from fuel consumption (not proxies such as distance travelled, or surveys), consequences would be that methane emissions are underestimated (and carbon dioxide overestimated), and similarly that the balance between nitrous oxide and oxides of nitrogen is not properly estimated. Improvements would require detailed assessment and comparison against the assumptions of the IPCC defaults, however as first step improvement in the general data in the inventory is recommended to be a priority, and hence this is not considered further inidentifying source categories as key.

- *High expected emission growth*: if significant growth is expected for a category, this may identify it as a key category. Such an approach is preemptive, identifying where a trends assessment is expected to identify a key source category in the future, instead of waiting for the change to occur and be identified by a trends assessment. This enables earlier selection and refinement of data collection and methodologies and simplify future comparisons. In the Fiji context, some options include comparison with the INC, consideration of the changes in the underlying activity (e.g. approvals data), and other information available since 2004. However, the benefits will be limited as it may not be practical to set up additional data collection and surveys for Third National Communication's baseline year.

- *High uncertainty*: identifying categories as key, where they have high uncertainty, can lead to additional emphasis being placed on these categories to gain the maximum improvement in inventory quality. Using Tier 2 methods explicitly takes uncertainty into account, so this approach mainly applies where Tier 1 methods have been used. For the Fiji energy inventory, only Tier 1 methods were used, therefore consideration will be needed to identify if any source categories should be identified as key due to uncertainty. Note that this is a relative (and qualitative) identification, as the uncertainty of the inventory is high, identifying a category as key for this reason indicates a need to use additional methods to improve certainty. In particular, it is unknown how fuel use is divided, particularly any assumptions made around fuel sold at service stations, which is typically used for road transport, but also marine navigation (small boats), household generators and equipment, agriculture, forestry and fishing equipment, and small and medium business activities.

- *Unexpectedly low or high emissions*: checks such as order of magnitude checks and comparisons can be used to identify source categories that do not match expectations and therefore require further investigation[17]. This approach can identify source categories as key, however limited opportunities were identified to improve the data. It is recommended that des-

[17] Section 8.7 of the IPCC Good practice guide provides further details and guidance

ignating key source categories may assist in future inventories.

Ultimately, the purpose of identifying source categories of key is to ensure that good practice is applied, including additional resources in data collection and factor selection, and using Tier 2 or 3 methods to reduce uncertainty as appropriate. For example, this could be additional surveys or sampling to revise data estimates.

Key source categories should receive extra attention; labelling all source categories as key does not assist in prioritising. Unfortunately, according to the assessment in Table 3.15, nearly all of the subsectors meet one of the criteria to be considered key. In order to make best use of the resources available, it would be recommended that cost effective improvements are considered for all categories, and that only a few are considered as key.

Overall, clarification of the underlying data sources is required for all energy sub-sectors. Improving data quality will generally improve all sectors, for example clarifying the relevant activities (by business code) listed under each sector will improve all. Discussions with licensing or regulatory bodies (such as the FEA, LTA; Forests for log size records, Fisheries for licensing, Mineral Resources Department for records of material extracted, etc), may enable better data collection on energy, and also on supplementary data that can illustrate the level of activity and therefore provide useful validation; these source categories could then still be calculated in accordance with Tier 1 or other measures as appropriate.

Therefore, it is recommended that key source categories be considered as:

- the residential sector, due to the importance of biomass and difficulty of estimating its use without household surveys;
- the commercial and institutional sector, as the largest sector and therefore suitable for further analysis of subsectors, possibly together with the manufacturing and construction sector given the possibility that allocation of data between these two sectors may be misinterpreted or have changed between the INC and SNC;
- the agriculture/forestry/fishing sector due to the major strategic importance of this sector in the Fiji economy together with a lack of information about its energy consumption.

The level of detail in future assessments would need to take into consideration the available resources and the benefits that additional data would provide, given that Fiji's energy sector emissions are not large in global terms.

The energy component of Fiji's greenhouse gas inventory for 2004 shows a minimal contribution to the global problem of greenhouse gas emissions, in line with its population, size and economy. While possessing good renewable energy resources, Fiji is dependent on imports for their fossil fuel supply which make up an increasing proportion of electricity supply. However, transport is the largest user of fossil fuels and emitter of greenhouse gases within Fiji's economy. The Reference Approach identified that most significant fuel is diesel, more than twice that of any other fuel; jet kerosene and petrol (gasoline) follow.

Industrial Processes And Product Use

The major industries of concern to Fiji are asphalt production for tarring of roads and the production of food and beverages. It was noted that in the Initial National Communication, the major emission under the industry sectoral emission was carbon dioxide from cement production.

Cement production produces large amounts of CO_2 during clinker production in the kiln. However it was reported by the Basics Industries Fiji Limited that the clinker production was stopped in 2000 and as a result the CO_2 emission was zero. In the 1994 Greenhouse Gas Inventory reported in the Initial National Communication, 45 Gg of non-energy related CO_2 was produced from cement production which has now been reduced by 100%. This is a great achievement for Fiji.

It is a known fact that HFCs are used as a replacement for ozone depleting substances in air conditioning and refrigeration. However there were no data available on which type of these gases and how much of it is imported into the country and what is the leak rate. Due to the unavailability of such specific data, HFC emissions were not calculated. Regarding Sulphur Hexafluoride (SF_6) applications, Fiji Electricity Authority (FEA) gave written confirmation of SF_6 usage as circuit breakers in couple of its plant. Again no data were available on the existing stock of this gas during the base year and consequently emissions could not be calculated. Hence only Non-Methane Volatile Organic Compounds (NMVOC) emissions from asphalt, alcoholic beverages and food production were considered in this report.

Estimating NMVOCs Emissions from Asphalt Production

In sheet 3 of worksheet 2-5 of module 2 IPCC 1996 guidelines calculates the NMVOCs emissions from road paving using asphalt. In this section the NMVOCs emissions were considered from the asphalt plants and from road surfaces. In 2004 Nasinu Quarry and StarMix produced 6821 tonnes of asphalt (Source:

Company's Production Data) and this was multiplied by the emission factor of 0.023 Kg NMVOC/t. Also according to Bureau of Statistics, approximately 7000 tonnes of Bitumen was imported and it was assumed that this was used in road surfaces as there are no other applications of bitumen in Fiji. Hence 7000 tonnes were multiplied with the emission factor of 320 Kg NMVOC/t and it resulted to 2.24 Gg of NMVOCs.

Estimating NMVOCs Emissions from Food and Beverage Productions

The beverage production data were provided by Paradise Beverages and the source of food production data was the Bureau of Statistics. *(Refer to Table 3.12)*

Total NMVOC emissions from the Industrial Sector

The total NMVOC emission from the Industrial Sector is 50.57 Gg, which is a ten-fold increase since the last greenhouse gas inventory carried out in 1994.

Table 3.11: The table summarizes the data obtained and its respective emission factors used in the study

Alcoholic Beverage Type	Quantity of Alcoholic Beverage Produced (hL)	Emission Factor (kg NMVOC/hL beverage produced)	NMVOC Emitted (kg)	NMVOC Emitted (Gg)
			C = (A x B)	D = C/1 000 000
Beer	196441	0.035	6,875.44	0.01
Spirits	6391.66	15	95,874.90	0.10

Table 3.12: The table summarizes the data obtained and its respective emission factors used for the food industry

	A	B	C	D
Food Production Type	Quantity of Food Produced	Emission Factor (kg NMVOC/t	NMVOC Emitted	NMVOC Emitted
	(t)	food processed)	(kg)	(Gg)
			C = (A x B)	D = C/1 000 000
Meat, Fish and Poultry	40245	0.3	12,073.50	0.01
Sugar	312000	10	3,120,000.00	3.12
Animal Feed	40264	1	40,264.00	0.04
Biscuits	8657972	1	8,657,972.00	8.66
Bread	4549020	8	36,392,160.00	36.39
			Total (Gg):	48.22

Agriculture

International guidelines

The calculation of emissions in the agriculture sector has closely followed the IPCC Revised 1996 Guidelines utilizing the Tier 1 default values provided.

Emissions in the agriculture sector are given below in Table 3.13.

Table 3.13: Methane and nitrous oxide emissions in 2004 from agriculture, Gg

Gas and source	Total per source	Total
Methane (CH_4)		**16.94**
• **Domestic livestock**		
- enteric fermentation	13.006	
- manure management	3.838	
	16.844	
• **Flooded rice fields**	0.091	
Nitrous Oxide (N_2O) from animals and synthetic fertilisers		**1.96**
• **Direct**		
- from synthetic fertilisers	0.615	
- from animals excretion	0.561	
• **Indirect** (from volatilising and leaching)		
- from synthetic fertilisers	0.464	
- from animals excretion	0.318	

As can be seen, the emissions in the agriculture sector, as measured in Gg are dominated by livestock emissions. (However, on a CO_2 equivalent basis the N_2O emissions from synthetic fertilisers became almost equally significant.[18])

Sources for which estimates have not been made due to unavailability of relevant activity data in 2004 include

- N_2O emissions from cultivation of organic soils
- CH_4, CO, N_2O and NOx from the field burning of agricultural residues (Note: sugar cane residues burned in sugar mills for energy production is not included in the agriculture sector inventory.)

There have been significant reductions in emissions from the agriculture sector over the period 1999-2004 due to the much lower levels of livestock numbers (and agricultural activity generally). This can be seen, for example, through the livestock numbers in the national census data for the agriculture sector shown in Table 3.14 below.

Table 3.14: Livestock numbers in national census data

Livestock Numbers In 2009		1991	1999
Source: 2000 National Agriculture Census Report		Census	Survey
Cattle	134,411	280,221	284,687
- Dairy	22,533	36,805	27,583
- Beef	20,263	55,634	45,236
- Non-diary and non-beef	91,616	187,782	211,868
Sheep	14,068	n/a	n/a
Goats	101,196	187,235	251,765
Pigs	73,698	90,850	92,251
Horses	27,124	36,570	n/a

However an accurate assessment of the emission reductions over the period 1999-2004 is not possible given uncertainties of livestock numbers in 2004.

[18] The GWP multiplier is 23 for CH_4 and 296 for N_2O

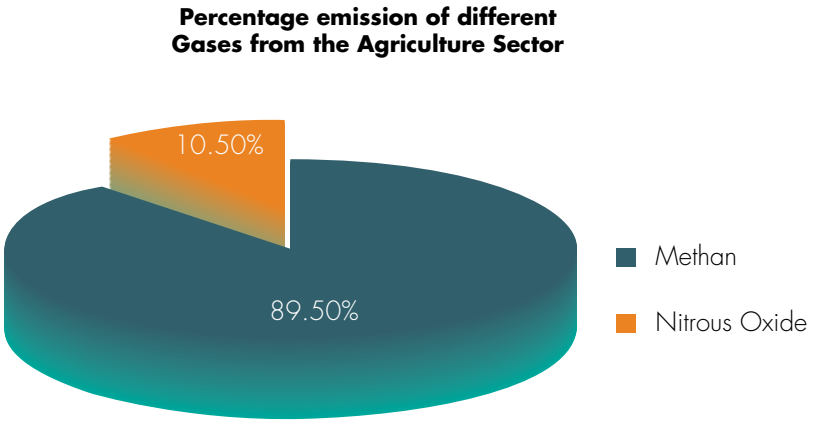


Figure 3.7: shows the the emission of different gases from the Agriculture sector

Land-Use Change And Forestry

International guidelines

The calculation of emissions in the LUCF sector has closely followed the IPCC Revised 1996 Guidelines utilizing Tier 1 default values provided where applicable and available. Some factors for annual growth rates were taken from the IPCC 2006 Guidelines Emissions (+) and removals (-) of carbon dioxide in the LUCF sector are given below in Table

Table 3.15: CO_2 emissions and removals in 2004 from LUCF, Gg

Gas and source	Total per source	Total
Carbon Dioxide (CO_2) net removals (negative emissions)		**- 7,987.7**
• **Removals in growing forests**	-3,800.7	
- Closed forests (indigenous)	-3069.5	
- Open forests	-885.5	
- Pine plantations	-738.5	
- Hardwood plantations	-8,494.2	
• **Emissions from forest harvest**		
- Indigenous	74.7	
- Pine	416.6	
- Mahogany	15.2	
	506.5	

Emissions and removals from other sources in the LUCF sector were not able to be calculated given the unavailability of data for 2004.

Waste

International guidelines

Disposal and treatment of industrial and municipal wastes can produce emissions of most of the important greenhouse gases. The most important greenhouse gas produced from this source category is methane, which typically 50% v/v of landfill gas. Approximately 5 – 20 percent of annual global anthropogenic CH_4 produced and released into the atmosphere is a by-product of the anaerobic decomposition of organic matter. Wastewater treatment also produces N_2O and the estimation of emission is included in the human sewage calculation. In the waste sector methane emissions are considered from solid waste disposal sites (SWDSs), wastewater treatment and waste incineration. In this report only emissions from SWDSs and wastewater treatment are considered. There are detailed methodologies provided in the revised 1996 IPCC guidelines for this source category. There is a serious lack of incineration data and hardly any research carried out on estimating emissions from this particular source.

Trends in Fiji's GHG Emissions from the Waste Sector

Methane emissions from SWDS are calculated to be 3.12 Gg and from wastewater and sludge is 1.10 Gg. Hence the total methane emission from waste sector is estimated to be 4.22 Gg for the year 2004. There is an increase of 14% since the last greenhouse gas inventory done in 1994 for the Initial National Communication. Hence it can be concluded that the rate of methane emission from waste sector is increasing at a rate of 1.4 % per year.

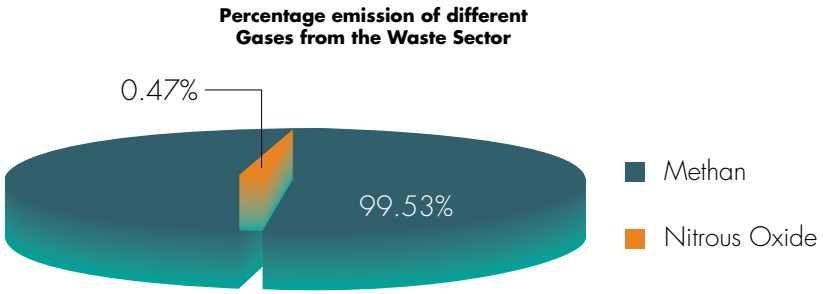


Figure 3.8: shows the emission of different gases from the waste sector

Key Gaps And Limitations

Industrial Processes

Calculation of HFC emissions

The challenge in estimating the HFC emissions from the air conditioning units and refrigeration units was trying to estimate what gas type is used in these household items and what is the leak rate. The most difficult was estimating the number of cars, refrigerators and air conditioning units in operation and how much of HFCs it was initially charged with and how many of these units are disposed in that particular year.

Calculation of SF_6 Emissions

In Fiji SF_6 is being used in the gas insulated switchgear (GIS) and circuit breakers. Fiji Electricity Authority (FEA) and Fiji Sugar Cooperation (FSC) are the two corporate sectors that use SF_6. It was noted that FSC only started using SF_6 in 2008 and was not considered in this assessment. However there were some FEA sub-stations which had circuit breakers with SF_6 installed as early as 1990. The major hurdle was trying to estimate what is the quantity of SF_6 contained in the existing stock of equipment in year 2004. The emission would be 1% of the quantity of the existing stock. It is highly recommended that FEA and FSC should keep a record of the quantity of this gas in their equipment to enable future calculations of SF_6.

Agriculture sector

The major limitation with the agriculture sector generally is the lack of activity data for 2004. The largest share of emissions in this sector is associated with livestock. The key data source is from the national agricultural survey done in 1999 and the national agricultural census done in 2009. Data for specific years between these dates from other sources is either unavailable or questionable, e.g. because the data from these sources (e.g. the FAOSTAT database for Fiji) is significantly different from the national survey/census in the years of this data. Estimates for livestock numbers in 2004 have therefore been interpolated as being midway between the 1999 and 2009 survey/census numbers. It is noteworthy that there has been a significant decline in most livestock numbers, most particularly cattle. This means that in reality there has been a significant decline in emissions from this sector over 1999-2009; however this is unlikely to have occurred in the linear manner assumed by choosing a midpoint number.

Future improvements in the GHG inven-

WASTE SECTOR LAMI DUMP

tory data used in Fiji's UNFCCC national communications for the agriculture sector can be made by picking a year that is close to a national census year for this sector. Also, as the next national communication can be expected to use the IPCC 2006 Guidelines, it would additionally be valuable to have a near term review made of these 2006 Guidelines for this sector (and other sectors). Such a review should identify improvements that can be made in both the estimates of the activity data and, as well, the use of calculation factors that are more specific to the country circumstance of Fiji.

LUCF sector

The major limitation with the LUCF sector generally is the lack of data for 2004, both in forest areas and carbon stocks. For this inventory, other than for pine plantations, forest areas use a linear interpolation from the National Forest Inventory (NFI) datasets for 1991 and 2007 (the methodology employed by the FAO Forest Resource Assessment (FRA) for Fiji). The pine plantation area was taken from Trines E, Constructing a Reference Emission Level/Reference Level for Fiji.

Future improvements in the GHG inventory data used in Fiji's UNFCCC national communications for the LUCF sector can be expected to emerge from the considerable effort currently underway to develop comprehensive MRV methodologies and data sets related to a national REDD+ programme. These efforts are intended also to serve the needs of the IPCC 2006 Guidelines for the Agriculture, Forestry and Other Land Use (AFOLU) sector and IPCC Good Practice Guidance for the Land Use, Land Use Change and Forestry (LULUCF) sector.

Waste Sector

Methane emissions from SWDSs

The major source of uncertainty in estimating emission of methane from SWDSs was the tonnage of waste generated at each municipal SWDSs. Almost all the sites did not have a weighbridge and therefore the tonnage of waste was estimated using the best practice guidelines as explained above.

The other major source of uncertainty was the lack of characterization of waste into these four streams: paper and textiles, food waste, garden and park waste and other (non-food) putrescible, and wood and straw waste. The data used in this report was supplied by the individual city and town councils and was merely a rough estimate. Only Suva City Council with the help of JICA volunteers did a waste characterization study and estimated the % organic component of our waste. However the individual breakdowns of the organic matter were not known.

Methane emissions from Wastewater handling

The level of uncertainty in estimating emissions from wastewater and sewerage treatment plant would be less as compared to estimating methane emissions from SWDSs. The primary reason is that all the data required for calculation was provided by the National Water Quality Laboratory. The only uncertainty was the population size catered for each sewerage treatment plant, data supplied by the (NWQL) did not add up to the population statistics for the individual city or town boundaries. The population data supplied by NWQL actually takes into account the households that are connected to the sewer lines but this raises serious questions about methane emission from the waste that are collected and dumped by the sewer trucks servicing households that are not connected to the sewer lines. However the waste collected from these households are actually dumped in the lagoons or ponds which is then pumped into the digester for anaerobic treatment. There was no account on what population size was serviced by sewer trucks collecting waste and dumping at the treatment plant. Hence it is only logically that for major cities and towns the peri-urban population should be taken into account when calculating the emissions.

4 IMPACT, VULNERABILITY & ADAPTATION

INTRODUCTION

Fiji launched its National Climate Change Policy in early March 2012 with an implementation framework that outlines strategies for adaptation per sector. The list of national-regional policies, legislations and international conventions which Fiji is signatory to highlight the synergies, hence opportunity to forge partnership and collaboration amongst stakeholders. The National Climate Change Policy provides a platform for coordination across sectors, direct national positions and priorities regarding climate change mitigation and adaptation. The National Climate Change Policy for Fiji recognizes the need for constructive co-operation amongst all relevant sectors. This interdisciplinary and multi-sectoral approach was emphasized in Agenda 21 of the 1992 United Nations Summit on Sustainable Development held in Rio de Janeiro. More specifically, NCCAS accounts and aim to support the implementation of adaptation-relevant objectives with actions defined in existing national, regional policies, strategies and plans on land-based resources.

Table 4.1: Listing of related national, regional and international policies to climate change adaptation.

Sector	National Legislation, Policies, Plans and Programmes
Agriculture Livestock management	• Disaster Risk Management Strategy for the Agriculture Sector 2010. • The National Climate Change Adaptation Strategy under development will contain sector specific strategies and actions to allow adaptation of the agricultural sector to climate change • Fiji Food and Nutrition Policy, 2008
Health	• Public Health Act (Cap. 111) 2002 • Fiji Food and Nutrition Policy, 2008 • The Ministry of Health is working with the WHO to address Climate Change impacts on public health 'Profiling climate sensitive diseases' • National Health Emergency and Disaster Management Plan (2012-2016)
Biodiversity/ Environment	• Environment Management Act 2005 • Environment Management (Waste Disposal & Recycling) Regulation 2007 • Environment Management (EIA Process) Regulation 2007 • Endangered And Protected Species Act 2002 • Endangered And Protected Species Regulations 2003 • National Biodiversity Strategy and Action Plan, 2007 • National Biodiversity Strategy and Action Plan Implementation Framework, 2010-2014 and Annual Work-plan (NBSAP) • The National Climate Change Adaptation Strategy under development will contain sector specific strategies and actions to allow address climate change impacts on terrestrial biodiversity • National Environment Strategy 1993 • CDM Policy Guideline • Fiji's Initial National Communication under the UNFCCC (INC), 2005 • Integrated Coastal Management Framework of the Republic of Fiji 2011
Marine and Fisheries	• Fisheries Act 1988 • Fisheries Act (Amendment) Decree 1991 • The National Climate Change Adaptation Strategy under development will contain sector specific strategies and actions to all address climate change impacts on mangrove areas • The Integrated Coastal Management Plan currently under development may address the impacts of Climate Change on water catchments and coastal environments
Forestry	• Forest Act 1979 • Forest Decree 1992 • Fiji Forest Policy Statement, 2007 • Fiji REDD-Plus Policy, 2010. • The National Climate Change Adaptation Strategy Fiji Forestry Strategy • Forest Outlook Study 2010-2020 • Revised Mangrove Management Plan for Fiji 2013 (draft)
Water Resources	• Draft National Water Resources and Sanitation Policy, 2011 • Rural Water Policy (Draft), 2011 (Provision of Sustainable Rural Water Supplies)
Land Management	• Native Lands (Ed. 1978) • Native Lands (Amendment) Act 2002 • Native Land Trust (Revised Edition 1985) • Native Land Trust (Amendment) Decree 1988 • Native Land Trust (Amendment) Decree 2000 • Native Land Trust (Amendment) Act 2002 • Irrigation (Rev. Edition 1985) • Land Conservation And Improvement (Revised Edition 1985) • Land Development Act (Rev. Edition 1985) • National Action Plan under the UNCCD (NAP),2007 • Rural Land Use Policy (2nd edition) 2006 • Land Resources Management Plan • National Integrated Coastal Management (ICM) Framework, 2011 • Integrated Coastal Management Plan

Sector	National Legislation, Policies, Plans and Programmes
Disaster Management	• Natural Disaster Management Act 1998 • Disaster Risk Reduction and Disaster Management: A Framework for Action 2005-2015
Energy	• Fiji's Revised National Energy Policy 2013
National Frameworks, Strategies and Action Plans	
	• The People's Charter (Government of Fiji's five year development plan), 2008/Roadmap for Democratic, Sustainable, Socio-economic Development (RDSSED) • Fiji Sustainable Economic and Empowerment Development Strategy (SEEDS), 2008-2010. • Fiji National Strategic Development Plan (SDP), 2007-2011 • National Trust For Fiji (Ed. 1978) • Natural Areas Protection Act 1988 • Rivers And Streams Act (Rev Edition 1985) • Housing Policy • National Climate Change Adaptation Strategy for Land Base Resources(draft) • Joint National Action Plan for Disaster Risk Reduction & Climate Change Adaptation (in progress)
Regional Frameworks, Strategies and Action Plans	
	• Pacific Island Framework for Action on Climate Change 2006-20015 (PIFACC) • Regional Framework for Action For Disaster Risk Reduction and Disaster Management 2005-2015 • The Pacific Plan for Strengthening Regional Cooperation and integration • Pacific Leader's Call to Action Climate Change (Annex A to the 2009 Forum Leader's Communiqué) • Alliance of Small Island States (AOSIS) Declaration on Climate Change 2009 • Pacific Island Adaptation Initiative (2003-2015) • Yokohama Plan for Action Initiative (2003-2015) • Forest and Tree Genetic Resource Conservation, Management and Sustainable Use in Pacific Island Countries and Territories: Priorities, Strategies and Actions, 2007–2015 • Towards a Food Secure Pacific: Framework for Action on Food Security in the Pacific • Pacific Regional Cultural Strategy • Pacific Regional Action Plan on Sustainable Water Management, 2002 • Regional Energy Policy

Vulnerability is generally described as a function of three elements: exposure, sensitivity and adaptive capacity. Vulnerability is the potential to be harmed by a combination of exposure and sensitivity to stresses and is reduced by the capacity to adapt to those stresses *(Ellison, J.C., 2012)*. Exposure refers to external factors that focus on character, magnitude and rate of change that a species or system will likely experience such as rate of relative sea level. Sensitivity generally refers to natural characteristics of a species or system and considers tolerance to changes in such factors as temperature, rainfall, humidity, seasonality or fire.

Adaptive capacity refers to the ability of a species or system to cope against climate change impacts with minimal disruption *(Ellison, J.C., 2012)*. Adaptive capacity can be through ecosystem or species response or human actions that reduce vulnerability to actual and/or expected changes in climate. Resilience is the ability to absorb and recover from the effects of disturbance, while resistance is the ability to withstand and continue to function. Therefore, adaptation includes actions to reduce vulnerability or enhance resilience.

APPROACHES USED FOR VULNERABILITY AND ADAPTATION ASSESSMENT

The Climate Change Unit under the Ministry of Foreign Affairs & International Cooperation played a major role in developing linked strategies to the recently launched National Climate Change Policy and coordination of adaptation activities across the sectors. Other key agencies include Ministry of Health, Ministry of Agriculture, Fiji Water Authority, Ministry of Works Transport & Public Utilities, Fiji Electricity Authority, Ministry of Local Government, Urban Development, Housing & Environment, Ministry of Regional Development, Ministry of I-Taukei Affairs, Ministry of Primary Industries (inclusive of agriculture, fisheries & forestry), Academia Institutions, Regional Environmental Organisations, Municipal councils, environment-based NGOs, charity foundations, development partners and private sector also contribute to the implementation of adaptation-linked initiatives.

On a regional level, the NCCAS supports the implementation of the Pacific Island Framework for Action on Climate Change 2006-2015 (PIFACC) and the Regional Framework for Disaster Risk Reduction and Disaster Management. On a national level, NCCAS supports the environmental and development principles of the Fiji Roadmap for Democracy and Sustainable Socio-Economic Development 2009-2014, aligned with the Initial National Communication, NBSAP and the National Action Plan under the UNCCD. On a sectoral and local level, the NCCAS supports the implementation of sector policies, strategies and action plans such as the Forestry Policy, the Rural Land Use Policy and Rural Water Policy. The overarching Climate Change Policy sets that platform for dialogue, collaboration among government agencies, stakeholders through organised planning, implementation of national and local climate change programmes. This Climate Change Policy defines objectives and accompanying strategies (i.e. NCCAS) to facilitate the mainstreaming of climate change issues into relevant sectors, supporting the provision of necessary technical and financial resources.

The scope of this national vulnerability assessment report is to provide updated information on the national climate circumstances. While the report will provide information on how climate variability and extreme weather events are impacting Fiji's economy with its ability to cope with them. The outcome of this national assessment provides basis to support the implementation of ongoing and future adaptation activities as well as to embody climate smart considerations in any sustainable development policy agenda. As decision makers in the various sectors grapple with information on climate change effects and how they may or may not impact their core mission(s), they are turning to existing tools and approaches for guidance. Three closely related approaches outline much of the considerations in preparation for future climate impacts: vulnerability assessment, climate risk assessment and adaptation assessment. Vulnerability assessment begins with the identification of existing stressors facing each of the different sectors and projects how climate change will impact and/or introduce new stressors in the future. The findings of the assessment can then be ranked to assess, prioritize and address vulnerabilities. Risk assessment evaluates the likelihood and consequence of climate-related impacts on each of the sectors.

In preparation of Fiji's NCCAS, key questions addressed and listed below:

- What impacts/vulnerability have been observed or experienced and what are the underlying drivers? (current vulnerability assessment);
- What are the impacts and vulnerability under projected climate and socio-economic conditions? (future vulnerability assessment);
- What are the adaptive responses to reduce vulnerability? (adaptation assessment);
- What are the implications for sustainable development? (Policy recommendations).

In order to address the above key questions, the main objective for SNC's Vulnerability and Adaptation (V&A) assessment from a national context was to identify the vulnerabilities for each identified vulnerable sector and highlight efforts on adaptive management strategies taken or actions proposed to reduce identified vulnerabilities.

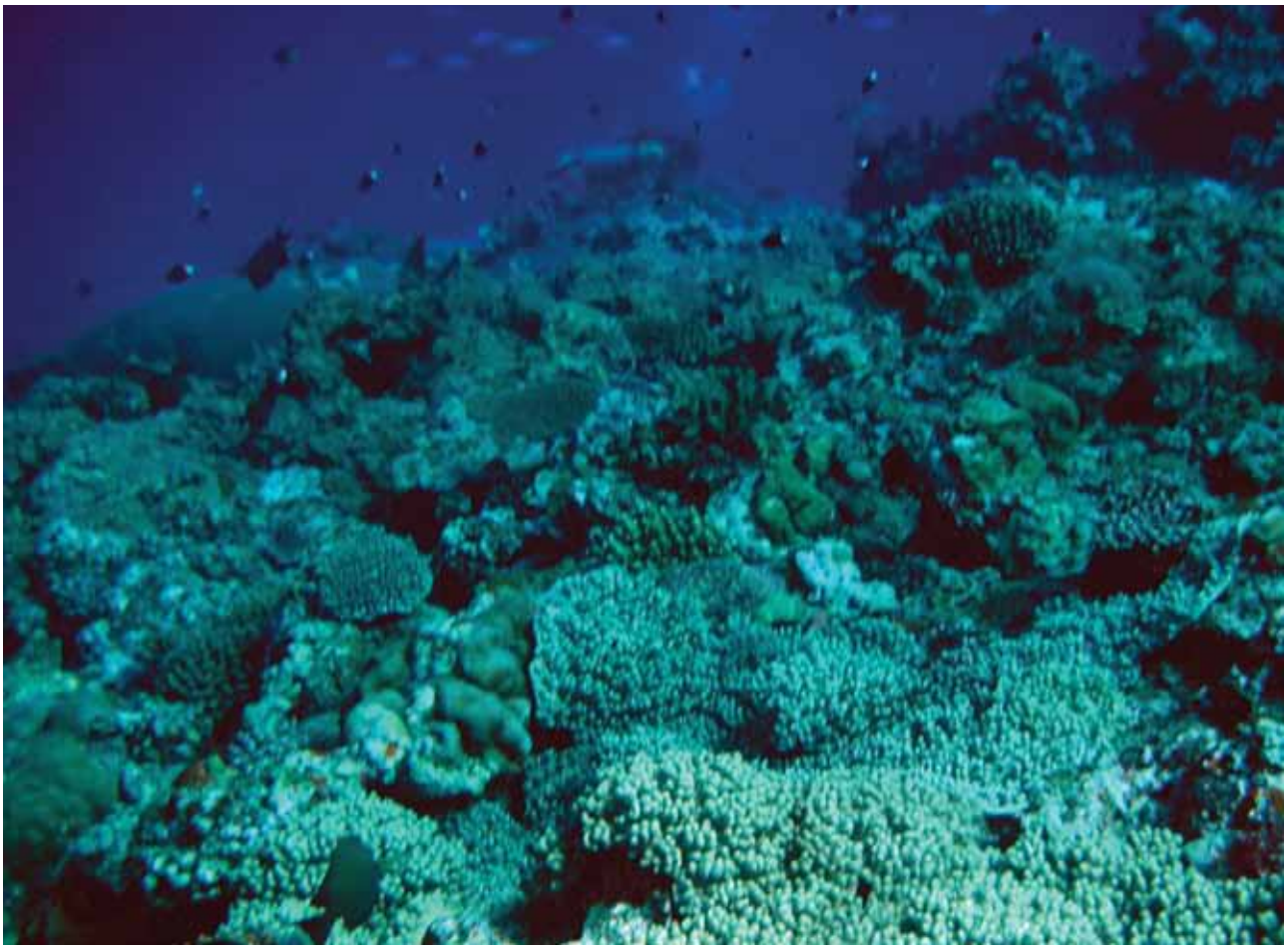
The following six principles for any vulnerability assessment *(Ellison, J.C., 2012)* were applied:

- Inter-disciplinary approach that includes the human-biophysical interactions.
- Participatory approach involving stakeholders to understand their perspectives and knowledge; engaging

local communities living in and in adjacent regions to the exposed area, to identify adaptation actions.

- Scale of the study area: consider the landscape or seascape units such as a delta. This scale ensures that exposure factors are fairly uniform within the study area.
- The global change drivers included should be recognized as multiple and interacting with socioeconomic development and land-use changes. Ultimately, all of these drivers interact with and affect processes within the human-environment system.
- In order to capture the region's ability to implement planned adaptation measures, the country should develop an adaptation index that will measure differential adaptive capacities[19]. Adaptation options may be constrained by inadequate resources or information or political and institutional barriers.
- Vulnerability assessments should be historical and forward-looking. Past biophysical and social records for a particular area can show resilience or changeability, which will assist in understanding vulnerability.

The VA follow IPCC, UNFCCC and community-based adaptation planning methodologies utilized and adapted by various institutions engaged in CCA activities in Fiji. Assessing future climate risks focus on the development of scenarios of future climate, vulnerability, socio-economic and environmental trends as a basis for considering future climate risks. A composition of information tools available, including a country risk profile with a simulation model of potential storms and earthquakes that could impact Fiji, SimCLIM customized version for use in Fiji with a local digital elevation model of the islands and its application on water resources and agriculture sector has yet to be tested and trialed.



[19] Metzger, et al. 2004. A multidisciplinary multi-scale framework for assessing vulnerability to global change. Milenium Ecosystem Assessment conference. 17-14 March 2004. Alexandria-Egypt.

CLIMATE CHANGE SCENARIOS

The climate trends presented in the following paragraphs used data records from eight high quality sites, dating from 1961 to 2012. The ocean data is used from Lautoka Tidal Gauge (South Pacific Sea Level and Climate Monitoring Project) that had been in operation since October 1992.

The annual and seasonal trends in air temperatures, rainfall, sea surface temperature, sea level and tropical cyclones are presented in this sub-section. Climate risk profile at selected sites are also presented as return periods of extreme rainfall, air temperature, sea level and surface winds for 2025, 2050, 2075 and 2100 time scales. Climate risks are based on the output of Global Climate Models and future emission scenarios based on average conditions and with the assumption of no change in variability in observed conditions. The climate risks are for grid square covering much of Viti Levu. This climate risk profile is reflective of the changes using seven sites across the country, thus available for planning, policy development and decision making and undertaking climate change adaptation and disaster risk reduction work.

Climate Variability

Climate of Fiji varies over different timescales and major features that drive our climate are:

- The El Niño Southern Oscillation (ENSO) phenomena (occurs every 2-7 years and 4 years on average),
- The South Pacific Convergence Zone, and
- The Trade winds.

ENSO phenomena, whose extremes are El Niño and La Niña events, are one of the most important drivers of inter-annual climate variations in Fiji. It has strong influence on rainfall, temperature, and tropical cyclone. Droughts are usually associated with El Niño events, whilst floods are associated with La Niña events. Other modes of variability are associated with Pacific Decadal Oscillation and Southern Angular Mode on 10 to 30 year timescales.

Seasonal Cycles

Fiji experiences a distinct wet season from November to April and a dry season from May to October. The seasonal cycle is strongly affected by the relative position of the South Pacific Convergence Zone (SPCZ), which is most intense during the wet season and close to the country. The Trade winds bring orographic rainfall to the eastern parts of the country. Approximately 70% of the national annual average rainfall is received in the wet season.

Climate Trends

Rainfall: Rainfall data for the last half century (52 years) show no significant change in the long term rainfall. The overall change over the last half century is about 7.3%. There is substantial variation in year to year rainfall (Figure 4.1) and these are usually associated with ENSO events. The observed annual and seasonal rainfall trends are as follows:

- There is a very weak positive linear trend in annual rainfall over Fiji. An annual increase of about 3.39mm/year (approximately 0.14%/year) is observed from 1961 to 2012 period;
- There is a weak decreasing linear trend in the wet season rainfall with a seasonal decrease of 0.87mm/season (approximately 0.05%/season);
- There is a weak increasing linear trend in dry season rainfall with a seasonal increase of about 1.57mm/season (approximately 0.21%/season).

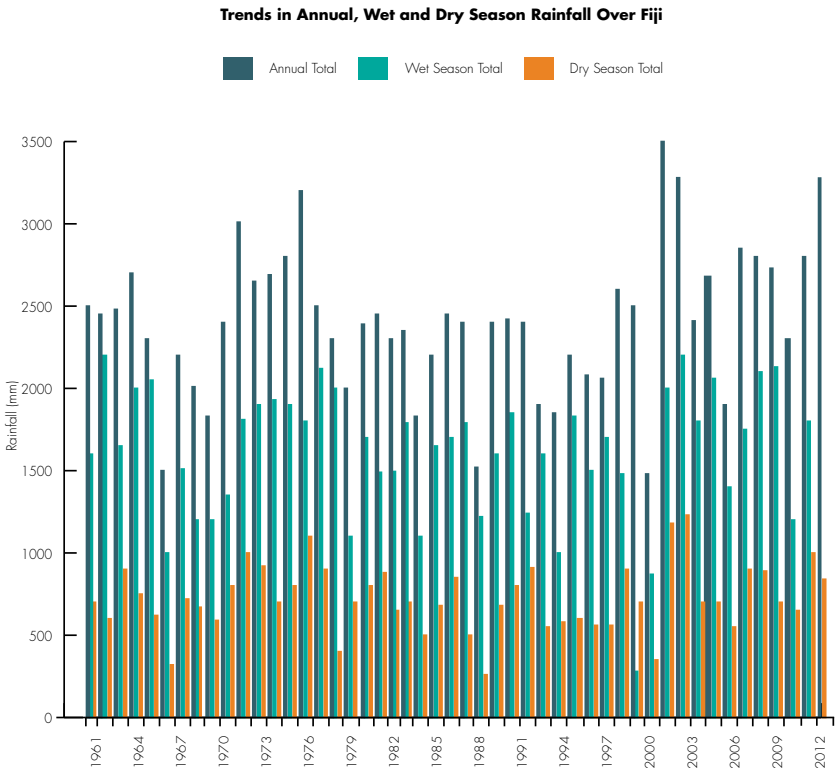


Figure 4.1: High inter-annual variation in annual and seasonal rainfall over Fiji.

Air Temperatures: Both the annual and seasonal maximum and minimum air temperatures over Fiji are increasing (Figure 4.2 and 4.3). The annual, warm and cool season minimum temperatures have increased at a rate of 0.12°C, 0.13°C and 0.11°C per decade, respectively. On the other hand, the annual, warm and cool season maximum air temperatures over the last 52 years have increased at a rate of 0.22°C, 0.23°C and 0.21°C per decade, respectively.

Mean Air temperature: Consistent with the global pattern of warming, the mean air temperature has warmed by 0.52°C (0.01°C/year or 0.1°C/decade) over the last half century. It is noted that the maximum temperatures have warmed at a faster rate than the minimum air temperatures over Fiji.

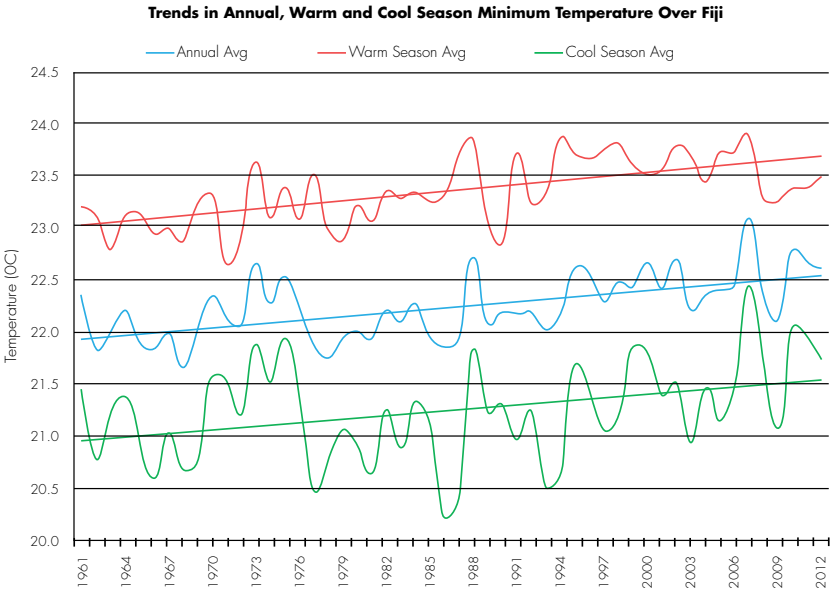


Figure 4.2: Inter-annual and seasonal variation in minimum temperature over Fiji

Minimum Temperature: The overall change in minimum air temperature is 0.62°C, over the 1961 to 2012 period.

- There is significant linear warming trend in annual minimum temperature that is consistent with global warming. The annual minimum temperature has increased by 0.012°C/year;
- There is significant increasing trend of 0.68°C (0.013°C/season) in the warm season for the same period;
- The cool season minimum air temperature has increased by 0.59°C (0.011°C/season) over the same period.

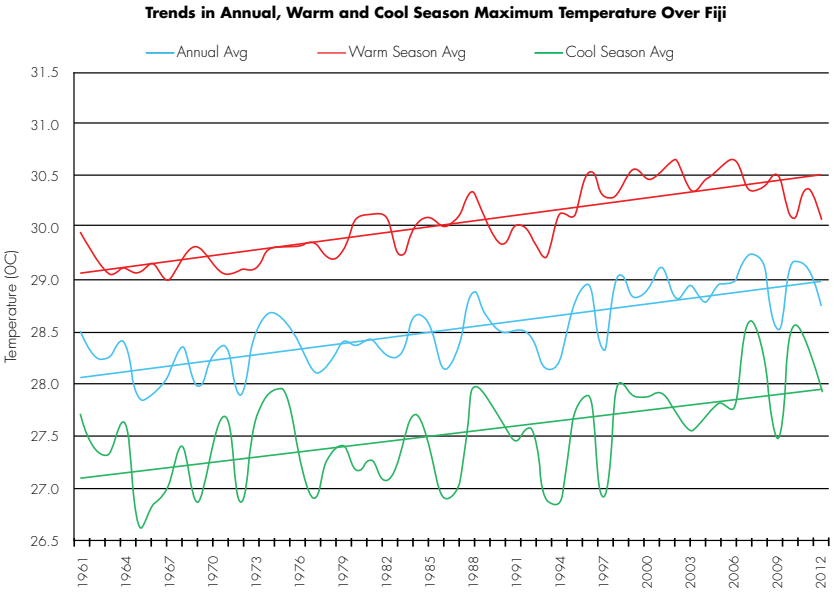


Figure 4.3: Inter-annual and seasonal variation in maximum temperature over Fiji.

Maximum Temperature: Significant warming trends are found in the maximum air temperature in Fiji over the last half century.

- The annual maximum air temperature has increased by 1.15°C (0.022°C/year) in the last 52 years;
- The warm season maximum air temperature has increased by 1.19°C (0.023°C/season) over 1961 to 2012 period;
- The cool season maximum air temperature has increased by 1.06°C (0.021°C/season) over the same period.

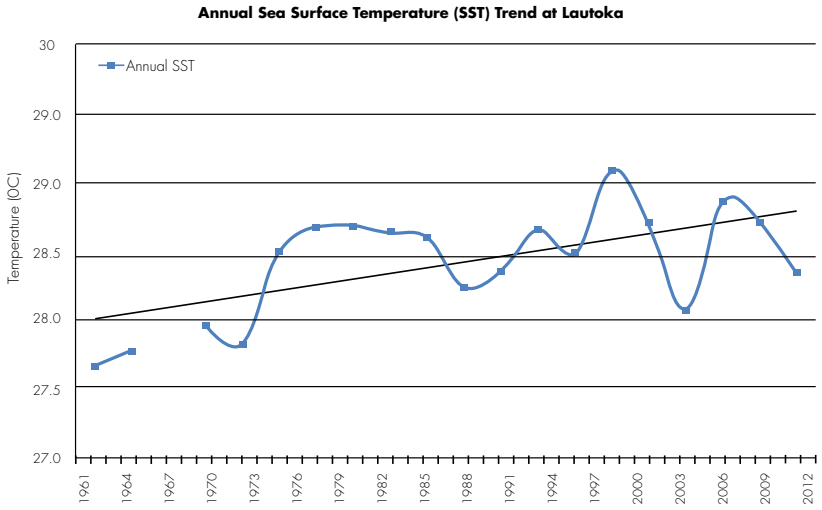


Figure 4.4: Annual sea surface temperature trends at Lautoka Tidal Gauge (Data Source: South Pacific Sea Level and Climate Monitoring Project).

Sea Surface Temperature: any conclusive long term trend for this parameter. However, with the available data, a linear increasing trend can be seen, matching a warming rate of 0.4°C/decade (Figure 4.4). Additionally, a periodic (2 to 5 years) cycle of warming and cooling, is observed. These variations in the annual SST are consistent with the existence of ENSO in the Pacific. Thus,

- The SST data from the Lautoka Tidal Gauge indicates a warming trend of 0.041°C/year over the 1993 to 2012 period.

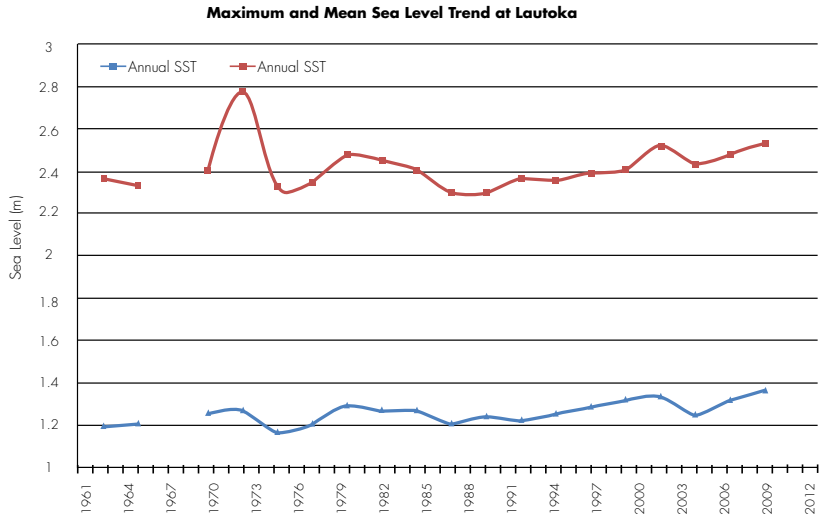


Figure 4.5: Trends in mean and maximum sea levels at Lautoka Tide Gauge (Data source: South Pacific Sea Level and Climate Monitoring Project).

Sea Levels: The mean monthly sea levels observed at the Lautoka Tidal Gauge show an increasing trend (after accounting for the precise levelling and inverted barometric pressure effect), at a rate of 60mm/decade, over the 1993 to 2012 period. However, given the brevity of the dataset, it is still too early to deduce any realistic long-term trend. It should be noted that the variations in the mean sea level include the influence of ENSO.

Tropical Cyclone: Tropical cyclones are one of the most severe extreme events that have affected Fiji on numerous occasions in the past four decades. They usually affect Fiji from November to April, noting tropical cyclones have also affected the country in May and October, as in the Tropical Cyclone Seasons of 1974/75, 1996/997, 1972/73 and 1997/98. On average, 1 to 2 cyclones affect some part of Fiji every season. There have been ten seasons (1971/72, 1975/76, 1976/77, 1993/94, 1994/95, 1995/96, 2005/06, 2008/09, 2010/11 and 2011/12) when Fiji was not directly affected by cyclones. In contrast, Fiji experienced five tropical cyclones during 1992/93 season and four in 1984/85 season (Figure 4.6). A decreasing trend in both the number of tropical cyclones and cyclones with hurricane intensity affecting Fiji has been observed in the last 4 decades.

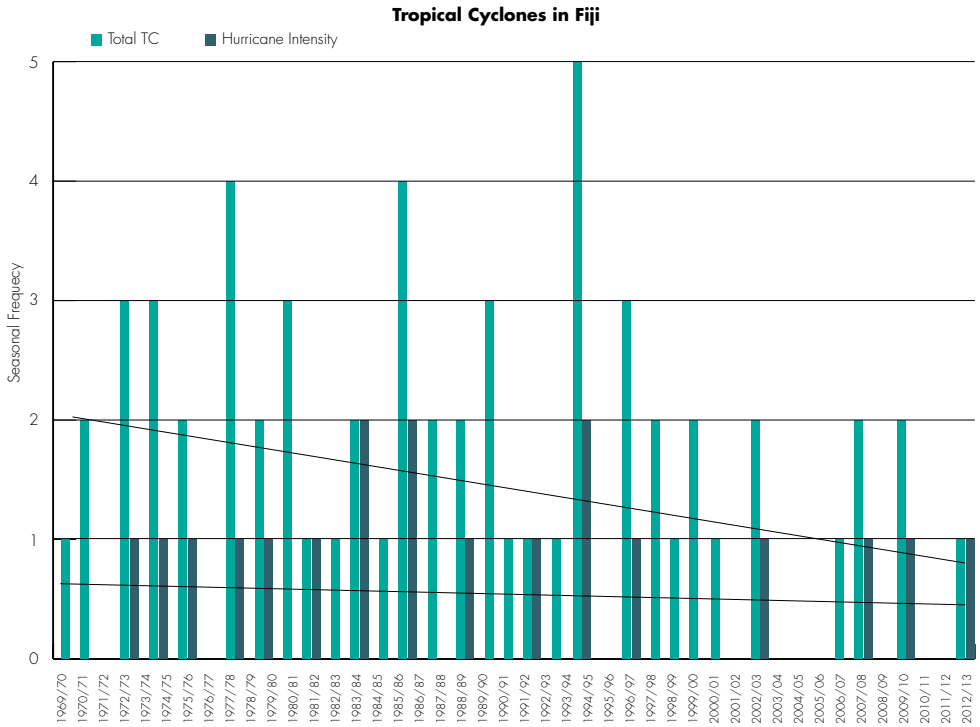


Figure 4.6: Seasonal frequency and hurricane intensity tropical cyclones affecting Fiji from 1969/70 to 2009/10 seasons.

Drought: Major meteorological droughts in Fiji have been associated with El Niño events. During moderate to strong events, the annual rainfall is reduced as much as 20% to 50% over most parts of the country as experienced during 1982/83, 1986/87, 1992/93 and 1997/98. The weak El Niño events do not have much influence on the country's total annual rainfall.

Floods: Flooding in Fiji is a common hydrological event. Large scale flooding is usually associated with prolonged, intense rainfall especially during the passage of tropical cyclone, tropical depression or enhanced, slow moving active convergence zone. Enhanced rainfall and localised flash flooding, in wet season, is very common during La Niña events.

Sea Flooding: Sea flooding is usually associated with the passage of tropical cyclones close to the coast. However, heavy swells, generated by deep depressions and/or intense high pressure systems some distance away from Fiji have caused flooding to low-lying coastal areas. At times heavy swells coincide with king tides to cause flooding and damage to coastal areas.

Climate Projections (Global Climate Models)

The most likely projected change for Fiji centered around 2030, is for warmer and little change in rainfall with annual mean temperature increases of 0.7°C and negligible (-1%) change in mean annual rainfall that is represented by 69% of the models. Warmer and drier change in projected climate are represented by 6% of the models with annual mean air temperature increases of 0.6°C and annual mean rainfall decreases of 6%. Warmer and wetter future conditions are represented by 13% of the models with annual mean air temperature increases of 0.8°C and annual mean rainfall increases of 7%.

Majority of the models (69%) continue to project warmer and little change in rainfall by 2055 with annual mean air temperature increases of 1.0°C and annual mean rainfall decreases of 1%. Moreover, warmer and wetter conditions are represented by 19% of the models with annual mean air temperature increases of 1.2°C and annual mean rainfall increases of 10%. Nine out of sixteen (50%) models represent a hotter and little change in rainfall by 2090 with annual mean air temperature increases of 1.9°C and annual mean rainfall decreases of 1%. The other likely high impact projected climate is for hotter and much drier conditions and this is represented by 6% of the models, with annual mean air temperature increases of 1.8°C and

annual mean rainfall decreases of 16%. Hotter and much wetter conditions are represented by two of the eighteen models with an annual mean air temperature increase of 2.3°C and annual mean rainfall increases of 21%.

The seal level projections was based from fourth IPCC report that global seal level changes are expected to be ranging from 0.21 to 0.48 meters by end of the century *(IPCC, 2007)*. There is significant uncertainty surrounding ice-sheet contributions to sea level rise and a larger rise than that projected cannot be excluded.

The projected change in climatic variables for Fiji under A1B emission scenario relative to 1981-2000 average for the 21st century is shown in Table 4.2. An ensemble of 16 models has been used for these projections.

Table 4.2: Projections for 20 year averages centered on 2030, 2055 and 2090 under A1B emission scenario (source: Fiji Meteorological Service, 2011)

Projections at intervals of 19 years from 2020 to 2099							
Variable	2020 - 2039		2045 - 2064		2080 - 2099		Confidence
	Best Guess	Likely Range	Best Guess	Likely Range	Best Guess	Likely Range	
Mean Air Temperature (°C)	0.7	0.4-0.9	1.0	0.7-1.5	1.9	1.3-2.6	Moderate
Maximum Air Temperature (°C)	0.7	0.4-0.7	1.0	0.7-1.3	2.0	1.2-2.2	Low
Maximum Air Temperature (°C)	0.7	0.4-0.7	1.0	0.7-1.3	2.0	1.2-2.2	Low
Mean Rainfall (%)	-0.5	-5.5-8.1	-1.0	-9.4-13.7	-1.2	-16.4 - 24.1	Moderate

Climate Risk Profile

Return Periods (Years) is used as a measure of the likelihood of an extreme event. It is a statistical estimate of how often an extreme event of a given magnitude is likely to be equalled or exceeded. This method is used to provide a climate risk associated with extreme events for Fiji.

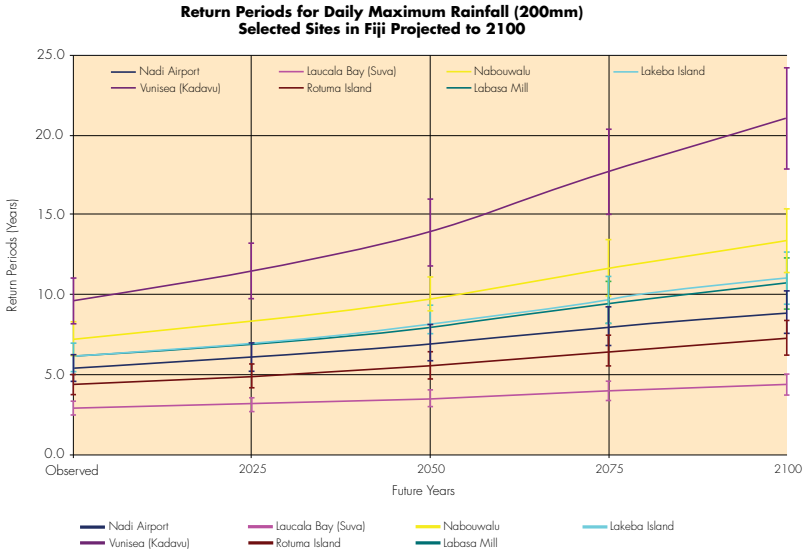


Figure 4.7: Projections for daily maximum rainfall of 200mm at various locations in Fiji.

The maximum daily rainfall of 200mm is projected to become less frequent by 2100 at various locations in Fiji.

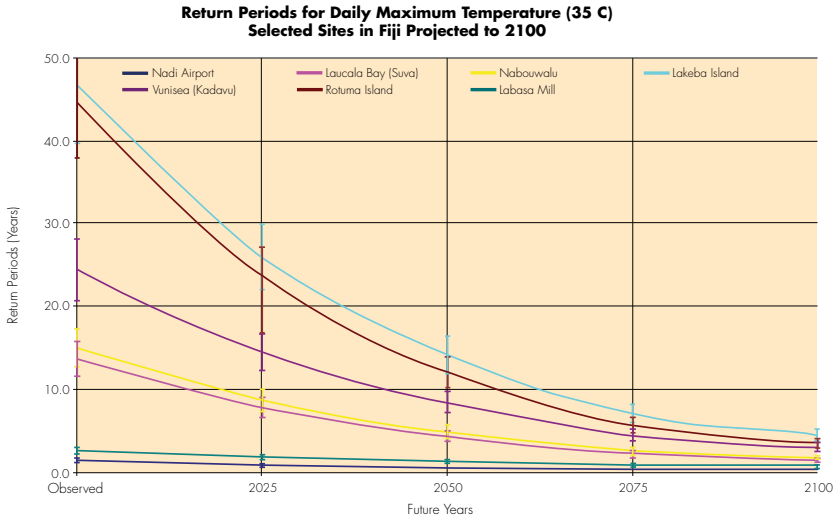


Figure 4.8: Projections for daily maximum temperature of 35°C at various locations in Fiji.

Maximum Temperature: The recurrence of the maximum temperature exceeding 35°C is expected to shorten in future and become a normal occurrence by 2100.

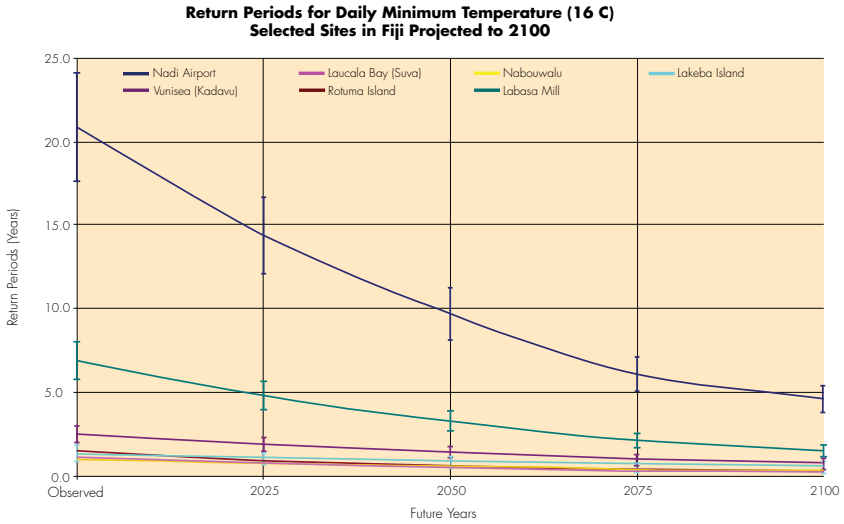


Figure 4.9: Projections for daily minimum temperature of 16˚C at various locations in Fiji.

Minimum Temperature: The return period of daily minimum temperature of 16°C at selected locations in Fiji is becoming more frequent than currently observed.

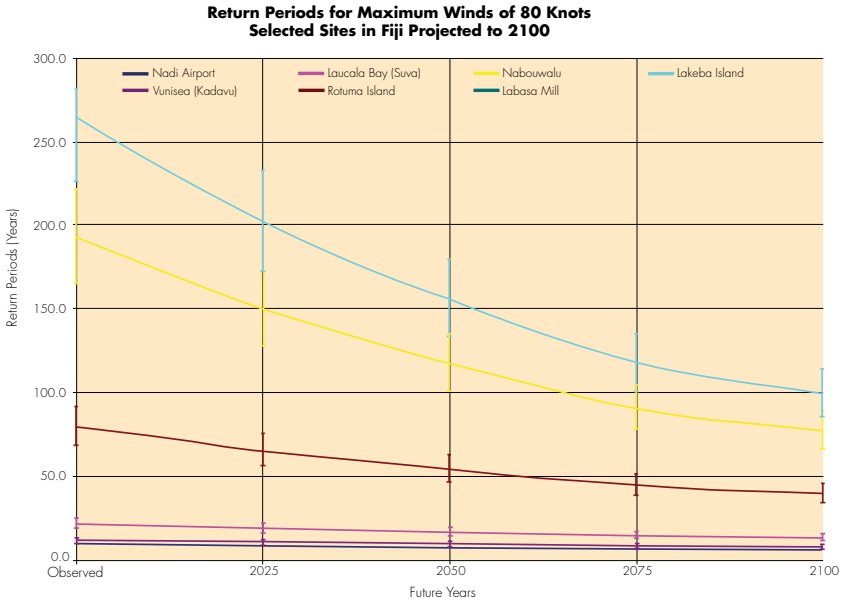


Figure 4.10: Climate risk of maximum wind of 80knots at various locations in Fiji.

Maximum Winds: Maximum winds exceeding 80knots at selected locations in Fiji are expected to become more frequent by 2100 than currently observed.

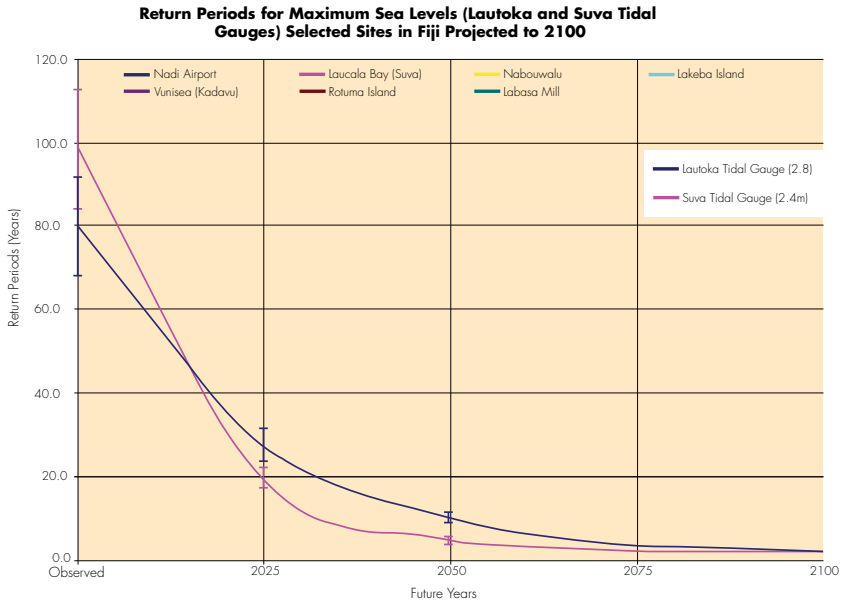


Figure 4.11: Climate risk of maximum sea level at various locations in Fiji.

Maximum Sea Levels: Maximum sea level currently observed at Lautoka and Suva Tidal Gauges are expected to become more frequent by at least by 2050 and become normal occurrence by 2100.

VULNERABILITIES AND ADVERSE EFFECTS IN SECTORS

The climate sensitive sectors considered in this assessment include 11 sectors with at least 7 having cross-cutting themes. These sectors play vital roles in the Fijian economy and contribute to livelihoods and general wellbeing of the entire country. In profiling the vulnerability of each of the sectors, statistics were provided on the level of contribution to the economy and pattern of growth or decline caused by risks of both market demand and in special circumstance of disaster events.

Agriculture

In Fiji, agriculture is organized more along commercial lines, although the subsistence sector remains important. Large-scale agriculture comprises mainly of coconut, sugarcane, and beef cattle, vegetable and root crop farming. According to Fiji's 2009 Agriculture Census result, the total number of farms in Fiji is 65,033. Majority of these farms (43.9%) have farm size of less than 1 ha, hence, mainly subsistence farmers.

According to Global Finance sources, the contribution of the agricultural sector to Fiji's GDP has declined marginally from 12.3% in 2001 to 10.5% in 2008 and further declined to 8.2% in 2010. The decline in performance then was the result of a combination of factors like minimal private investment into the sector, inadequate infrastructure, marketing deficiencies, soaring production cost and limited access to finance.

Current percentage contribution of agriculture to GDP is 9.4%. The value of non-sugar agriculture exports increased from $40m in 2006 to $50m by 2011 and value of food imports increased from

$438m in 2006 to $633m in 2010 (Fiji Bureau of Statistics, 2012).

In 2011 heavy rainfall period caused losses in the agricultural sector. The flood caused by the heavy rain in the Western division recorded a bill of damages amounting to $7.2million *(Min. Agriculture, October, 2011).*

Current agricultural practices in Fiji provide a level of resilience to the projected impacts of climate change such as diversification of traditional crop species resilient to flood, drought and saltwater or those resistant to disease spread; traditional agroforestry and integrated farming practices. Consequently, the productive capacity of the land can be assessed by sets of indicators which indicate that land degradation has taken place. According to UN/FAO definition, land degradation refers to land resources (soil, water, vegetation, climate and relief) changing for worse, either temporarily or permanent decline.

Climatic effects impacting the agricultural sector include:

- Seasonal changes in rainfall and temperature influencing agro-climatic conditions, altering growing seasons, planting and harvesting calendars, water availability, pest management, weed and disease populations. The projected impacts of climate change for agriculture include extended periods of drought and loss of soil fertility *(SPREP, date unknown; IPCC, 2007)*.
- Evapotranspiration, photosynthesis and biomass production is altered *(GTZ, 2010)*.
- Alteration of land conditions, suitability *(GTZ, 2010)*, due to salt water intrusion, coastal and river-bank erosion and exposure to salt water sprays and heat stress on soils.
- Increased CO_2 levels may lead to a positive growth response in a number of staples under controlled conditions, also known as the "carbon fertilization effect" *(GTZ, 2010)*.
- Reduced food security in terms of food production, food quality, nutritional availability, affordability and access.

Agricultural and land management practices in rural areas can also determine the rate and level of damage that will be exacerbated by detrimental effects of climate change. Changes in natural landscape for agricultural development cause a decline in regulatory ecosystem services, including those responsible for reducing community's exposure to floods (Millennium Ecosystem Assessment 2005).

Impacts on sugar production: Climate change impact assessment on sugar production was conducted as part of the preparation of the First National Communication Report for Fiji in 2005. Using the period from 1992 to 1999, when Fiji was subjected to two El Niño events and an unusually high number of tropical cyclones; as an analogue for future conditions under climate change it might be assumed that over the next 50 years (DoE/UNFCCC, 2005):

- 47% of the years will have the expected production of 4 million tonnes,
- -/+33% of the years will have half of the expected production,
- 20% of the years will have three-quarters of the expected production.

In addition to crop damage, flooding can also cause significant damage to mill operations and key transport infrastructure assets such as tramlines. In a review of the impacts of the 2009 floods on the sugar belt, the total economic cost of the floods on the growers' farms and non-farm costs, millers' costs, damage to

the cane access roads and other infrastructure was estimated to be about $24 million *(Flood Economic Survey in Lal et al, 2009)*.

Impacts on root crop production: Climate change impact assessments on root crop production were also conducted as part of the preparation of the First National Communication Report for Fiji in 2005. Current agricultural practices in Fiji have incorporated climate risk in its integrated farming practices. The planting of traditional crops such as swamp taro species, resilient to main climate risks such as flood, drought, and high soil salinity are examples of innovative research into past coping mechanisms regarding crop varieties, to safeguard food security issues and increasing market demand.

Using the PLANTGRO model, the following patterns were projected for taro (dalo) and yam production (INC, 2005):

- Projected changes in mean conditions would have little effect on dalo production, with the exception of the extreme low-rainfall scenario (using the DKRZ GCM), which would result in half of land area providing high yields. It is likely that yam production will remain unaffected, although if rainfall increases significantly, yam yields may fall slightly.
- When El Niño conditions are factored in, reductions in production of 30-40% might be recorded in one out of three years, with a further one in five years affected by the residual effects of the ENSO events.
- Using the same ENSO assumptions we find a converse response for yam production. In one out of three years, yam production might be expected to remain the same or increase. On the other hand, yields may decrease in around half of the remaining years, especially when La Niña conditions prevail.

Table 4.3a: Sector: Agriculture- Crop production

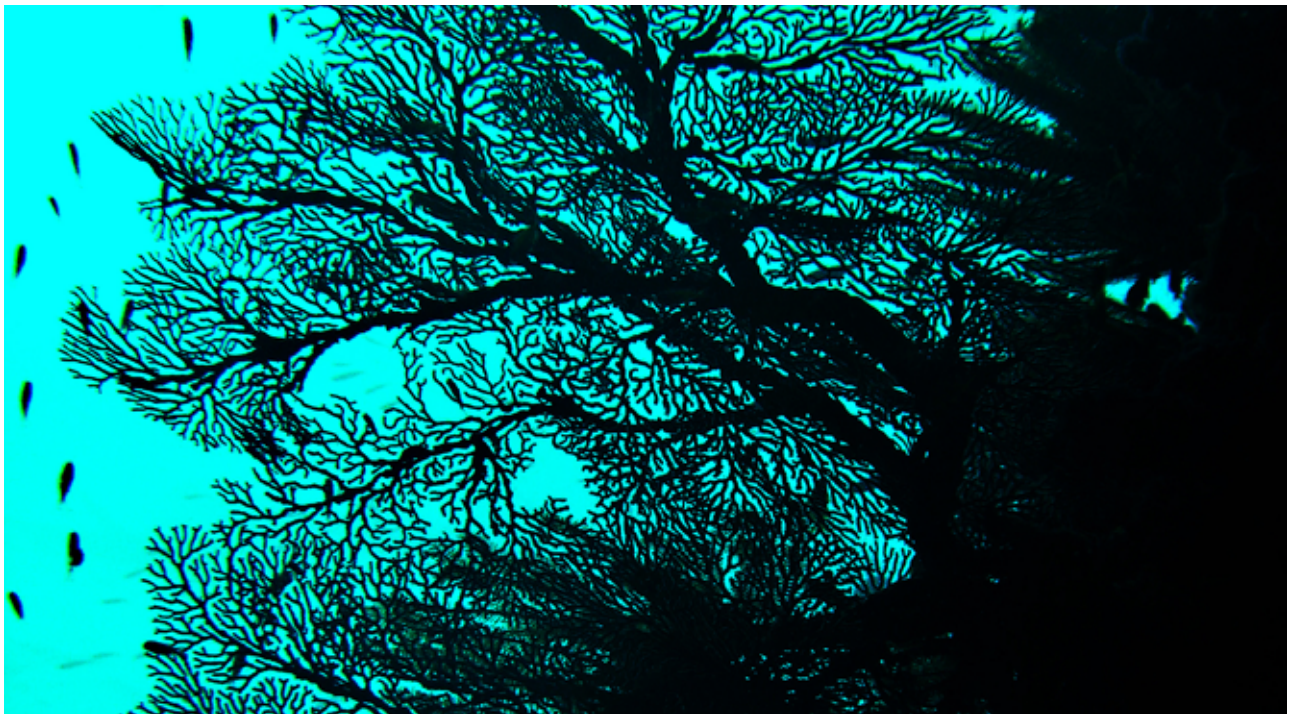
Climate Risk	Specific climate impacts	Sensitivity to climate change	Proposed adaptation measures
Droughts Increased temperature (heat)	• Reduced water availability and quality for agriculture • Increased evapotranspiration • Wind erosion of soil and soil nutrients causing loss of soil fertility • Altering growing seasons, planting and harvesting calendars • Increased risk of fires • Outbreaks and spread of invasive species • Increase in pest and disease incidences (introduction of new pests and diseases) • Altering plant respiration and photosynthesis • Plant stress; slow growth and low yields from food crops • Soil compaction • Additional risks on food security	• Agriculture–important economic sector especially for rural areas eg. Sugar, cash crops, vegetables & fruits • At least 50% of population depend on subsistence agriculture & live in rural areas • Small holder production (small farms) is predominantly on subsistence & cash crop • Small holders have limited financial resources • Lack of low-cost irrigation systems • Sugar industry is very susceptible to incidences of saltwater intrusion, drought, impact on harvests due to rain, reduced fertility, damage due to winds • Introduction of pests and diseases • Lack of adequate food storage and preservation measures in some rural areas	• Agricultural diversification (farming system approach) • Traditional multi-cropping methods • Traditional planting methods eg. Planting of vetiver grass for soil stabilization • Traditional food preservation methods eg. Fermented breadfruit, jam making • Increasing the number of small farm plots (involvement of rural dwellers) • Use of more tolerant and tested species and cultivars • Root crops like dalo and yams are naturally resistant to extreme events such as droughts • Sustainable and affordable management practices for traditional crop production • Use of legumes for soil enrichment. • Existent rapid propagation technologies eg. Tissue culture, cropping • Good drainage and irrigation systems in place (+ongoing rehabilitation)
Heavy rainfall/flooding High density of rainfall Prolonged rainfall	• Increase in pest and disease incidences (introduction of new pests and diseases) • Plant stress: slow growth and low yields from food crops.		

Climate Risk	Specific climate impacts	Sensitivity to climate change	Proposed adaptation measures
	• Damage to agricultural infrastructure (sugarcane mill, tramlines, etc) • Loss of soil fertility (due to soil erosion) • Crop loss (eg. Root crops rot) • Siltation of irrigation trenches (loss of drainage systems) • Increased fertility of lowland farms (due to siltation) • Research plots & gene-banks are destroyed • Pollution due to washing in of pesticides into soil • Additional risks on food security • High water saturation in soil in very short time (leading to flooding & landslides)	• Lack of water storage facilities (especially on the outer islands) for agriculture • Outlying islands sensitive to extreme events (lack of inter-island transport) • High water saturation in soil	• Hydroponics • Tree crops like breadfruit, chestnut
Cyclones & storms	• Flooding and salt water intrusion of agricultural lands in low lying areas • Increase in pest and disease incidences (introduction of new pests and diseases) • Plant stress; slow growth and low yields from food crops • Damage to home crops and gardens from salt spray (even inland crops are burnt) • Increased salinity of agricul tural lands • Disruption of crop transport systems	• Lack if alternative crops eg. Substitute for sugar, potatoes • Most of fertile land is located in floodplains subject to floods • Limited land availability for agriculture • Seasonal supplies of certain crops and vegetable • Lack of obtaining and sharing knowledge, information eg. on coconuts, apiculture, local climate history. • Importance of coconut as 'tree of life' especially for outer islands • Coastal protection structures are not sufficient for future sea level rise • Tidal gates are not appropriate for extreme rainfall events • Very specific localized events eg. strong rain in Nadi and no rain in Suva • Lack of awareness and enforcement of current policies eg. fire risk • Lack of capacity to identify and monitor climate impacts	• 'ivi' and bananas are naturally resistant to extreme events such as flooding • Widespread mangrove planning projects • Agroforestry • Tree planting • Ability and traditional knowledge of farmers on appropriate crops • Existing integrated watershed management projects (ecosystem based approach) • Widespread use and knowledge, practices of participatory approaches, tools • Existing policies (land use, forestry) • Existing research activities eg. on resistant varieties and regular testing of soil samples • Good weather forecast system (6 months, 3 months outlook) • Disaster awareness • Use of natural insecticides • Introduction of salt water resilient crop varieties • Relocation of crop farms from coastal areas to the inland with appropriate farming systems
Strong winds	• Wind damage to agricultural crops eg. Sugar, cassava • Additional risks on food security		
Salt water intrusion	• Damage to home crops and gardens close to the coastline & delta areas • Increased salinity of agricultural lands • Plant stress • Reduction of arable land • Additional risks on food security • Reduction of crop yields		
Soil erosion	• Loss of agricultural land and need for relocation to higher level eg. Coastal villages • Additional risks on food security • Coastal erosion • Inland erosion		

Table 4.3b: Sector: Agriculture- Livestock production

Climate Risk	Specific climate impacts	Sensitivity to climate change	Proposed adaptation measures
Droughts	• Lack of available water quality • Increased animal stress • Declining livestock health, production (eggs, meat, milk) and reproduction capacity. • Erosion of pasture land (loss of soil fertility) • Loss of animals and potential animal genetic resources • Reduction in vegetation (pasture reductions, decrease in animal feed) • Additional risks on food security • Increased fire risks to pastures and fodder plants • Heat stress for farmers thus reduced productivity	• Small scale farms are predominant • Farmers rely on streams for water supply • Pastures and farms are generally located along coasts of rivers. • Low nutritional value of pastures eg. for cattle • Overstocking of small scale livestock (poultry) • Lack of veterinary services • Outbreak of diseases • Lack of water during droughts • Rapid deterioration of products such as milk, meat • Stress on poultry • Lack of community awareness • Lack of proper planning and consultation between farmers, NGOs and MPI • Weak/sensitive infrastructure that is not cyclone proof • Lack of specific research activities to deal with climate change • Lack of and access to update date eg. agricultural census, vulnerability maps, soil erosion, flooding • Lack of documentation of existing farming systems • Weak design, standards and orientation of livestock infrastructure • Lack of water quality • Lack of accessibility and variability to weather forecasts and information eg. in the vernacular	• Use traditional animal medicine • Plant shade trees eg. grazing of cattle or pigs under coconut plantations • Traditional meat preservation methods in rural areas • Follow storm warnings to move animal herds to safe locations • Good seasonal weather forecasting by FMS to enable farmers to prepare and assist with their planning activities • Allow larger animals to roam free to find adequate shelter eg. from a cyclone • Avoid corrosive fencing materials • Install water harvesting/storage facilities and identify additional water sources during droughts • Utilize drought/temperature resilient livestock varieties • Plant flood resistant pasture grass and fodder species • Identify and utilize locally adapted feed stuff/ plants/ crops for stock feed • Good infrastructure and logistics to transport products such as milk and meat • Hygienic conditions of slaughter of animals for food security (commercial consumption) • Use of a variety of feeds • Selective breeding (breeds that withstand heat, wet conditions diseases etc) • On farm technology to process milk & improved refrigeration (meat for self-consumption) • Existing policies, research activities • Have in place an evacuation plan in case of emergencies • Locate livestock shelters away from flood prone areas • Establish elevated housing/ pens for animals (especially poultry) in flood prone areas • Identify best traditional livestock practices for possible adoption • Adopt environmental-friendly animal waste technologies to reduce risk of animal waste contamination (cont'd)
Increased temperature	• Loss of animals (poultry and pigs) • Animal stress • Animals become temperamental and difficult to handle • Declining livestock health • Reduced production (eggs, meat, milk) and reproduction capacity • Heat stress for farmers thus reduced productivity • Heat stress for machinery and equipment • Additional risks on food security • Increase of harmful bacteria and pathogens		
Heavy rainfall/ flooding	• Increased animal stress • Flooding of grazing areas/ pastures • Declining livestock health, production (eggs, meat) and reproduction capacity • Introduction of weeds • Erosion of pasture land (loss of soil fertility) • Destruction of livestock infrastructure eg. farm shelters, fences • Loss of animals and potential animal genetic resources • Increased diseases and pests incursions • Increased risk in animal waste contamination to water sources and public health risks		
Cyclones/ storms	• Increased animal stress • Destruction of livestock infrastructure eg. farm shelters, fences		

Climate Risk	Specific climate impacts	Sensitivity to climate change	Proposed adaptation measures
	• Increased salinity of pastures • Salt spray leading to corrosion of fences that need to be replaced or renewed leading to higher costs • Lack of drinking water • Destruction or damage to roads, bridges etc • Salinization of pastures (increasing costs of farm maintenance, rusting of equipment, fences, etc) • Additional risks on food security increases risk of animal waste contamination to water sources, pastures and public health risks		(cont'd) • Install cooling systems in commercial operations during high temperatures eg. sprays, fogging • Use of local available materials for infrastructure and feed • Establish and implement a database for monitoring • Utilize live fences for shade, feed and wind protection for animals.
Saltwater intrusion	• Lack of available water • Increased salinity of pastures • Destruction of livestock infrastructure eg. farm shelters, fences • Declined production • Reduced livestock feed • Additional risks on food security		
Coastal erosion	• Loss of grazing land/pastures and other arable land eg. for pigs • Additional risks on food security		



Sustainable Land Management

The Land Use Section of the LRPD of the Ministry of Primary Industry play a pivotal role in Fiji's commitment and collaborative adaptation approach to Fiji's vulnerability to climate change impacts. Sustainable land management activities fulfill national commitments to the three conventions of UNFCCC, UNCCD and UNCBD. For the past few years, the Land Use Section (LRPD Division, Department of Agriculture) have been carrying out land use assessments and surveys of all catchments with the aim of initiating sustainable land management (SLM) in the regions. Strategies adopted for these SLM-focused projects include biophysical survey, awareness and training on SLM, participatory land use planning and establishment of demonstration farms. Fiji has a Land care Steering Committee, chaired by the Permanent Secretary for the Ministry Of Agriculture with the main purpose of adopting the Land care initiative and setting up groups in the country. Mali and Dreketi (province of Macuata, Vanua Levu) LandCare Groups are the first at district level to be established in Fiji (2011) with components on forest restoration, river care, mangrove rehabilitation and protection, community waste management as well as addressing health issues. Such national initiatives on land care and SLM generate greater awareness and educate land users on better land use management with applied lessons for other important catchment areas in Fiji experiencing development problems, also exacerbated by extreme weather variability and climatic change.

Table 4.4: Sector: Land Management

Climate risk	Specific climate impacts	Sensitivity to climate change	Possible adaptation options
Droughts/ heat spells	• Soil erosion (loss of soil fertility) • Depletion of vegetation • Impact on water catchment areas • Inland mangrove areas are affected by heat	• Majority of economic activities along coastline • Infrastructure eg. roads, com munication lines often al located along coasts • Most tourist destinations and infrastructure is allocated along coasts • Lack of information eg. vulner ability maps • Farmers are not adopting SLM methods eg. cropping on steep and fragile soils • Lack of awareness on soil conservation and proper land use planning • Contradiction and confusion between sector policies and legislations eg. on maximum sloping threshold for agricul ture or forest management • Unsustainable forest manage ment on steep slopes • Lack of land care pro grammes by government and private sector • Lack of law enforcement • Lack of rehabilitation eg. forests leading to species invasion • Lack of building codes • Disputes on land boundaries • Increased demand for land (for residential, commercial or agricultural purposes) • Mining explorations and operations • Lack of upstream develop ment control	• Foreshore protection in some parts but at great costs • River diversion eg. Nadi river • Dredging • Awareness on CC impacts at local level eg. school curriculum • Best practices on SLM con tain adaptation activities eg. soil conservation measures • Existing land use planning • Agricultural diversification (farming system approach) • Traditional multi-cropping methods • Increasing the number of small farm plots (involvement of rural dwellers) • Sustainable and affordable management practices for traditional crop production • Use of legumes for soil enrichment • Agroforestry • Tree planting • Existing integrated watershed management projects (EBM approach) • Widespread use and knowledge and practices of participatory approaches and tools • Relocation • Existing policies (land use, forestry, etc.) • Existing research activities • Use of GIS/ remote sensing for VA and mapping
Heavy rainfall / flooding	• Damage to rural and urban infrastructure • Impact on economy • Impact on livelihoods • Soil erosion • Landslides • Siltation of river mouths and mangroves • Changes to land form (topography) • Pollution to the environment (eg. accumulation of waster) • Loss of land value		
Cyclones/ storms	• Damage of rural and urban infrastructure (especially in coastal zones) • Destruction of vegetation • Impact on economy • Impact on livelihoods • Soil erosion • Landslides • Siltation of river mouths and mangroves • Changes to land form (topography)		
Salt water intrusion	• Change of land use suitability and fertility • Spread of brackish estuarine systems • Loss of land value		

Climate risk	Specific climate impacts	Sensitivity to climate change	Possible adaptation options
Coastal, riverbed & delta erosion	• Loss of land • Loss of villages • Impact on livelihoods • Loss of some land use options • Increase of land boundary issues and disputes (new surveys are needed, involving high costs) • Loss of mangrove belts • Loss of traditional fishing grounds	• Human activities eg. boats cause riverbank erosion	

Freshwater

Water is an essential environmental resource for basic health and well- being of a country. Data on water-related Millennium Development Goals for Fiji highlighted that 72% of the population have access to improved sanitation facilities and yet 47% of that same population access some form of water source *(IWRM Report, SOPAC 2007)*.

Surface water is used as the main source of water supply for all major towns on the larger, higher islands as well as industrial and irrigation uses. A combination of surface water and groundwater is used to supply the smaller more rural settlements not supplied by the major water utility. Surface water availability is limited in many of the low lying inhabited small islands and some rely exclusively on groundwater. Rainwater harvesting using roof systems is widespread in Fiji and in most cases fail to account for the risk of extreme climate events and drought, thus providing small capacity storage instead of larger capacity. Groundwater occurs on both the large islands and small low-lying islands but the groundwater issues and challenges in these different physical environments differ. For instance, groundwater is found in superficial and medium-depth strata on the larger islands of Viti Levu and Vanua Levu, other large islands in either fractured rock and sedimentary formations. Significant groundwater deposits such as the Nadi Valley coastal aquifer on the large islands are available and under pressure for development. Groundwater resources on small islands play a different role. There are cases in Fiji, of islands having superficial groundwater lenses in sand-beds or coral formations, which lie on marine water and can be readily exhausted. The fragility of superficial groundwater lenses means that careful management is needed *(IWRM Report, SOPAC 2007)*.

Table 4.5 Water services in Fiji have been identified in the following sectoral areas:

Nature of water services	Responsible Agency
Urban water supply and sanitation	Water Authority of Fiji
Irrigation	Ministry of Agriculture
Major hydropower	Fiji Electricity Authority, the national commercial energy provider.
Rural water supply and sanitation	Water Authority of Fiji and managed by local communities (at village level) when constructed.
Urban drainage	Municipality
Flood control	Ministry of Agriculture but in limited areas.

There are no special coordinating arrangements to ensure that the development and use of water resources by sectors and agencies are consistent. No agency has the responsibility for ensuring such consistency. The EIA process under Town and Country Planning procedure, identifies environmental impacts with an ongoing mechanism to guarantee that such activities as water abstraction are consistent with environmental objectives that does not adversely affect the water resource available to others.

On the basis of projected climate change, water infrastructure in Fiji needs to improve its capacity to deal with extreme rainfall events, and long term water shortages. Assets will also need to be resilient to physical damage caused by extreme weather events and cyclones. Failure of the sewerage network during or after an extreme weather event will result in further impacts, including risks of diarrheal diseases and pollution of waterways.

The history of water infrastructure to cope with variability in water availability dates back to ancient times. Over time, this has developed into many water management options, such as dams and water reservoirs used for drinking water storage, flood control, hydropower generation or irrigation for cultivated land. This is done to maintain community activities and safeguard public health during extreme hydrological events *(Muller, 2007)*. There are three major water treatment plants on main island Viti Levu generating a daily capacity of between 60-100Ml *(WAF, 2013)*.

Water Authority of Fiji has 43 water treatment plants and facilities throughout the country providing piped water supply. The water supply includes utility managed supplies, community managed supplies at the rural areas and tap stands. These schemes often have capacity and management problems even without any climate change effects, but climate change could amplify these problems in the future. The degree and timeframe will vary but the sector is likely to face problems and there is a need to know more about how these problems can be addressed. An increased average rainfall scenario for Fiji have caused the piped water supply from a surface water source system during flooding situations to reduce water quality through ingress in distribution pipes of flood water or overflowing sewerage water. Another potential problem can be that groundwater levels rises in the future due to increased rainfall, subsequently leading to polluted water ingress. Increased rainfall intensity is also a potential threat to water distribution when it leads to high runoff levels, causing soil erosion and water quality problem for the treatment plan due to sedimentation transport *(Howard, et al., 2010)*. The main vulnerability regarding piped water would be water deficit with lower levels of rainfall. When the supply decreases due to water flows the often used intermittent management approach will result in low internal pressure in pipes followed by an increased risk of dirty surface water ingress *(Persson, 2009)*. Piped networks are dependent on energy for treatment and distribution of the water, thus can be a risk in areas where there is a shortage of electricity. Climate change effect could cause disruptions in energy supply with subsequently would lead to a water distribution problems. Gravity feed schemes would be more resilient to these risks *(Howard et al., 2010)*.

Fiji has experienced both drought and flooding. Flooding tends to affect local areas rather than major catchments and floodplains but the progressive removal of forest cover may cause flood peaking to become more extreme in the future (like in the two recent floods in the West of Viti Levu, 2012). The uncapped development in areas subject to relatively frequent flooding will continue to cause damage to property and the economy.

Table 4.6 below provides a summary of the main water sector vulnerabilities linked to observed and projected climate changes *(WRF, 2009)*. The inter-related nature of the impacts underlines the need to incorporate climate risk information within integrated resource planning and to maintain flexibility given under the uncertain climate projections *(IWRM, 2007)*.

Table 4.6 Summary of water-sector vulnerabilities to observed and projected climate change.

Issues	Observed and /or projected changes
Water demands for agriculture	Increasing temperatures raise evapotranspiration by plants, lower soil moisture alter growing seasons, and increase water demand.
Water supply infrastructure	Changes in water level may affect reservoir operations including flood control and storage as well as the functioning of diversion, storage and conveyance structures.
Legal water systems	Earlier runoff may complicate prior appropriation systems and water-source stewardship issues affecting rights holders which receive water and operational plans for reservoirs.
Water quality	Changes in water temperature, the hydrograph timing and shape may affect sediment loads and pollution impacting human health.
Energy demand and operating costs	Warmer air temperatures may place higher demands on hydropower reservoirs for peaking power.
Mountain habitats	Rising temperature and soil moisture changes may shift mountain habitats towards higher elevations.
Disturbance regimes	Changes in air, water and soil temperatures may affect the relationships between forests, surface and groundwater, wildfires and pests invasion. Water stressed trees eg. maybe more vulnerable to pests.
Riparian habitats and fisheries	Rising water temperatures could have direct and indirect effects on aquatic ecosystems, including the spread of in-stream non-native species and diseases to higher elevations and the potential for non-native plant species to invade riparian areas. Changes in stream flow peaks and timing may also affect riparian ecosystems.
Water-based recreation	Changes in reservoir storage can affect river recreation activities; changes in stream-flow volume and timing will continue to affect rafting directly. Changes in the character and timing of rainfall will continue to influence recreational activities and tourism.
Groundwater resources	Changes in long-term precipitation and soil moisture can affect groundwater recharge rates, coupled with demand issues, thus increase pressure on groundwater resources.

Wastewater infrastructure is similarly critical to maintaining the health of residents. To ensure continued health and safety of residents, sewerage infrastructure must be resilient to the projected increases in extreme weather events. Failure of the sewerage network during or after an extreme weather event may result in sewage overflows, which may increase the spread of diseases and infections and put fresh water and food sources at risk by polluting waterways.

Storm-water infrastructure is critical in times of heavy rain, flooding and storm surge. The capacity and speed with which the system can allow water to be removed from roads and properties has a significant impact on the level of damage, and the time of disruption to normal activities. Reduction of litter in Storm-water drains through improving waste collection and raising awareness of linkages between litter and Storm-water drainage capacity can improve maintain or improve the capacity of Storm-water drainage networks.

Table 4.7 Sector: Water – Assessing vulnerabilities to climate change

Climate risk	Specific climate impacts	Sensitivity to climate change	Possible adaptation options
Drought/Heat spells	• Increased water shortages (especially in remote small islands) • Declining water quality of groundwater and water in tanks causes skin diseases and other illnesses as well as undrinkable water • Surface water quality (eg. lagoon) and drainage (eg. urban areas) problems • Excess evapotranspiration • Reduce base flow runoff in rivers during dry seasons • Reduced depths of ground water tables and groundwa ter recharge rates (renewable groundwater resources) • Deterioration in the quality of freshwater bodies eg. by livestock	• Isolated and small communi ties already have insufficient water sources for sustainable supply (no surface water, only groundwater) • Increased water demand due to population growth and eco nomic sectors (tourism, mining, commercial sector) • Lack of adequate water storage and distribution infrastructure • Uncontrolled excavation from streams, rivers or groundwater bodies can lead to a siltation of reservoirs • Disruption of power supply to pumping stations (eg. during a cyclone) • In many areas freshwater is limited to small groundwater reserves and rainfall • Enhanced salt and sedimenta tion concentrations in water • Lack of financial resources for infrastructure maintenance • Lack of portable water (espe cially on small remote islands) • Pollution of freshwater sources by human activities eg. use of fertilized, chemicals, waste and sewage • No general and systematic water monitoring system in place • Lack of capacities and funds to conduct water monitoring activities • No water resource database of the quality, quantity and location of water resources in place • Lack of awareness of CC means people are not taking action to conserve water • Competition of water use • No water reuse (recycling) • Lack of water-saving measures eg. water saving appliances • Poor or inadequate water drain- age systems (open channel, pipes) • Corrosion of metal water pipelines • Lack of clear management re- sponsibilities and water resource ownership • Lack of existing regulations • No clear demarcation of wa ter catchment areas especially on village level.	• Existing rainwater harvesting systems in some communities and urban centres • Communities on larger islands have access to multiple water sources (groundwater, surface water, rainfall water) • Bottled water available in and around urban centres • Increased water recycling • Better metering and monitoring by WAF • Realistic price protocol • Regular monitoring of saltwater intrusion • Enhanced water conservation measures eg. leakage detection, education • Existing pilot projects for IWRM eg. Nadi Basin • Existing awareness • Existing water safety plans
heavy rainfall flooding	• contaminated water • damage to infrastructure includ- ing water • siltation • increased water treatment costs • increased impact on health eg. water borne diseases		
cyclones/ storms	• increased saltwater con tamination, especially in outer islands • damage to water infrastructure • disrupting water supply during a cyclone (often electricity fails so pumps stop) • contaminated water (eg. after a big storm) • spread of invasive species		• Increase awareness on water resource management at com- munities, urban centers and sub-national level. • Improve on water resource database knowledge manage- ment within the relevant water authority • Upgrade and improve water drainage systems (open chan nel, pipes) • Encourage water source management planning at com- munity, village and district level in consultation with Water and Sewerage Department. • Improve on tenure boundaries with iTaukei Department and Pro- vincial Offices in the demarca- tion of water catchment areas • Effective coordination of all activities at provincial level in synergy with national policies
saltwater intrusion	• increased salt water con tamination, especially in outer islands • intrusion of salt water into freshwater lenses, estuaries, coastal aquifers		

Management of the Coastal Zone

Fiji group of islands comprise 1,130km of coastline with an area of 31,000 sq. km of coastal and inshore waters. The urban centres and an estimated 690,000 people out of the 900,000 people live within 30km of the country's reefs which surrounds *(Burket et al. 2011)*. According to global projections, over 50% of Fiji's population live in urban areas and expected to increase to 70% by 2050 *(ICM Framework for Fiji, 2011)*. However, a significant proportion of Fiji's urban areas are poorly planned and serviced. Increasing trends of rural-urban drift coupled with expansion of informal settlements in low-lying coastal areas where sub-standard housing and sanitation practices have been causing threats to the health of Fiji's coast.

The 2005 EMA (Environment Management Act) is the most relevant legislative *framework for ICM and the development of a coastal management plan (2011)*. The EMA defined Fiji's coastal zone as the areas within 30metres inland from the high water mark that extend up to the fringing reef or if there is no fringing, within a reasonable distance from the high water mark.

The greatest impacts to Fiji's inshore environment flow from the myriad of land-based activities which occur up in the watershed and riverine systems. The national ICM Plan recognise the connection of the coastal zone with upland systems and the 'ridge to reef' principles of management.

Coastal erosion has become prevalent in many parts of Fiji over the past 50 years *(Mimura and Nunn 1998)*. Despite this knowledge, very little is known about rates of erosion and the effectiveness of activities in response to stabilise shoreline and beaches. A 1998 study quoted an annual loss of 21 million tons in the four major watersheds of Viti Levu- Rewa (9.3 million ton/year), Ba (6.4million ton/year), Sigatoka (1.1 million ton/year), Nadi (4.2 million ton/year) *(JICA, 1998)*. Several reports have documented the problem at a localised level, caused by natural processes as well as human activities *(Mimura and Nunn, 1998; Thaman et al. 2005; Tokalauvere 2007; Webb, 2007; Vanualailai, 2004)*. The southern coasts of most parts of Fiji are considered less stable due to prevailing wind direction which enhances wave and storm impact. The clearing of mangroves and coastal vegetation exacerbated coastal erosion, vital for protecting the coast *(Mimura and Nunn, 1998)*. Another common problem is people who build homes and villages too close to the shore or coastal bank, thus, causing high risk of exposure to the coastal changes which occur, be it natural or human induced. The continuation of large-scale tourism development and urban expansion, changes a landscape relatively quick over a short period, especially when mangroves are cleared for reclamation *(Ministry of Tourism, Fiji 2006)*. Relative sea level rise due to climatic change is expected to further increase difficulty of maintaining the integrity of the coastal zone. It becomes more pressing that domestic activities are managed so as to reduce human-induced damage to Fiji's coastal areas.

Table4.8. Sector: Coastal zone – Assessing vulnerability to climate change

Climate risk	Specific climate impacts	Sensitivity to climate change	Possible adaptation options
Water quality	• deterioration of water quality • increasing high temperatures causes algal blooms	• increased access to prime land along the coast • increased and unmanaged tourism development activities along the coast	• Strengthening monitoring systems of water quality of coastal waters adjacent to urban centers. • Awareness in settlement areas of low cost, low technology waste management schemes • Green waste and low- plastic management schemes adopted by town councils • Regular water quality monitoring of water-ways adjacent to industrial zones
Coral reef bleaching	• Increasing warm sea surface temperatures • Outbreaks and spread of invasive species • Coral health stress • Additional risk on fisheries food security	• Main source of protein diet and income for much of Fiji's rural coastal population • Health of associated coastal habitats such as seagrass and mangroves linked to health of coral reefs	• Sustainable fisheries management • Support for FLMMA network • Community-based monitoring of managed marine areas
Inundation & flooding	• Soil erosion • Impact on economy and livelihoods • Siltation of river mouths and mangroves • Loss of land value and pollution to the environment	• Developers not adhering to conditions of lease agreements • Majority of economic activities along coastline	• Foreshore & wetlands protection • Awareness on CC impacts at local level • Best practices on SLM eg. buffer measures along waterways
Beach erosion	• Loss of beach land & vegetation • Loss of habitat affects potential nesting beaches for turtles	• Lack of coastal littoral (strand) vegetation • Damage to beach property	• Use of GIS/remote sensing for VA and mapping change • Promote local knowledge use and practices of coastal plants eg. herbal, building materials • Replanting and restoration of coastal vegetation • Improve coordination between regulatory authorities
Saltwater intrusion	• Lack of available water • Increased salinity of backyard gardens • Loss of soil fertility • Impact on water wells	• Increased salt water contaminants • Intrusion of salt water into freshwater lenses, estuaries and coastal aquifers	• Encourage use of knowledge and practices of participatory approaches and tools • Relocation

Biodiversity/ Environmental Management

The observed and projected changes to climate and the potential impacts of climate change on Fiji's biodiversity has not been seriously considered except for recognizing ecosystems role in providing goods and services to communities. Some indigenous and rural communities are reliant on many of these goods and services for their livelihoods, that include food, fiber, fuel, medicines, clean water, flood/storm control, pollination, seed dispersal, pest and disease control, soil formation and maintenance, biodiversity, cultural, spiritual, aesthetic and recreational values *(WGII TAR Section 5.1)*.

The Government of Fiji has committed to protecting Fiji's biodiversity heritage through the enactment of Fiji's National Biodiversity Strategy and Action Plan (hereafter, FBSAP). The FBSAP was the result of a very extensive consultative process. It was completed in late 1999, endorsed by Cabinet in 2003 and published in 2007 (without any substantive change to the original document). There are seven thematic areas in the FBSAP: Coastal development (ICMC), Invasive Alien Species (FIST), Forest Conversion (Department of Forestry and linkages to the REDD+ Policy), Inland Waters (Wetlands Steering Committee), Inshore Fisheries (FLMMA), Species Conserva-

tion (CITES), Protected Areas Committee (PAC).

The conservation priorities for protected areas identified in the FBSAP were based on a synthesis of existing conservation analyses and working group consultations of biodiversity specialists. The FBSAP identified Protected Areas as a core component of the overall plan and included it as one of the five Focus Areas of the Plan. It also identified a suite of Priority Protected Areas which included all those from the NES and added a few more as well as some marine sites.

Table 4.9: NBSAP protected area location

FBSAP – Priority Protected Area Locations	
Land Areas	
Island	Location
Viti Levu	Tomaniivi National Park (Tomaniivi N.R. + Wabu).
	Sovi Basin
	Monosavu-Nadrau Plateau
	Koroyanitu
Vanua Levu	Tunuloa Silktail Reserve
	Vunivia
	Waisali
Taveuni	Taveuni Conservation Area. (Taveuni F.R. + Ravilevu N.R.+ Bouma-Lavena Forest Park)

FBSAP – Priority Protected Area Locations	
Marine Areas	
Island	Location
Kadavu	Great Astrolabe Lagoon
Nadi Bay	Tai I., Levuka I., Vomo I., Vomo Sewa I. – fringing and offshore reef areas
Taveuni	Taveuni Conservation Area. (Taveuni F.R. + Ravilevu N.R.+ Bouma-Lavena Forest Park)
Namenalala	Fringing & Barrier Reefs
Yadua Taba	Fringing Reef and surrounding waters
Lau Group	To be determined

FBSAP – Priority Protected Area Locations	
Mangrove Areas	
Ba Delta	Nawaqarua - Natutu
Rewa Delta	Muanicake-Nasoata R.
Labasa Delta	Labasa R.; Labasa Delta Mouth

The Fiji National Protected Area Committee (PAC) was established in 2008 under section 8(2) of Fiji's Environment Management Act 2005 as a technical advisory arm to the National Environmental Council (NEC) and currently chaired by the National Trust of Fiji. The main goal of the PAC is to advance Fiji's commitments under the Convention on Biological Diversity (CBD), as ratified by the Fiji Government in 2001 with specific functions to advise the NEC on protected area policies and priorities; support the establishment of an adequate and representative national protected area system; facilitate consensus on national priority areas for conservation; identify gaps in the existing protected area system; identify actions for the establishment and effective management of protected areas; source options for sustainable financing of protected area management; and facilitate the exchange of information and data among stakeholders.

Olson et al (in press) provides the most comprehensive synthesis of Fiji's terrestrial biodiversity significance and argues its status as a global conservation priority. This stems from Fiji's unusual biogeographic history which has imparted an

exceptionally diverse terrestrial biota characterized by pronounced endemism at the level of species and higher taxa, and the presence of numerous basal and primitive lineages, unusual radiations, and Gondwanan elements *(refer Ash & Vodonivalu 1989; Davis et al. 1996; Evenhuis & Bickel 2006; GoF 2003; Heads 2006; Hall 2003; Hollingsworth 2004; Jenkins 2006; Kroenke 1998; Kretschmar 2000; Olson and Dinerstein 2002; Masibalavu and Dutson 2006; Watling 2005 amongst others)*.

Fiji also offers one of the few opportunities in the South Pacific to conserve forest wilderness – nearly 40% of its forest remains intact, and some islands such as Taveuni, still have large expanses of forest covering the mountaintops to the coast. However, it is a biota at risk with many species threatened with extinction. The extreme vulnerability of island ecosystems and species to impacts such as habitat destruction and invasive species has resulted in the flora and fauna of Fiji and other Pacific island archipelagos being amongst the most endangered in the world. This is well known for conspicuous groups such as birds, but is even more serious for many groups of invertebrates and plants. Currently 90 species are documented in the IUCN Red List as globally threatened. While useful for vertebrates, the list is woefully incomplete for plants and invertebrates. Habitat loss and degradation is increasing, while predation and competition by invasive species are widespread and serious. These are compounded by a poor state of knowledge and ineffective conservation management.

In addition to its intrinsic conservation values, Fiji's terrestrial and marine biodiversity underpins Fiji's current and future development options by providing a range of environmental services and products. For example, its forested watersheds play a critical role in protecting Fiji's water resources and renewable energy in the case of Monasavu, and both water resources and renewable energy in the case of Vaturu. Its coastal and marine biodiversity provides food security, shoreline protection in the case of mangrove ecosystems, and subsistence and commercial income. At the national level, marine ecosystems support large-scale fisheries that contribute millions of dollars to GDP. Both terrestrial and marine ecosystems, if properly conserved[20] and managed, can provide a basis for adaptation to climate change by protecting water and soil resources, stabilising coastal areas and maintaining marine ecological diversity that will be essential to subsistence fisheries and food security.

The first national forest inventory *(Berry & Howard 1973)* identified nearly 30% of the forest resource as 'Protection Forest', a management designation comprising mostly rugged, upland areas where logging was not permitted. Most of these areas were carried through in the subsequent national forest inventory (1992) and identified as 'Preserved Forest', again where no logging was permitted, though this has proved difficult for the Dept. of Forestry to enforce. The current national forest inventory is planning to revert to designating 'Protection Forest' areas, similar to those identified in 1973.

In 1972 a UNDP/World Bank Tourism study recommended eight protected forest areas. Eight years later the National Trust for Fiji and WWF produced a landmark report detailing a proposed system of national parks and reserves along with information on how to establish develop and manage them *(Dunlap & Singh 1980)*. The report provided definitions for protected areas, guidelines for prioritizing them and made recommendations for sites based on ecological and heritage values. A total of 88 terrestrial and marine sites were identified in seven planning regions. The report promoted 'eco-development' for Fiji and provided a Draft Act for the establishment of national parks and reserves. None of the recommendations have ever been fully implemented. In the mid1970s the Namenalala island reserve was established – a landmark NLTB-brokered lease for a combination of resort development (restricted to 6 acres) and conservation (the remaining 50 acres of the island). This was followed in 1980 by an informal agreement with the landowners for sanctuary status for Yadua Taba Island. 24 years later, the island was formally leased from the landowners to the National Trust as a protected area.

The J H Garrick Memorial Park, comprising of 426 ha of lowland forest on freehold land in the Deuba-Namosi area, was donated to the State in 1983 and is now managed by the National Trust. In 1988, the Native Lands Trust Board (NLTB) supported the first serious ecosystem-based study for forest conservation areas, nominating 15 sites for protection *(Maruia Society 1989)*. Three of these sites have been set aside from logging, including – importantly – Sovi Basin, but management of the other sites is unchanged. Logging has taken place in several of the recommended conservation areas. In the same year, Cabinet passed a Decree for the establishment of the Sigatoka Sand Dunes National Park.

[20] 'Conservation' in the context of 'wise use'.

Four years after this study, the 1992 State of Environment Report noted that although neighbouring Pacific nations had internationally recognised protected areas, Fiji had none: '*Unless a system …… is set up quickly valuable aspects of Fijian heritage, both natural and cultural, will be lost.*' The report noted that:

- Protection forests (a Forestry Dept. classification with no legal standing) had no long term security for conservation
- Forest and Nature Reserves are under departmental and not national authority with inadequate legislation and institutional support to resist political or social pressure.
- De-reservation of Forest Reserves had increased in recent years.
- Because of the land ownership system and lack of economic returns to landowners, current reserves had no long term security.
- Planning and limited attempts at implementation of reserves had been made by at least four institutions with inadequate objectives and co-ordination.
- With inaction Fiji risks the danger of picking up pieces that are left – without any basis of ecological or heritage values.

In the 15 years since the NES, several forest areas have been reserved either through formal leasing arrangements with landowners or through informal agreements. Notable among these are Waisali – established through a formal lease in 1996; and the 'Heritage Parks' of Bouma and Abaca, the former established as a result of an MoU between the landowners, NLTB, DoF and the New Zealand Government. These latter two areas were the key products of a push from NLTB to establish community-based ecotourism projects associated with forest conservation. They have attracted significant donor funds and Abaca was one of the regional sites of the GEF-Supported South Pacific Biodiversity Conservation Programme.

Significantly, the 20,000-hectare Sovi Basin is now well on the way to reserve status with an associated trust fund for landowners. Equally significant has been the establishment of over 200 locally managed marine areas (FLMMA). The Navua Gorge Conservation Area is a privately managed protected area of a Site of National Significance, leased by the NLTB on behalf of the landowners. It was subsequently nominated and listed as Fiji's first Ramsar site, as a wetland of international significance. The Department of Water and Sewerage and the Fiji Electricity Authority hold reserves, leased from their landowners, for water catchment protection purposes in areas that are also of ecological significance. Amongst these are some of great ecological significance for example: Vaturu, Monasavu and Savura.

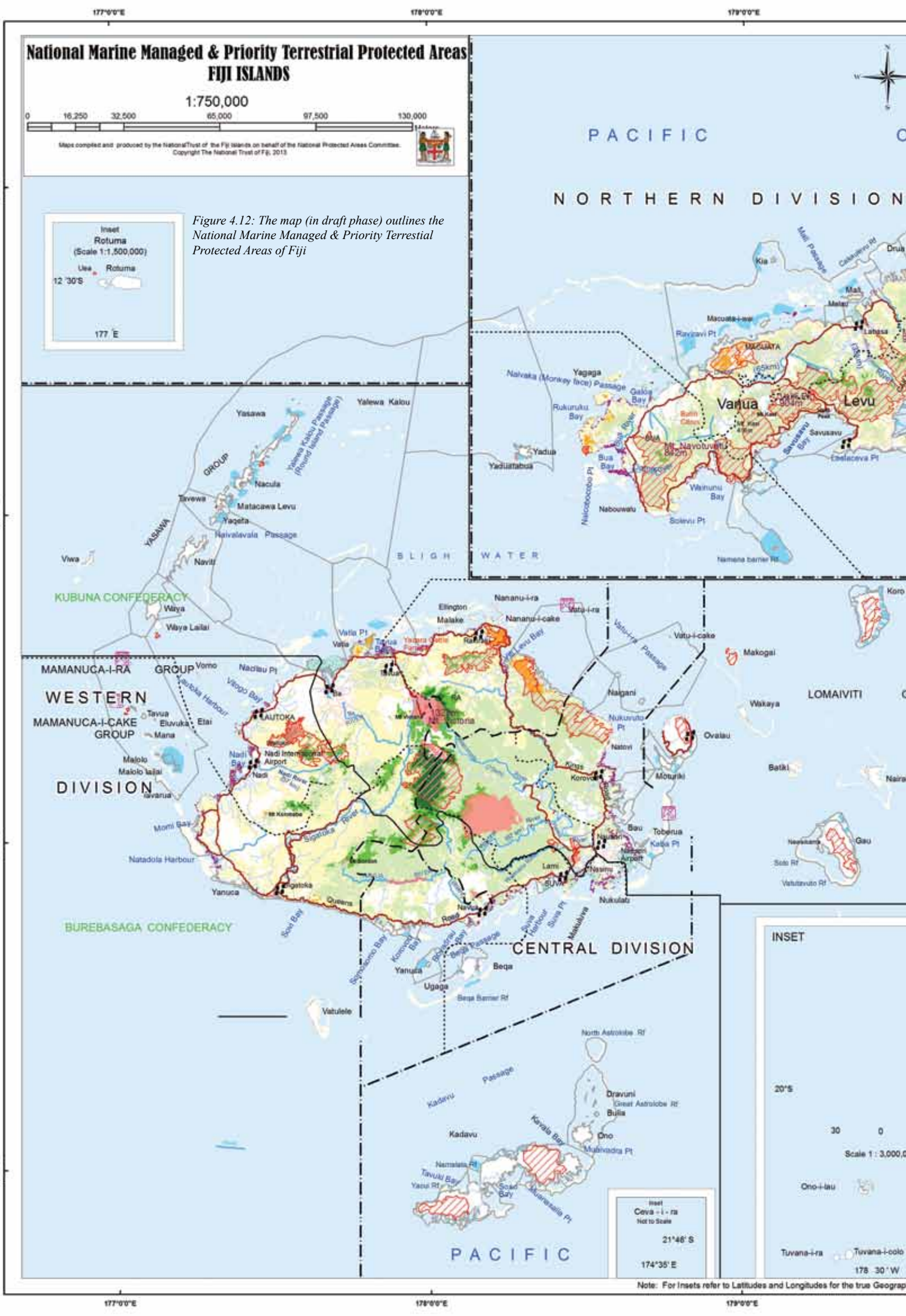
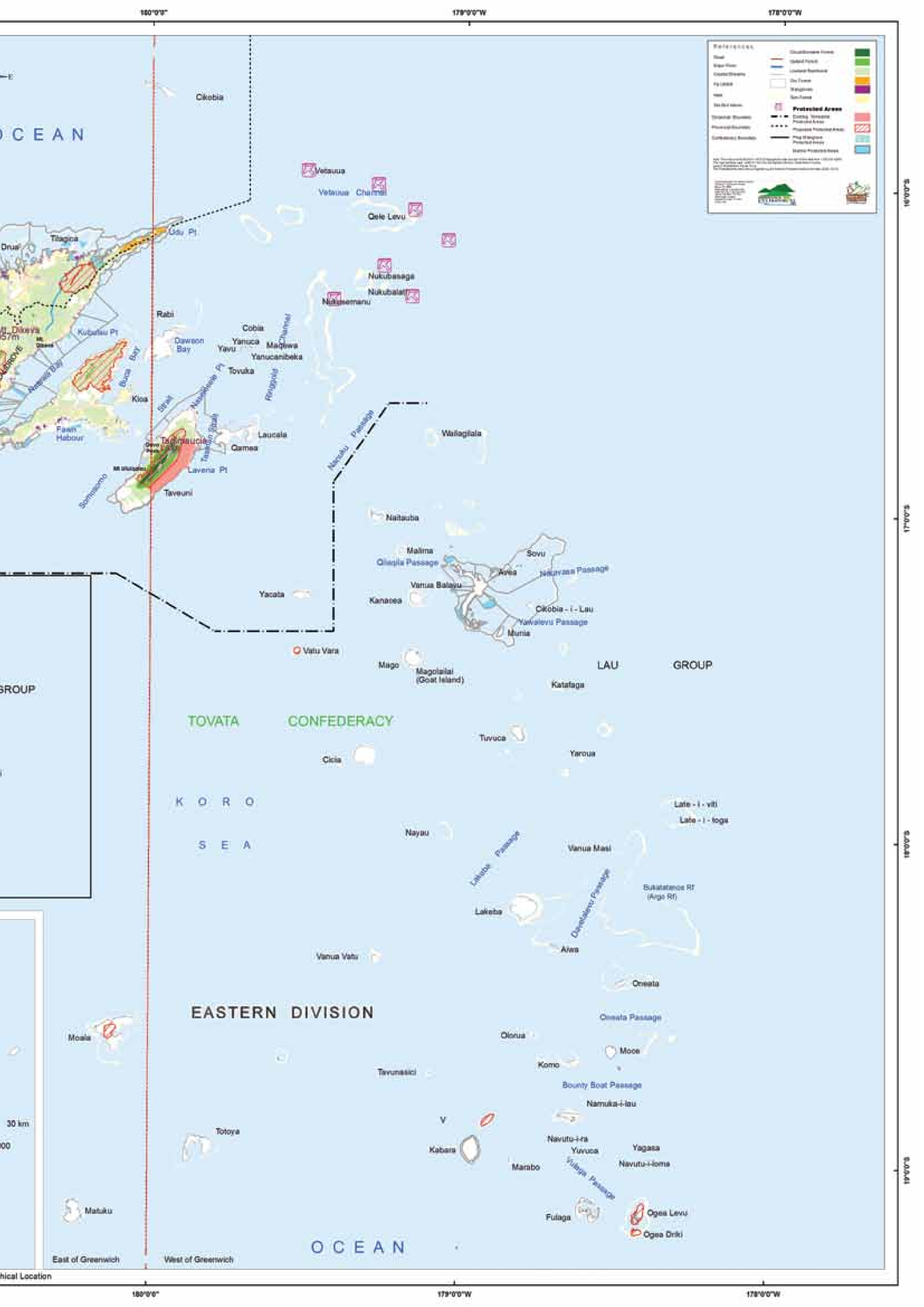


Figure 4.12: The map (in draft phase) outlines the National Marine Managed & Priority Terrestial Protected Areas of Fiji



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Tilagica
Drua
Rabi
Kubulau Pt
Dawson Bay
Cobia
Yanuca
Yavu
Maqewa
Yanucanibeka
Tovuka
Channel
Ringgold
Buca Bay
Kioa
Strait
Fawn Habour
Taveuni
Laveria Pt
Qamea
Laucala
Somosomo
Tasman Strait
Wailagilala
Nanuku Passage
Naitauba
Malima
Qilaqila Passage
Sovu
Avea
Vanua Balavu
Nasavusa Passage
Kanacea
Cikobia - i - Lau
Yacata
Yawalevu Passage
Munia
Vatu Vara
Mago
Magolailai (Goat Island)
LAU GROUP
Katafaga
GROUP
TOVATA CONFEDERACY
Tuvuca
Cicia
Yaroua
K O R O
S E A
Lafe - i - viti
Lafe - i - toga
Nayau
Vanua Masi
Lakeba Passage
Bukatatanoa Rf (Argo Rf)
Lakeba
Davetalevu Passage
Aiwa
Vanua Vatu
Oneata
EASTERN DIVISION
Oneata Passage
Moala
Oloruá
Moce
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Tavunasici
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V
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Kabara
Navutu-i-ra
Yuvuca
Yagasa
Marabo
Navutu-i-loma
Fulaga Passage
Matuku
Fulaga
Ogea Levu
Ogea Driki
OCEAN
East of Greenwich
West of Greenwich
hical Location

Table 4.10: Sector: Environment/ Biodiversity

Climate risk	Specific climate impacts	Sensitivity to climate change	Possible adaptation options
Droughts/ heat spells	• increased risk of fires that destroy habitats • shifts in latitudinal and altitudinal distributions of flora and fauna; shifting habitats/ boundaries of pollinators and seed dispersers (forest insects, birds and other species) • decreased food sources for animals especially for fish and eels • plants and animal stress, negatively impacting on health, production and reproductive capacity • significant risk of insect extinction (tropical insects are relatively sensitive to temperature change and are currently living very close to their physiologically optimum temperature • outbreaks of invasive species	• lack of awareness on environmental issues • lack of means and incentives to protect biodiversity (especially in remote areas) • lack of enforcement of environmental legislation • unclear responsibilities and limited human resources to manage environmental issues especially between urban and rural areas • increased use of pollutants (insecticides, pesticides, herbicides) • changes on flowering patterns • extraction of coral, sand and gravel for construction purposes • destruction of breeding grounds for animals (birds, turtles, etc.) • some plant and animal species are intolerant to moisture	• Existing nature reserves eg. PAC initiatives • promotion of ecotourism as a driving force for environmen tal protection and biodiversity conservation • delineation of buffer and re habilitation zones • relocation of endangered species • existing plant resource data base especially for crops • existing EIA • existing integrated develop ment framework • existing litter decree
Heavy rainfall / flooding	• plant and animal stress, negatively impacting on health, production and repro ductive capacity • increase in invasive species • species extinction		
Cyclones / storms	• plant and animal stress, negatively impacting on health, production and repro ductive capacity • waste accumulation by tropi cal cyclones (both organic and inorganic eg. building waste) • spread of invasive species • species extinction		
Saltwater intrusion	• plant and animal stress, negatively impacting on health, production and repro ductive capacity • species extinction		
Coastal erosion	• risk coastal animal and plant extinction due to diminish ment or disappearance of the aerial extent of habitats		

Human health and vulnerability to climate change

Climate change negatively impacts the basic determinants of human health- clean air, safe and sufficient water, food and shelter. Direct impacts of climate change on health include injury, disease and death from extreme heat and cold, cyclones, floods and droughts. Indirect impacts include increases in vector-borne, water-borne, cardiovascular, respiratory and renal diseases and psychosocial impacts from increase in the range and number of disease spreading vectors, compromised food and water sources, livelihood losses and population displacement. Fiji is especially vulnerable to adverse health impacts of climate change, due to its small size geographical size, exposure to extreme climate events and a small economy that depends largely on natural resources.

This subsection demonstrates the impacts of climate variables, like temperature and rainfall and extreme events on human health in Fiji and lists some adaptation measures that need to be implemented. There are clear links between climate and communicable diseases (CDs or infectious diseases) like dengue and typhoid fevers, leptospirosis and diarrhoeal illnesses and between extreme climate events like floods and droughts and malnutrition. Anecdotal evidence from health practitioners also suggests a link with non-communicable diseases (NCDs), particularly those related to nutritional deficiencies. While further research is required to identify the true burden of climate-attributable health risks in Fiji, enough evidence exists globally to underscore adaptation and mitigation in the health and related sectors (in particular, energy, transport, water, housing and agriculture).

Key Health Indicators for Fiji

In recent years, Fiji's population (868,000 in 2011) has increased at a rate of 1% per year. In the past 50 years, the rural population has decreased from 70% to just under 50% of the total, which has put significant strain on services in urban areas, in particular water and sanitation. Gross national income per capita has been stable at around $4500 over the past 5 years. Overall, 23% of the population live on less that $2 per day (US$ PPP); 43% of rural population and 18% of the urban population live below the poverty line. Income is unequally distributed: the top 20% of earners receive 50% of the income, while the poorest 20% receive only 6% *(World Bank, 2012)*. Government health expenditure is approximately 3.7% of gross domestic product annually *(Snowdon, 2012)*.

In 2010, the top two causes of mortality were diseases of the circulatory system and endocrine, nutritional and metabolic diseases. Child mortality fell from 23.2/1000 live births in 2009 to 17.7/1000 live births in 2010. Maternal mortality fell from 27.5/100,000 live births in 2009 to 22.6/100,000 live births in 2010 (Ministry of Health, 2011). Poverty, the inability of many to buy sufficient food and unhealthy diets has caused significant amounts of micronutrient (especially iodine and iron) malnutrition (Snowdon, 2012). A survey of youth in the Suva-Nausori corridor revealed that 26% of females and 17% of males were overweight, more than 30% of Indo-Fijian students were under-weight and less than 30% of students engaged in any physical activity (Tuiketei et al., 2010).

Approximately 82% of all deaths in Fiji are attributed to NCDs (WHO, 2011). Of these, 42% are from cardiovascular diseases alone. As per the Fiji NCD *STEPS Survey report 2002*, the prevalence of diabetes was 16.2% and prevalence of hypertension was 19.1% *(Ministry of Health, 2005)*. These rates are anticipated to have increased in the 2011 NCD STEPS Survey. Interestingly, though unfortunately, mortality due to diabetes for 2011 was recorded to be 53.5% more than in 2010. The prevalence of cancers in 2011 was noted to be 10.9% with the female to male ratio being 3:1 (MoH, 2012a).

With regards to CDs, the incidence of tuberculosis, a disease of poverty, declined between 2009 and 2010 *(Ministry of Health, 2011)*. In the last 50 years, about six distinct outbreaks of dengue were experienced in the country. On average, about 20-100 cases of leptospirosis are reported in the country annually. While data shows that the incidence (number of cases per 100,000 of population) of typhoid fever may be increasing, improved diagnostic and reporting since 2005 may help explain the rise in numbers. Together, dengue fever, leptospirosis and typhoid fever are considered the country's "Three Plagues" and with diarrhoea, are major public health concerns *(PCCAPHH, 2012)*. In 2010, 19,234 cases of diarrhoea were recorded nationally *(Ministry of Health, 2011)*. Between 1995 and 2010, the incidence of diarrhoea was nearly always more than 500 cases per month *(PCCAPHH, 2012)*. While diarrhoea is known globally to be sensitive to climate conditions, poor water and sanitation concerns also play a major role. Nearly all of the population is said to have access to improved water sources, but 70% of the rural population do not have improved sanitation *(World Bank, 2012)*.

Observed Impacts of Historical Climate Variability on Human Health in Fiji

Evidence is growing globally of various health outcomes being sensitive to, or negatively affected by climate variability and change. Global evidence also shows that climate change will negatively impact environmental and socio-economic determinants of health, which in turn will result in a higher global burden of communicable and non-communicable diseases (WHO, 2009). Results of studies on the climate-sensitivity of diseases and health determinants in Fiji are summarised below.

Communicable Diseases

Dengue fever: In a study conducted in 1999, positive correlations were identified for dengue and La Nina conditions in the Pacific *(Hales et al., 1999)*. Of the eight dengue outbreaks that occurred in Fiji over the last 50 years, 7 occurred during periods of La Nina (wet conditions), while the 1998 outbreak occurred during the an El Nino (dry conditions) period *(PCCAPHH, 2012)*. It is thought this was due to people storing water in un-covered containers close to their homes and that these containers were ideal breeding sites for the Aedes mosquito *(FMS, 2003a)*. Following the floods in January and March, 2012, the incidence of dengue fever was very high in the Western Division. Vector indices and dengue case numbers both peaked a month following the respective floods. The highest number of laboratory confirmed cases were noted in the Lautoka and Nadi sub-divisions *(Ministry of Health, 2012b)*.

Dengue outcomes in Lautoka following the floods were consistent with the results for Lautoka in Table 4.11 below.

The joint Ministry of Health-WHO-UNDP Piloting Climate Change Adaptation to Protect Human Health utilised historical monthly climate and communicable disease data from 1995-2009 and identified the following associations between dengue and climate conditions.

Table 4.11: Summary of Poisson Regression between Monthly Dengue Fever Cases and Monthly Climate Variables in Four Medical Sub-Divisions in Fiji

Medical Sub-division	Climate variable/model[c]	Strength of Association (pseudo r^2 value)[b]	Notes:
Ba	Rainfall (mm) - lagc 1, 2, 3	0.3, 0.27, 0.32	a Seasonally adjusted, using a dummy variable for months.
	Maxtemp (°C)d- lag 0, 1, 2, 3	0.29, 0.38, 0.32, 0.29	b All results are significant to the 5% level (p-values ≤ 0.05)
	Mintemp (°C)e- lag 2	0.25	c Lags refer to the relationship between disease numbers in a particular month and cli mate conditions of the same month (lag 0), or 1, 2, 3 months prior (lags 1, 2, 3) respec tively.
	Relative Humidity (%)- lag 1	0.34	d Maximum temperature
	Best Model: Rainfall, Maxtemp, Humidity at lag 1	0.39	e Minimum temperature
Bua	Rainfall- lag 0, 1, 2	0.4, 0.3, 0.37	
	Maxtemp- lag 0, 2, 3	0.37, 0.33, 0.31	
	Mintemp- lag 0, 1, 2, 3	0.35, 0.30, 0.32, 0.31	
	Humidity- lag 0	0.33	
	Best model: Rainfall, Maxtemp, Mintemp at lag 0	0.52	
Lautoka	Rainfall- lag 1	0.42	
	Maxtemp- lag 1	0.53	
	Mintemp- lag 1	0.27	
	Best model- Rainfall, Maxtemp, Mintemp at lag 1	0.54	
Suva	Rainfall- lag 2	0.47	
	Maxtemp- lag 3	0.50	
	Mintemp- lag 0, 2	0.57, 0.52	
	Humidity- lag 2	0.47	
	Best model- All four climate variables at lag 2	0.6	

(Source: PCCAPHH, 2012)

Where higher r^2 values are seen (Lautoka, Suva and Bua) climate conditions can be said to explain dengue fever outcomes to a greater extent. In other subdivisions, the associations were weaker but still statistically significant. Relationships between dengue and climate appeared to be non linear. For example, in the Bua sub-division, night time temperatures above a threshold of approximately 25°C appear conducive to dengue transmission, with a time lag of 2 months (Figure 4.13).

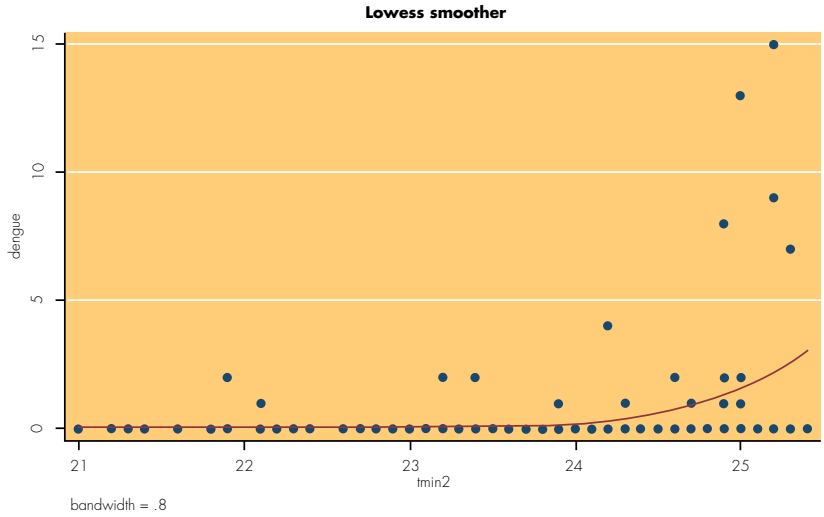


Figure 4.13: Monthly dengue cases vs. Average Monthly Minimum Temperature Two Months Prior in Bua

Further work was done to determine the association between dengue fever and extreme climate events like droughts, cyclones and floods. The likelihood of a dengue outbreak in Ba, one month after floods caused by tropical depressions was 10 times more than months when no tropical depression occurred. Furthermore, the likelihood of a dengue outbreak in Ba during drought months was 5 times more than months without droughts.

Diarrhoeal Illnesses: *Singh et al. (2001)* undertook a study of diarrhea in infants in Fiji and showed positive associations with very low and very high rainfall and increasing temperature (lagged by one month). Singh et al. noted a 3% increase in diarrhea cases for every 1°C increase in temperature, controlling for seasons. Higher temperatures create conditions that allow pathogens to proliferate while water supply and safety, as well as sanitation and hygiene are compromised during periods of droughts and floods. Following the March 2012 floods in the Western Division, water supply and safety were compromised in both urban and rural flood-affected areas, resulting in a high incidence of diarrhea. In many areas, water trucks supplied water to affected families; 2779 WASH kits (containing water purification tablets, water containers and soap), 40 large tanks and bladders, 7,000 water containers, and 9600 sachets of Oral Rehydration Salts (ORS) were also distributed *(UNOCHA Pacific, 2012)*. Analysis by the PCCAPHH project produced the following associations between climate and diarrhea.

Table 4.12: Associations between Monthly Diarrhoeal Illnesses and Monthly Climate Variables in Three Medical Sub-Divisions in Fiji, 1995-2009

Medical Sub-division	Climate variable/modela	Strength of Association (pseudo r^2 value)[b]
Ba	Rainfall- lag 1	0.1
	Maxtemp- lag 3	0.06
	Mintemp-lag 3	0.07
	Humidity- lag 1	0.14
	Best model: All for climate variables above	0.17
Bua	Rainfall- lag 0	0.12
	Maxtemp- lag 0, 1, 2	All ~0.10
	Mintemp- lag 0-3	All ~0.10
	Humidity- lag 2	0.12
	Best model: Rainfall, Maxtemp, Mintemp at lag 0	0.13
Suva	Rainfall- lag 1, 3	~0.4
	Maxtemp- lag 0, 3	~0.4
	Mintemp- lag 3	~0.4
	Best model: Three climate variables above at lag 3	0.41

Notes:

a Seasonally adjusted, using a dummy variable for months.

b All results are significant to the 5% level (p-values ≤ 0.05)

c Lags refer to the relationship between disease numbers in a particular month and cli mate conditions of the same month (lag 0), or 1, 2, 3 months prior (lags 1, 2, 3) respectively.

d Maximum temperature

e Minimum temperature

(Source: PCCAPHH, 2012)

It is clear from the above table that other than in the Suva sub-division, the linear associations between monthly diarrhea and monthly climate conditions are quite weak. When the same data was analysed using the Lowess smoothing for the Suva sub-division however, the following U-shaped curve was noted, similar to findings by *Singh et al. (2001)* (Fig. 2). This shows that in the Suva sub-division, diarrhoea cases are higher during periods of very low and very high rainfall, but more pronounced during drier periods *(PCCAPHH, 2012)*.

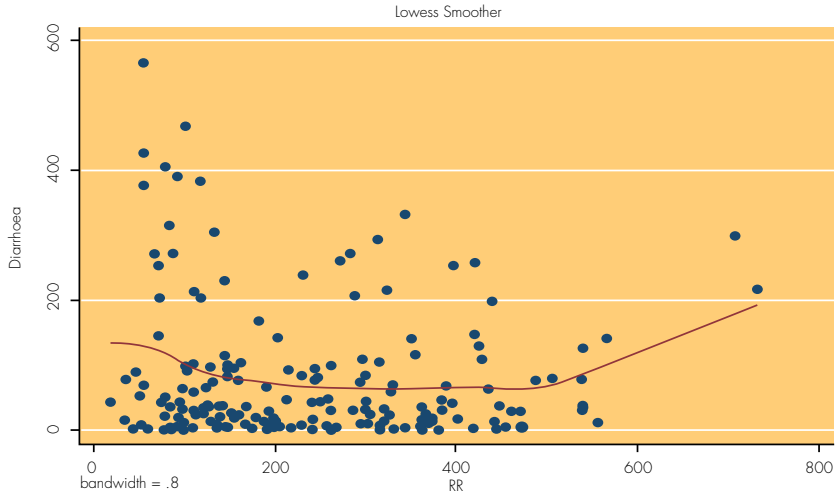


Figure 4.14 Monthly Diarrhoea Cases vs. Average Monthly Rainfall in the Same Month in Suva

Interesting associations were also noted with minimum temperature in Suva for the same month and a one-month lag (Fig. 3 below). Both graphs suggest that 25°C is the threshold minimum (night-time) temperature, beyond which diarrhoea cases increase in the Suva sub-divisions (PCCAPHH, 2012). It is important to consider minimum temperatures as colder temperatures will inhibit the proliferation of certain pathogens.

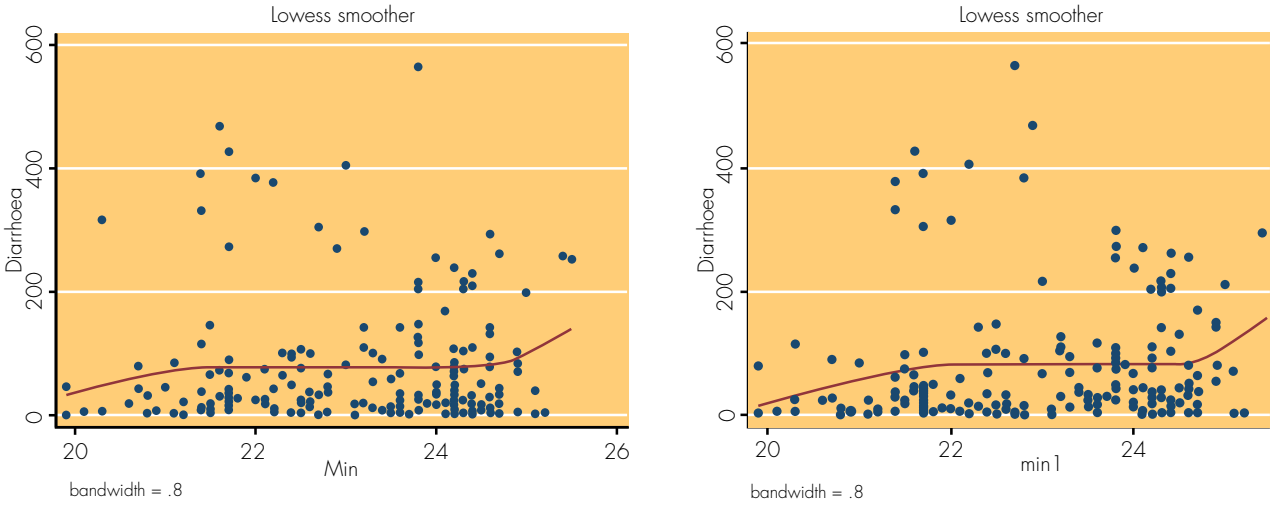


Figure 4.15: Association between Monthly Diarrhoea Cases and Minimum Temperature at Lags 0 (left) and 1 (right) in Suva

Analysis also revealed strong positive associations with extreme events like floods and cyclones in the Ba medical sub-division. The likelihood of a diarrhoea outbreak in Ba one month after flooding caused by tropical depressions is 9 times more than months in which tropical depressions do not occur. In comparison, the likelihood of a diarrhoea outbreak one month after all floods is 3.5 times higher than all months without flooding (PCCAPHH, 2012).

Analysis above shows the need to design adaptation measures to both abrupt and on-going changes in the climate, noting all the while the communicable diseases to tend to rise following natural climate disasters.

Typhoid Fever is endemic in Fiji. Outbreaks have been noted following floods and 2 months after cyclones (Jenkins, 2010; Ram et al., 1983) and mass food distribution events. Outbreaks in Koroboya and Naitasiri (Tavua medical sub-division) and Nanoko (Nadroga-Navosa sub-division) in 2012 demonstrated that poverty, poor sanitation and hygiene and the movement of healthy carriers are also significant risk factors. The Western Division experienced typhoid outbreaks following the January and March 2012 floods, with the highest number of cases reported in the Ba sub-division, followed by the Nadi and Lautoka sub-divisions. Particularly following floods and cyclones, the close proximity of people in evacuation centres and compromised sanitary and hygiene facilities in evacuation centres also contributes to transmission of typhoid. The Ministry of Health launched a public campaign following the floods and distributed more than 8000 information, education and communication materials on preventing typhoid fever and on health during natural disasters (Ministry of Health, 2012b). Analysis by the PCCAPHH project produced the following associations between climate and typhoid fever.

Table 4.13. Summary of Poisson Regression between Monthly Typhoid Fever Cases and Monthly Climate Variables in Two Medical Sub-Divisions in Fiji, 1995-2009

Medical Sub-division	Climate variable/model[a]	Strength of Association (pseudo r^2 value)[b]
Ba	Rainfall- lag 1, 2, 3 Maxtemp- lag 0, 3 Mintemp- lag 1, 2, 3 Humidity- lag 0, 1, 2, 3 Best model- Rainfall and Mintemp at lag 2	0.47, 0.63, 0.49 0.47, 0.49 0.46, 0.52, 0.46 0.48, 0.46, 0.47, 0.5 0.66
Bua	Rainfall- lag 0 Mintemp- lag 0, 3 Humidity- lag 3 Best model- Rainfall and Mintemp at lag 0	0.35 0.36, 0.36 0.35 0.36

Notes:
a Seasonally adjusted, using a dummy variable for months.

b All results are significant to the 5% level (p-values ≤ 0.05)

c Lags refer to the relationship between disease numbers in a particular month and cli mate conditions of the same month (lag 0), or 1, 2, 3 months prior (lags 1, 2, 3) respectively.

d Maximum temperature

e Minimum temperature

(Source: PCCAPHH, 2012)

Typhoid outbreaks in the Ba sub-division are explained to a significant extent by rainfall and minimum temperature of the area. Results for the Bua sub-division illustrate that other socio-economic determinants can explain typhoid outbreaks in the area.

Leptospirosis. Over the last 15 years, between 20-100 cases of leptospirosis have been reported in Fiji annually. While leptospirosis is endemic in Fiji, outbreaks also occur. Globally, leptospirosis is known to be sensitive to higher temperatures and higher rainfall patterns in tropical areas. In Fiji, young male farmers are at higher risk as their occupations expose them to infected animals or soil and water contaminated by infected animals. It is thought that especially following floods and cyclones, people and leptospirosis vectors (domestic animals, rats) come into closer proximity, increasing the risk of transmission (PCCAPHH, 2012). For example, leptospirosis outbreaks were noted following floods in January and March 2012 in the Western Division. In some cases, outbreaks occurred in evacuation centres where people were in close proximity. Furthermore, rodents in Ba town are thought to have caused outbreaks in town areas following the January and March floods in 2012 (Ministry of Health, 2012c). The highest numbers of cases following the floods were reported from the Lautoka sub-division, followed by the Ba, Nadi and Nadroga-Navosa sub-divisions. The highest number of deaths due to leptospirosis was also from the Lautoka Divisional Hospital. Health promotional messages to prevent leptospirosis were aired on Fiji TV and FBC, while approximately 6200 information, education and communication materials on the same subject were distributed to the public (Ministry of Health, 2012b).

Analysis by the PCCAPHH project produced the following associations between climate and leptospirosis.

Table 4.14: Summary of Poisson Regression between Monthly Leptospirosis Cases and Monthly Climate Variables in Two Medical Sub-Divisions in Fiji, 1995-2009

Medical Sub-division	Climate variable/model[a]	Strength of Association (pseudo r^2 value)[b]
Ba	Rainfall- lag 2 Maxtemp- lag 1, 2 Humidity- lag 1, 2 Best model: Rainfall lag 2 and Mintemp lag 1	0.3 0.32, 0.3 0.3, 0.3 0.35
Bua	Rainfall- lag 0, 2, 3 Maxtemp- lag 0, 3 Mintemp- lag 0, 1, 2, 3 Humidity- lag 0, 1 Best model: Rainfall, Maxtemp, Mintemp at lag 3	0.42, 0.4, 0.48 0.38, 0.45 0.4 (all) 0.45, 0.40 0.59

Notes:
a Seasonally adjusted, using a dummy variable for months.

b All results are significant to the 5% level (p-values ≤ 0.05)

c Lags refer to the relationship between disease numbers in a particular month and cli mate conditions of the same month (lag 0), or 1, 2, 3 months prior (lags 1, 2, 3) respectively.

d Maximum temperature

e Minimum temperature

(Source: PCCAPHH, 2012)

The strongest correlation between average monthly climate conditions and monthly leptospirosis was noted for the Bua sub-division, with a model that combined rainfall, maximum temperate and minimum temperature at a lag of 3 months.

Sexually Transmitted Infections: While no quantitative studies have been undertaken to determine the association between sexually transmitted infections (STIs) and the climate in Fiji, some observations following the January and March floods in the Western Division are noted below. Medical practitioners noted an increase in unsafe sexual activities, particularly among teenagers and youths, and especially so in evacuation centres. As a result, group activities like yaqona consumption were banned in most evacuation centres to encourage parents to supervise their children. Furthermore, cases of rape and incest were also noted, especially on unaccompanied women in evacuation centres. To prevent further cases, police officers were posted at evacuation centres and where necessary, women were housed in separate rooms in evacuations centres and provided police protection (Ministry of Health, 2012c).

Non-Communicable Diseases

While non-communicable diseases (NCDs) are known globally to be sensitive to diet, no quantitative studies have been undertaken to demonstrate associations between NCDs and the climate in Fiji. Thus, this is an area of research, especially as some examples of associations are starting to become more visible and as NCDs are significant health problems. Some of the pathways in which climate change can affect NCDs are explored below.

Heat-related illnesses: While Fiji does not experience heat-waves like those experienced in many temperate countries, hotter days and nights are expected to create conditions where people engage in less physical activity (working on farms or exercising outside). This can lead to a rise in obesity, which is a risk factor for many NCDs like diabetes, cardio-vascular illnesses, musculo-skeletal disorders (like gout and osteoarthritis) and some cancers like endometrial, breast, rectal and colon cancer (National Food and Nutrition Centre and Ministry of Health, 2009). Increased heat levels could also cause increased restlessness in high blood pressure patients, creating conditions for increase in related illnesses.

Malnutrition-related illnesses: Perhaps the most important potential pathway linking climate change and NCDs is via food and nutrition. Currently, endocrine, nutritional and metabolic diseases are the second most common cause of mortality in Fiji (Ministry of Health, 2011). Extreme temperatures, as well as natural disasters like droughts, cyclones and floods cause significant damage to agricultural output. More than 12,000 farmers lost their crops and the agriculture sector overall incurred a loss of more than FJD16m after the March 2012 floods (UNOCHA Pacific, 2012), which resulted in fresh fruit and vegetable shortages throughout the Western Division. The Ministry of Health distributed nutritional supplements that included Vitamin A and micronutrients to avoid malnutrition in flood-affected families (UNOCHA Pacific, 2012). Where farms are unable to recover from natural disasters, long-term shortages of fresh, local fruits and vegetables are experienced. As a result, people consume

canned and preserved food, which are often high in salt and sugar. Excessive amounts of salt and sugar increase the risk of illnesses like high-blood pressure, strokes and cardio-vascular diseases, diabetes and obesity. Anecdotal evidence suggests an increase in diabetic foot-sepsis among people of the Eastern Division 2 years after Cyclone Tomas' destruction of farms in the area.

Climate change is also causing sea surface temperatures and sea levels to rise and altering the mixing of ocean layers which reduce nutrient availability and fish supply. Rising sea surface temperatures and increasing variability in the form of the El Nino Southern Oscillation will negatively impact coral reefs, leading to further reduction in fisheries (FAO, 2008). Seafood is an important source of protein in Fiji and the lack of fresh fish will further push consumers to buy canned fish, which are normally high in salt.

In the long-term, damages suffered by the agriculture and fisheries sectors may create significant food security issues, including very large increases in NCDs and very high dependence on imported foods.

Death and injury from extreme events: Drowning from swimming in flooded rivers, or trying to cross flooded crossings is a major cause of death during floods and cyclones. A summary of deaths from recent major cyclones and floods is presented below.

Deaths cause grief and sorrow in affected families and if families lose their breadwinners, then their losses are greater. Related impact on the mental health of family and friends is varied yet quite notable. The possibility of depression and stress increases during such times.

Psychological impacts

A largely neglected health impact of climate change and extreme climate events, the UNOCHA Pacific coordinated Humanitarian Response Team recognized this as an important area following the March 2012 floods (UNOCHA Pacific, 2012). Psychological stress and depression can arise from loss of livelihoods (e.g. drought damage to crops), death of or severe injury to family members, loss of homes to floods and/or cyclones, the inability to recover from disasters, conflict over limited resources like water/productive land and the relocation or displacement of populations to less vulnerable, and in some cases more vulnerable areas. It can affect adults, children and youth and can take the form of "social isolation, mental disorders, reduced socio-economic status and associated health problems" (WHO, 2009: 12).

Access to Health Services

Hurricane Ami (January 2003) caused FJD$ 857,000 of damage to health infrastructure (FMS, 2003b). The March 2012 floods caused FJD 607,000 damage to health infrastructure (UNOCHA, 2012). Buildings, equipment, drugs and records get damaged from water and wind and replacement costs are very high. Electricity and water cuts also severely limit the operability of health facilities. In addition, access to health facilities and affected communities is also cut-off by flooded roads and bridges. Transporting emergency cases to hospitals becomes difficult during such times (Ministry of Health, 2012c). The Ministry of Health is currently undertaking the terminal review of its Health Emergency and Disaster Management Action Plan, which will see the development of Standard Operating Procedures to address these issues. During disaster periods, health teams comprising medical officers, nurses, environmental health officers and dieticians undertake shift clinics in evacuation centres and communities to maintain population access to health services.

Table 4.15: Deaths during major recent cyclones and floods

Extreme Event	No. of deaths	Source
Hurricane Ami (January 2003)	17	FMS, 2003b.
Floods due to Tropical Depression (January 2009)	11	McGree at al., 2010.
Tropical Cyclone Mick (December 2009)	9	ABC News, 2009.
Floods due to Tropical Depression (March 2012)	4	UNOCHA Pacific, 2012.

Projected Impacts of Climate Change on Human Health in Fiji

Fiji's climate is projected to warm over the coming century. Days and nights are expected to become warmer, with 35^{0}C days and over 16C^0 - 21^{0}C nights becoming regular occurrences by 2100. Generally, the country is projected to get drier and sea levels are expected to rise (Government of Fiji, 2012). These changes will have profound impacts on availability of water, agriculture and food and living conditions. In other words, climate change will continue to compromise the basic determinants of human health.

Studies undertaken using the PACCLIM model in 2005 (Government of the Fiji Islands, 2005) projected increases in the incidence of dengue fever, diarrhoea and nutrition related illnesses in Fiji. Using 1990 as the baseline, 43% of Viti Levu was found to be at low risk of a dengue outbreak. By 2100, even under the B2 (sustainable development) scenario, only 21% of Viti Levu (interior of the island) was projected to be at low

risk of a dengue outbreak, with the remainder of the population estimated to be at moderate to high risk of an outbreak. When the worst case scenario (A2) was considered, 45% of Viti Levu's population was projected to be at high to extreme risk of an outbreak by 2100. The study also concluded that as a result of warming, the frequency of epidemics may increase, epidemics may cease to be seasonal (occur at any time of the year) and even become endemic, and the morbidity and mortality from epidemics could rise significantly.

The same study concluded that as Fiji trends towards a warmer climate with more frequent droughts, water and sanitation would be compromised leading to increased diarrhoeal outbreaks. Nutrition related illnesses were also projected to increase as extreme events occur more frequently and increase in intensity. Finally, the study projected serious health impacts if climate change disrupted Fiji's social, economic and ecological systems *(Government of the Fiji Islands, 2005)*.

Failure to adapt locally and mitigate globally would result in the above impacts being felt in Fiji. Some adaptation measures to protect human health from climate change are listed below.

Health sector adaptation measures

It is important to note that improved human health outcomes will depend on adaptation and progress in ALL development sectors. Many adaptation options for the health sector involve strengthening existing disease surveillance; monitoring and control measures while others require systematically incorporating climate information in health planning and interventions. Some health adaptation measures for Fiji include:

- Continuous health vulnerability assessment for communicable and non-communicable diseases and for safety and accessibility of health facilities/healthcare.
- Improve access to primary health care.
- Integrated vector management by building or strengthening partnerships with relevant stakeholders.
- Facilitate rapid and accurate disease notification.
- Identify and protect the health of the most vulnerable members of society (elderly, disabled, women, children, poor).
- Vaccinate humans against diseases like typhoid fever and livestock and pets against diseases like leptospirosis.
- On-going education and training on climate change, disaster risk reduction, community health adaptation, etc.
- Incorporate climate change into existing health policies and plans.

Natural disaster-specific measures include:

- Strengthen disaster risk reduction, recovery and response programmes. This includes Standard Operating Procedures and health staff and facilities being adequately resourced (funding, personal protective equipment, food rations, electricity, water, communications).
- Improve coordination among inter-sectoral partners (DISMAC and UN Humanitarian Assistance group).
- Develop or strengthen early warning systems.
- Climate-proof health infrastructure. This includes relocating health facilities if they are in vulnerable areas, ensuring facilities have back-up or renewable electricity, water (e.g. installation of water tanks), sufficient drugs and supplies during natural disasters and undertaking regular repair and maintenance.

Adaptation in other sectors:

Water, agriculture, rural development, housing, environment, community empowerment and livelihoods, energy, etc

The WHO argues that human health should be the bottom line of all adaptation activities and programmes (WHO, 2009). A healthy population is a resilient population and for these reasons, ALL development sectors in Fiji must aim to improve human health outcomes through their adaptation activities. Some priority sectoral and inter-sectoral adaptation measures are highlighted below.

- Provide clean water; improve sanitation and household disinfection especially in areas where disease incidence is higher.
- Improve social indicators like education, women's empowerment, improved housing and equitable access to development opportunities.
- Improve economic indicators like employment rate, alternative livelihoods and access to markets.
- Enhance community resilience against climate change and disasters.
- Encourage agricultural diversification and sustainable agriculture. Discourage farming in marginal areas.
- The natural environment is a source of food, shelter, medicine, clean water and air. It also acts as a buffer against extreme climate events like floods and cyclones. Moreover, an unpolluted environment is safe for human habitation whereas an altered environment may create conditions for disease microbes and vectors to spread. *(Corvalan et al., 2005)*. For these reasons, ecosystems must be protected from unsustainable use.
- Local mitigation measures like increased use of public transportation, walking/cycling instead of using

fossil-fuel powered transport, use of efficient wood-stoves that emit less smoke create co-benefits for health while reducing greenhouse gas emissions. (Ministry of Health, 2012c; WHO, 2009).

Summarily, health facilities, healthcare services, communicable and non-communicable diseases and all the basic determinants of health are sensitive to climate conditions. Impacts are projected to become worse as climate change continues. This highlights the need for urgent adaptation in the health and other development sectors and urgent, up-scaled mitigation of greenhouse gases globally. To conclude, human health should be the bottom-line of all adaptation activities and increased funds are required to secure the necessary human and other resources for adaptation to take place at the required rate.

Marine and Fisheries

Fiji lies within the Archipelagic Deep Basins Province (ARCH). The climate and ocean within this province are influenced by a complex current regime caused by the occurrence of many islands, archipelagos and seamounts. These formations divert oceanic circulation to create eddies resulting in upwelling, down welling and other mesoscale processes. The projected changes to the key features of the tropical Pacific Ocean surrounding Fiji relative to the long-term averages are expected to result in increases to sea surface temperature, sea level and ocean acidification. Changes to ocean currents with increases in the South Pacific gyres and reductions in nutrient supply are also expected to occur (Bell, JD et al. 2011).

Fiji is an archipelagic nation with an EEZ of 1.3million square kilometers. Fiji fisheries can be placed into six categories- coastal commercial, coastal subsistence, offshore locally-based, offshore foreign-based, freshwater and aquaculture. The fisheries sector contributed 1.9% of Fiji's GDP with a USD 56.2million *(Gillet, 2009)*. Fiji has a locally-based, industrial fishery operating within and outside its exclusive economic zone based mainly on the longlining for albacore, yellow fin and big eye tuna. Recent catches from this fishery have averaged 13, 850 tonnes per year, worth >USD 67 million *(Bell, JD et.al 2011)*. Fiji also licenses foreign fleets to fish for tuna in its EEZ, although recent catches by these fleets have been only about 250 tonnes but land significant catches (>10,000 tonnes) caught elsewhere in the region. Exports of fishery products are about 9.1% of all exports including the access fees paid by foreign fishing vessels, representing 0.03% of all government revenue and jobs directly related to fisheries represent about 3.8% of the total number of jobs in Fiji *(Gillet, 2009)*. Coastal fisheries also provide significant opportunities to earn income for coastal communities throughout the country, with >90% of households in representative communities earning their first or second income from catching and selling fish *(Bell, JD et al. 2011)*.

In 2008, ADB profiled fishery production in the Pacific with a general pattern of decreasing total national catches going from west to east across the region and from equatorial to higher latitudes. Fiji illustrated a relatively large contribution of non-tuna production.

Fisheries sector is the third largest primary sector *(Ministry of Finance and National Planning, 2006)*. There are many small outer islands in the Lau, Lomaiviti, Yasawa and Rotuma that heavily rely on fisheries resources for food and income. The coastal fisheries are made up of four components: demersal fish, near shore pelagic fish, invertebrates targeted for export and invertebrates gleaned from intertidal and subtidal areas. The total annual catch was estimated to be 26,900 tonnes in 2007, worth USD 67.6million. The commercial catch was 9500 tonnes. Demersal or bottom-dwelling fish associated with coral reef, mangrove and seagrass habitats were estimated to make up 65% of the total catch, signifying the healthy connections to these habitats to fisheries productivity *(Bell, JD et al. 2011)*. Climate change is expected to exacerbate the existing local threats to coral reefs, mangroves, seagrasses and intertidal flats in Fiji.

Climate and related oceanic variations are already having significant impacts on fish catches, both subsistence and commercial. Coral bleaching is also likely to have adverse effects on coastal biological diversity and fisheries *(DoE, 2005)*. A combination of high rainfall accompanying cyclonic activity and storm events, as well as steep bare slopes causes rapid runoff, river floods and sediment discharges into the near-shore coral reef habitats, adversely impacting the fisheries sector. Variations in tuna catches are especially significant during El Niño and La Nina years. For example, the El Niño of 1997/98 negatively affected skipjack tuna catches highlighting the sensitivity of fish stocks to changes in the climate. Changes in migration patterns and depth of fish stocks affect the distribution and availability of tuna during such periods and it is expected that changes in climate may cause migratory shifts in tuna aggregations to other locations. Healthy reef ecosystems and management of marine areas both at a seascape and community scale are strategies to build habitat resilience to extreme climate variability. Mangroves and associated coastal habitats, coral reefs provide physical buffers and ecosystem services.

The main aquaculture commodities in

Fiji include those produced for livelihoods in coastal waters such as black pearls, shrimp, seaweed and marine ornamentals and Macrobrachium grown in ponds. Tilapia, carp and milkfish are also produced in freshwater ponds for food security. Increasing SST, rainfall and ocean acidification are expected to reduce the number of sites where seaweed can be grown successfully and reduce the survival and growth of ornamental products (coral fragments and live rock), pearl oyster spat and sea cucumbers. Higher rainfall and air temperatures are expected to have positive effects on pond aquaculture. The projected effects of climate change on aquaculture in Fiji are mixed.

Average national fish consumption in Fiji is estimated to be 21kg per person per year, well below the recommended levels for good nutrition *(SPC 2008)*. In rural areas, about 50% of this consumption is supplied from subsistence fishing yet coastal habitats are estimated to be able to supply a small surplus (5 kg per person) above the recommended consumption level of 35 kg per person per year. Fiji will have an increasing total demand for fish for food security due to the predicted population growth. Consequently, the current estimated fish surplus is expected to change to a shortfall of 3kg per person per year in 2050 and 9 kg per person per year in 2100. Fiji faces further declines in the fish available per person due to the combined effects of population growth and climate change. *(Bell, JD et al. 2011)*.

Forestry

Fiji forests include natural forests and mangroves, which are important ecosystems for terrestrial biodiversity and a provider of essential environmental services such as carbon sequestration, soil conservation and regulation of the water cycle. Fiji has a total forest cover of 58% of the total land area, comprising of native forest (899,229ha), plantation forest (116,488ha) and mangrove forest (38,742ha) *(NAR January, 2010)*. Plantation forests of mainly pine and mahogany account for 13% of total forest area. Natural forests and forest plantations contribute on average 1.2% of the GDP and 4.1% of export earnings (NAR January, 2010). The performance of the sector in the past few years has been poor due to complex institutional environment in which the sector operates, such that a decline by 1.6% in 2007 and 3.4% in 2008. However, a recovery in the forestry sector as government puts in place measures to address the current institutional constraints. The National Forest inventory, formalization of the Fiji Forest Policy Statement and the National Forest Program provides the framework for the sustainable management of Fiji's forest resources *(NAR January, 2010)*.

The Forestry Department is also collaborating with NGOs, SPC/GIZ and the Department of Environment through a four year GEF funded project of US$3.7million on the conservation of Sovi Basi located in Naitasiri and Namosi provinces. In Fiji, the management of productive plantations and their extension has a significant potential for high value timber supply and rural development. However, forest plantations are sensitive to forest fires caused by droughts and heat spells or windbreaks caused by cyclones. Sensitivity of the natural forest ecosystems is relatively high mainly to population growth and the demand for greater agricultural production for food security, thus leading to deforestation.

The current lack of financial competitiveness with agricultural land is potentially a major factor for forests being degraded or converted, thus leads to soil erosion and compaction or even landslides on steep slopes during heavy rainfall. Mangrove forests are highly sensitive when mangroves are cut for fuel-wood or the land is reclaimed for residential land.

Table 4.16 Sector: Forestry

Climate risk	Specific climate impacts	Sensitivity to climate change	Proposed Adaptation options
Droughts/ heat spells	• Increased forest fire risk • Erosion of soil and soil nutrients • Changes in seasonality (flowering seasons) of tropical forests • Loss of traditional plants and other important elements of biodiversity • Negative impact on hydrology • Reduced regeneration and decreased forest growth • Plant stress, forest degradation (particularly monocultures are subject to wind gusts, pests and diseases). • Spread of pathogens causing pest and diseases affecting roots of trees • Shifting habitats/ boundaries of pollinators and seed dispersers (forest insects, birds and other species) • Outbreak of invasive species	• Lack of financial competitiveness with agricultural land • Risk of forest conversion due to higher demand for agricultural land caused by population growth and climate change • Forest degradation due to illegal logging and fuelwood collection • Monocultures subject to wind gusts, pests and diseases • Lack of financial resources for sustainable forest management (planting, pruning, thinning and harvesting) • Mangroves are cut for fuel wood or are converted into other land use systems • Mangroves are cut for illegal residential areas caused by urbanization • Forests are often allocated on steep slopes subject to erosion or landslides • Lack of an effective fire management system • Lack of a current fire regulation that covers areas outside the forest • Lack of /and accessibility to current data and information especially on district level • Lack of forest owner and community awareness and education on new climate change issues (esp. communication lines and procedures) • Non-timer products ef. Sandalwood, sago palm are overharvested • Damage to reefs (=important protection for mangroves)	• Natural resistance of sustain ably managed native forests • Effective management of forest reserves minimizes potential impacts such as floods and erosion • Existing policies (eg. REDD+ Policy) • Existing Fiji forest harvesting code of practice • Existing tree improvement pro gramme for wind tolerant trees • Existing pilot projects on com munity forest management eg. Drawa natural forest • Community awareness pro grammes on SFM • Community tree planting • Use of agroforestry systems • Existing forestry trainings • Practice pollarding/ topping to enhance wind resistance • Reforestation and afforestation programmes (plant local, en demic and cyclone resistant species) • Existing windbreaks • Mangroves can move further inland if no structure is prevent ing it.
Heavy rainfall/ flooding	• Erosion of soils • Landslide on steep slopes • Spread of pathogens causing pest and diseases affecting roots and trees • Loss of forest animals • Shifts in flowering patterns eg. fruit trees • Damage to infrastructure eg. sawmills, roads • Decreased forest production eg. forest products • Loss of income • Loss of employment		
Cyclones/ storms	• Damage to windbreaks • Damage to trees on the coastline due to salt spray • Spread of pathogens causing pest and diseases affecting trees • Plant stress and forest degradation (particularly monocultures are subject to wind gusts, pests and diseases) • Erosion of genetic diversity (eg. damage to genebanks and clonal orchards) • Increase in tree deformation and damage • Reduction in saw log quality • Spread of pests and diseases		
Saltwater intrusion	• Increased salinity levels in soils in coastal areas • Growth of inland trees species is affected • Loss of traditional plants and other important elements of biodiversity		
Coastal erosion	• Erosion of soils in low-lying coastal areas due to wave surges and flooding • Decrease of mangrove area • Loss of coastal tree species		

Tourism

Tourism is the fastest growing industry in Fiji and is sensitive to climate conditions. The tourism sector recorded a total of 674,913 international visitor arrivals recorded for the period January-December 2011 and represented a 6.8 per cent increase over the 631,868 total recorded in 2010 *(Ministry of Tourism, 2012)*. Foreign exchange earnings from Fiji's tourism now contribute an estimated FJD-1074million to the local economy (*Bureau of Statistics, June 2012)*. In 1998, total tourism earnings were estimated at F$568 million while sugar earned F$244million in foreign exchange (Narayan, 2000). Employment in the tourism sector represent around 31% of the country's total GDP and is responsible for employing some 45,000 full time equivalent jobs *(Ministry of Tourism, 2012*).

Climate risk in the tourism sector and its infrastructure is high since cyclones and high wind speeds; big waves, sea surges; sea level rise; water shortage; intensive rainfall events, flooding and landslides; drought and the risk of wildfire; coral bleaching and storm damage to reefs; health impacts can affect the tourist. Fiji's climate risk profile highlighted that maximum daily rainfall of 200mm is projected to become less frequent by 2100 at various locations in Fiji; maximum winds exceeding 80knots at selected locations in Fiji expectedly will become more frequent than currently observed. Tropical cyclones are one of the most severe extreme events that have affected Fiji on numerous occasions in the past 4 decades, usually from November to April period but have also occurred in October and May. On average, 1 to 2 cyclones affect some part of Fiji every season and with the greatest risk during El Niño season. A decreasing trend in both the number of tropical cyclones and cyclones with hurricane intensity affecting Fiji has been observed in the last 4 decades (refer Figure 4.6). However, the diversity of tourism destinations and services available in Fiji may minimize disruption caused by extreme weather events. And yet, growth in the tourism sector maybe hindered by the need for increased capital investment. Increasing costs to implementation of adaptation measures would subsequently be absorbed by tourists and related service providers (Challenger, 2002).

This sector's level of adaptive capacity based on past experiences cyclones and storm damages, its low financial sources with also a limited technical knowledge of climate change along the coastline make it highly vulnerable to climate change. The objective of the pilot project is to increase the resilience to climate change of Fiji's tourism industry in cooperation with national and international organizations. To strengthen the adaptation capacity at national, enterprise and local level, this tourism-focused project implemented the following measures:

- Early warning systems and the development of a risk management framework, including guidelines;
- awareness raising campaigns and implementation of training programmes;
- integration of climate change issues in tourism policies and development of preventive regulations;
- detailed analysis of risk management and business plan development at two destinations;
- establishment of a network and a website for the dissemination of practical experience and background information;
- and the incorporation of tourism aspects in national climate change framework. Tourism stakeholders are represented in the National Climate Change Country Team and the sector is highlighted in the National Climate Change Policy.

Table 4.17: Sector: Tourism

Climate risk	Specific climate impacts	Sensitivity to climate change	Proposed Adaptation options
Increased storm activity, coastal erosion, cyclones, increased rainfall	• Damage to buildings and infrastructure from sea level rise, storm surge, cyclones, floods, salt-spray, coastal erosion and landslides	• Disruption of land, sea and air transport to facilities • Decrease in tourist arrivals due to changing weather conditions and patterns, degradation of pristine natural attractions and damage to infrastructure • Increasing costs to implementation of adaptation measures, that would be subsequently absorbed by tourists and related service providers • Growth in the tourism sector may be hindered by the need for increased capital investment and increased climate related challenges	• Diversity of tourism destinations and services to minimize disruption caused by extreme weather events

Urban Development and Housing

The Department of Town and Country Planning role is to execute the duties and responsibilities set out in the TP Act and Subdivision of Land Act. To manage these functions, the Department is divided into three sections;

1. ***Forward Planning***: prepares & reviews Town Plan (TP) Schemes for approval, considers rezoning and major developments.
2. ***Development Control***: processes applications for developments referred to by Local Authorities. Includes applications of areas approved by Town planning scheme and applications for conditional development.
3. ***Subdivision***: processes applications for subdivision by developers. Includes applications from all parts of Fiji except Suva and Lautoka city (Councils By-laws for subdivision).

The purpose of a scheme to provide a framework to guide development and future land uses and to provide guidelines to accommodate the current changes taking place as requirement under legislation; "Town Planning Act Cap 139, section 16." The TP scheme consists of 3 reports and a map, a working document to guide the town council in the appropriate development of the town.

- ***Scheme statement*** – contains objectives, plan policies for development for particular land uses identified and implemented through Council's Policies and Plans.
- ***Scheme General Provisions*** – lays the requirements controlling developments within the zones & category of development.
- ***Report of Survey*** – background study and information relating to the revision of scheme.
- ***Scheme Plan*** expected to have a lifetime of 15-20 years. Scale map delineating the area of the scheme & defines the various boundaries. Short term represented by 1-5 years, medium term (6-10 years) and long term (11-15 years).

Despite the existing protocol for managing urban developmental needs outlined in its plans which consider elements of exposure to risk and potential hazards in its scheme plan, for instance, such information continues to get neglected and ignored. The continuous growth of urbanization in Fiji indicates a strong demand for housing will continue. The provisional 2007 population census shows an increase in urban households by 18.4% with approximately 61,300 total increases in population. 51% of the population is urban and the urban growth rate is 1.7% compared to the national growth rate of 0.7%. Approximately 90% of the increased population is in the Western and Central Division. The Suva and Nausori urban and peri-urban area has an increasing population of approximately 32,300 people posing a significant challenge in terms of planning, delivery and community development (NAR, January 2010). The majority earn less than $7,000 per year. The rate of poverty has increased with at least 31% of the population living in poverty and 19% attributed to the urban areas (Bureau of Statistics 2008-2009).

Table 4.18 Sector: Urban Development and Housing

Climate Risk	Specific Climate Impacts	Sensitivity To Climate Change	Proposed Adaptation Options
Flooding, drought	• Extreme events such flooding and cyclones incur an economic cost to townships. • Extreme events or natural disasters will affect lives of people in poorly built or poorly located houses, marginal communities are likely to be more severely affected. • Added pressure on services and utilities to cope with demands brought about by extreme events such as heatwaves, water shortages and disease outbreaks. • Land loss and reduction in arable land could lead to migration in urban centers, resulting in overcrowding. • Floods, storm surges, cyclones and other extreme weather events can damage houses and residential buildings, and have the potential to put their occupants in danger during or after an extreme weather event	• Increased energy efficiency and use of renewable energy in residential, commercial and industrial sectors • Reduction of household waste burning	• Some traditional building practices provide resilience to extreme weather events • Sustainable housing programs should complement with income generating opportunities and accessibility to amenities. • Construction of buildings and structures away from foreshore areas, riverbanks and floodplains • Utilization of cyclone and flood resilient construction methods • Utilization of construction materials resilient to strong winds, water damage, high solar radiation and salt spray • Flood control through: diversion channels; the building of weirs, cut-off channels, retarding basins and dams; and river-improvement activities such as channel widening, dyke construction or river-bed excavation. • Catchment management including reforestation, land-use controls, protection of wetlands and soil conservation. • Regulating development on flood plains and promoting flood-proof building design.

Housing as a Sector

The housing needs of the majority of people in Fiji are met by the private sector; however, with the expiry of land leases there is increasing number of people seeking housing, evident in the growing number of informal settlements and growth of private rented housing sector. There are at least about 200 squatter informal settlements comprising of about 100,000 people in the country and about 80% live in the greater Suva urban area. To address Fiji's housing sector that include planning, urban design, infrastructural investment, land management and public service delivery such that the greater quantity of housing must not be at the expense of quality development. The plan to encourage the use of land to improve rural situation via provision of incentives for rural living in order to reduce urban migration is necessary. Resource constraints limit government to provide enough land for people to prosper, build and own houses, ultimately forming sustainable communities.

Official statistics indicate that 164 houses were completely destroyed during the 2009 floods *(Lal et al, 2009)*. The Navua floods incurred an economic cost to households of F$6.7 million *(Holland (2008) in Lal et al, 2009)*. As a source of protection and safety, houses form a critical component of resilience against climate change. Poorly built or poorly located houses have the potential to put their occupants in danger during or after an extreme weather event or natural disaster. Some aspects of Fiji's urban areas and housing provide a level of resilience, including traditional building practices provide resilience to extreme weather events.

Disaster Risk Management

Fiji is located in the Pacific 'ring of fire' thus exposed to geo-physical (earthquakes, tsunamis and landslide) and hydro-meteorological hazards that include tropical cyclones, floods and droughts. Climate change is likely to increase the frequency of hydro-meteorological events. Fiji is also located in the tropical cyclone belt, consequently it experiences on average one cyclone per year. This poses problems for the government as repair of national infrastructure required following cyclones and other hazardous events drains limited national financial resources *(SOPAC, 2011)*. An economic impact study of the January 2009 floods conducted in Ba and Nadi revealed losses to the local communities and small business at more than FJD$330 million *(Ambroz, A. 2009 and Holland, P.2009)*.

The NDMO provides an institutional structure and regulations for the implementation of disaster preparedness programmes, disaster mitigation programmes and disaster response and rehabilitation. The Roadmap for Democracy and Sustainable Socio-Economic Development 2010-2014 includes a goal to "reduce vulnerability to disasters and risks and promoting sustainable development". The strategy recognizes the need to increase emphasis on a comprehensive approach to disaster reduction including community preparedness and disaster mitigation, and the integration of the impact of disasters into national development planning. The NDMO in collaboration with Ministry of Strategic Planning, National Development and Statistics, Climate Change Unit Ministry of Foreign Affairs and other stakeholders to develop a JNAP for Disaster Risk Management and Climate Change Adaptation.

Thus the level of investment in DRM in the annual budget identified cross sectoral DRM expenditures from 2000-2010 according to their five functional classifications: General Administration sector, social sector, economic, infrastructure and Miscellaneous.

Since 1950 Fiji has experienced 101 hazardous events. It was only possible to obtain estimate damage costs for 16 events out of the 101 (15.8% of the hazardous events which occurred during the period of 1950-2011. Droughts have the highest average cost, approximately USD30million *(SOPAC, 2011)*.

Table 4.19: Past events & there costs 1950-2011

Event type	Number	Estimated Cost (USD millions	damage	Population affected
Drought	2	50.03		431,000
Flood	3	65.33		42,000
Tropical cyclone	11	235.0		361,781
Total	16	350.36		834,781

Source: PDN, GUDE, APCED, DAM Consultant Joe Barr

Given the available data, the total cost of past disasters amounted to USD-360million (Table 4.19) spread over 16 events; the total impact on the economy is likely to have been significantly higher. In recognition that DRM is a cross cutting issue, some cross sectoral expenditures were identified by the Ministry of Finance in the following ministries for which sector funding had been provided for DRM purposes:

- National Disaster Management Office (General Administration)
- Ministry of Education (social sector)
- Ministry of Health (social sector)
- Agriculture (economic sector)
- Mineral Resources Department (economic sector)
- Meteorological Services and (infrastructure sector)
- Department of National Roads (infrastructure sector).

The majority of expenditures in DRM equivalent to 96% relate to maintenance and repair of roads, crossings, bridges, equipment following damage from a hazardous event. Activities classed as risk reduction initiatives i.e. the purchase of new and improved technologies accounts for only 4 % which suggests that there is a greater need for investment in risk reduction to help reduce the post-disaster costs in the infrastructure sector. Ministries of Health and Education, 100% of the expenditure relates to disaster rehabilitation and NDMO only 1% of the expenditure relates to risk reduction activities whilst the remaining 99% is for disaster management purposes such as rehabilitation and communications equipment. In contrast, the economic sector which comprises expenditures from the Ministry of Agriculture and the Mineral Resources Department, invests heavily in disaster risk reduction with 91% of the FJD49 million going towards mitigation activities such as drainage and flood protection. The remaining 9% of expenditure relates to crop rehabilitation, maintenance of irrigation systems and seismic activities. In total, the identified expenditure on DRM activities largely relates to disaster management work with 94% of activities being classified under this heading. The remaining 6% relates to disaster risk reduction activities. In order to reduce such large expenditures on post event response more consideration should be given to disaster risk reduction activities and the maintenance of equipment provided (such as that under the HYCOS and Navua Flood Early Warning Systems) to help lessen the effects of future events *(SOPAC, 2011)*.

Thus, comprehensive hazard and risk management (CHARM) now underpins disaster risk management in Fiji. Government policy has shifted away from emphasizing only timely emergency response to placing increased emphasis on a comprehensive approach that includes community preparedness and disaster mitigation; integration of disaster risk reduction in national development planning *(GOPA, 2011)*.

Adaptation Measures

Table 4.20: Matrix for reporting on impacts, vulnerabilities and adaptation options in Fiji

Critical Vulnerable sector/ system	Impacts	Adaptation Options I	Adaptation Options II	Adaptation Option III	Adaptation Option IV	Adaptation V	Difficulties/ barriers to adaptation
Water Resources	1. changes in water availability 2. Changes in water quality 3. changes in the frequency and intensity of floods and droughts	Improvement of water use efficiency	Seasonal forecasting	Enhancement of treatment works	Improvement of flood warning and dissemination of information	Catchment management to reduce pollution and/or runoff	Lack of financial resources; inadequacy of technical capacity
Agriculture	1. Changes in the length of growing season 2. Changes in crop productivity 3. Changes in livestock productivity	Selection of plants and livestock	Multiple cropping system and agroforestry	Enhancement of the role of community participation and public policy	Improvement of irrigation systems	Development of heat and drought tolerant crop and livestock species	Lack of financial resources Access to innovative technologies by local farmers & producers

Critical Vulnerable sector/ system	Impacts	Adaptation Options I	Adaptation Options II	Adaptation Option III	Adaptation Option IV	Adaptation V	Difficulties/ barriers to adaptation
Coastal zone	1. Coastal flooding 2. Coastal erosion 3. Salt water intrusion 4. Retreat of shoreline	Identification of setback areas and no-build zone	Managed realignment of coastal structures/ activities	Building of seawalls, beach nourishment	Introduction of new building design and salt tolerant crops	Relocation of population and economic activities	Limited synergies and collaboration amongst line agencies managing resources and developing in the coastal zone
Human Health	1. Thermal Stress 2. Increase in the incidence of infectious diseases	Early warning systems	Promotion of health education	Promotion of personal hygiene behavior	Improvement of house/ building design	Sustainable diseases surveillance, prevention and control programs	Outreach and access of awareness information to rural remote communities
Ecosystems	1. Loss of habitats for species 2. Shift in the structure of biological communities 3. Changes in the number and distribution of species	Establishment of national and regional management institutions	Expansion of aquaculture as a way of meeting increasing demand for seafoods of an increasing population	Support for innovative research and integrated management of ecosystems	Development of database on the results of integrated ecological monitoring to identify anthropogenic changes, and predict productivity	Organization of marine/ terrestrial biosphere reserves and protected areas.	Strong compliance and monitoring of restrictions on resource use and management of protected areas; key species of concern listed in FBSAP, PAC.

Capacity Building Needs

Evident from the delayed progress in reporting for the Second National Communications, was the limited technical resources and human capacities locally to provide tailored information on climate change trends and associated risks, as well as monitoring of climate impacts on natural resources, for informed decision making in the relevant sectors. For instance, the Agriculture-Land Use and Water Management sectors lack the expertise needed to analyse data and provide tailored information to agricultural users. The capacity gaps in terms of preparing and disseminating accurate extreme weather and climate warnings to users; lack of systematic analysis and dissemination of cross-sectoral adaptation experience in order to support integrated adaptation in interventions in communities *(GOPA, 2011)*. There is very limited information available on crop agronomical and water requirements; crop and forestry models that incorporate existing and potential climate change risks; crop and forest species suitability according to soil properties, vegetation, topography and land use information overlayed with climate information; impacts of climate change on biodiversity. The lack of capacity to integrate climate risk and resilience into watershed management, agriculture and forestry sector related policies, strategies and instruments *(GOPA, 2011)*.

Summary

Human vulnerability in a socio-ecological context refers to the potential for people living in coastal communities to be negatively affected by social and environmental changes in the absence of adaptive capacity *(McCarthy et al., 2001)*. Potential for loss is determined by exposure and sensitivity to perturbations and capacity to recover and adapt *(Nelson, et al. 2007 ; Barnett, 2001)*. A person or a group of people's adaptive capacity refers to their ability to act to reduce their vulnerability to social and environmental change and usually dependent on access to income, knowledge, skills, technology, infrastructure and social networks *(Barnett, 2008)*. This implies that those at the margins of social and economic power are the most vulnerable because they often live in hazardous conditions and have less money with minimal political influence to cope with the impacts of environmental and social changes.

A third of Fiji's population continues to live below the basic needs poverty line

of approximately $6,000-$8,000 annually per household, despite Fiji achieving most of the MDG targets, ie. very high literacy reates (92.6%), with declining low child mortality rates *(ADB, 2003)*. About 60% of the poor are resource dependent for their income engaging in agriculture, fisheries and forestry *(Lal, 2009)*. Due to direct dependence on natural resources and limited access to basic services, the vulnerability of the rural population clearly contrasts that of the urban. About half of Fiji's population are rural dwellers and 40% of them live below the basic needs poverty line compared to 29% of the urban population *(Lal, 2009)*. Rural people's resource dependent economy makes them particularly exposed to the impacts of climate change and natural disasters such as cyclones, floods and storms, whilst their limited income makes it difficult to recover from such events. The poverty cycle is further re-enforced with lower education quality and retention rates particularly in the outer islands *(ADB, 2003)*.

The significant increase of urban squatter settlements has emerged due to issues related to land tenure, poor access to services and low rural wages. The expiration of rural info-Fijian agricultural leases has significantly contributed to this trend. With an annual 10% increase in squatter population, there is an increasing number of Fiji's people live in squatter or informal settlements *(Lal, 2009)*. The impacts of such migration places significant pressure on coastal ecosystems as squatter communities are mainly located on flood plains or cleared mangrove areas, at high risk to floods and other hazards. The absence of basic services such as adequate management of waste means that larger quantities of solid and liquid waste is continuously released into the coast on a regular basis. Inadequate water and sanitation standards and poor environmental quality means that both the poor are more exposed to various health hazards with limited resources to pay for medical care.

However, these generalised issues occur within a society that continues to demonstrate a high level of social resilience. Largelt evident in the i Taukei (indigenous) culture, the sharing of resources and social influence between people of the same kin is evident in levels of financial remittance received from overseas, as well as the domestic remittances from urban to rural. Such social resilience is also evident in the other cultures that exist in Fiji. Given the pressure posed by environmental, economic and social change, it is importnant to acknowledge the strengths of these social relationships for building a resilient Fijian society.

INTRODUCTION

Despite having a very small Green House Gas (GHG) emission profile as described in Chapter 3 (GHGI), Fiji like the other Pacific Island Countries (PICs) faces some of the worst effects of climate change. Moreover, Fiji's dependence on expensive imported fossil fuels for transport and electricity generations puts a big dent on the economy. These dual challenges make climate change mitigation activities an important exercise for the sustainable development of Fiji.

The mitigation chapter picks up from the last national communication and provides further details of the mitigation efforts taking place in Fiji. The base year for information is 2005.

Fiji's first national communication indicated that the energy and transport sectors contributed 100 % of total carbon dioxide (CO_2)[21]. Thus, this chapter focuses mainly on the energy related emissions (transport and power generation) highlighting measures taken to reduce the GHG emissions by either reducing the use of fossil fuels in power generation and transportation through promotion of renewable resources, and reduction in energy consumption via energy efficiency and energy conservation.

These efforts are supplemented by a concerted public campaign by means of workshops, awareness events and other outreach activities to promote sustainable energy.

[21] This figure must have changed in the intervening years.

ENERGY DEMAND AND MITIGATION OPTIONS IN THE ENERGY SECTOR

Fig.5.1 shows the energy use in Fiji as compared to other PICs. The consumption in Fiji has stayed around 400- 500 KTOE per year over the years. Fossil fuels account for 30 % of Fiji's total import bill *(SE4ALL, 2013)*. This fuel import comprises of approximately 259 million litres of diesel, 58 million litres of petrol 191 million litres of kerosene and 16 kilo tonnes of LPG *(SPC report)*.

The transport sector accounted for approximately 70% of the total energy demand *(SPC, 2012)* with the electricity sector accounting for the rest 30%. The electricity supply in Fiji is mostly met by the Fiji Electricity Authority (FEA national grid) and the Rural Electrification Unit (REU) which a part of the Fiji Department of Energy (FDoE). The electricity production by FEA is as shown in table 5.1 and it can be seen that the energy production is increasing yearly in order to supply increasing demands. Hydro and diesel based generation were mostly used to meet the electricity need.

This figure must have changed in the intervening years.

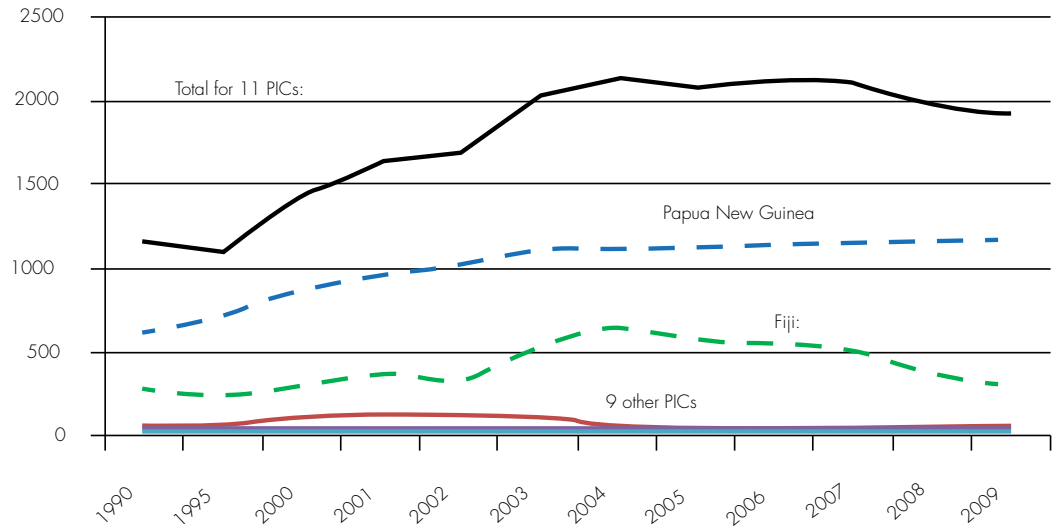


Figure 5.1 PIC Energy use in KTOE (Source: Johnston, P, 2012)

Table 5.1 FEA Energy mix (after FEA 2012 and 2013Report)

Station / Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wailoa hydro (MWh)	448253	343655	357279	322489	315569	481098	462986	436081	382963	424818	466765
Wainiqeu (MWh)	1945	74	1159	1099	1329	1387	688	63	898	1968	1027
Wainikasou (MWh)			8919	15151	18272	21079	18420	16058	19238	19404	18721
Nagado (MWh) [18]					6085	4922	12996	7990	10520	10279	8856
Nadarivatu (MWh)											29892
Total Hydro	450198	343729	367357	338739	341255	508486	495090	460192	413619	456469	525261
Butoni (MWh)						3351	4604	7211	6420	4977	6809
Grid connected solar(MWh)	9	9	6	1.53[19]	4	0.74	-	-	-	-	-
Biomass											
Total Renewable (MWh)	450207	343738	367363	338740	341259	511837	499694	467403	420039	461446	535070
VLIS diesel (MWh)	117763	244848	241084	304863	354174	183329	162760	153990	236356	211767	94215
diesel others (MWh)	35738	39772	41110	41169	40189	41740	46178	43670	52537	44453	48187
HFO (MWh)						30920	60807	112264	126237	83540	128881
Total diesel (MWh)	153501	284620	282194	346032	394363	255989	269745	309924	415130	339760	271283
Total production (MWh)	603708	628358	649557	684772	735622	767826	769439	777327	835169	801206	803353
% renewable (mainly hydro)	74.57	54.70	56.56	49.47	46.39	66.66	64.94	60.13	50.29	57.59	66.6
% diesel	25.43	45.30	43.44	50.53	53.61	33.34	35.06	39.87	49.71	42.41	33.4

[18] Nagado system suffered significant damage during the December 2012 cyclone.
[19] The 10 kW GCPV system installed at FEA depot in Navutu stopped functioning in 2008. In 2011-12, 51 kW of Grid connected PV came into operation. A further 110 kW was added in early 2013.

Figure 5.2 FEA's projection for supply-demand balance (not including the new solar unit). (Source: SE4ALL, 2013)

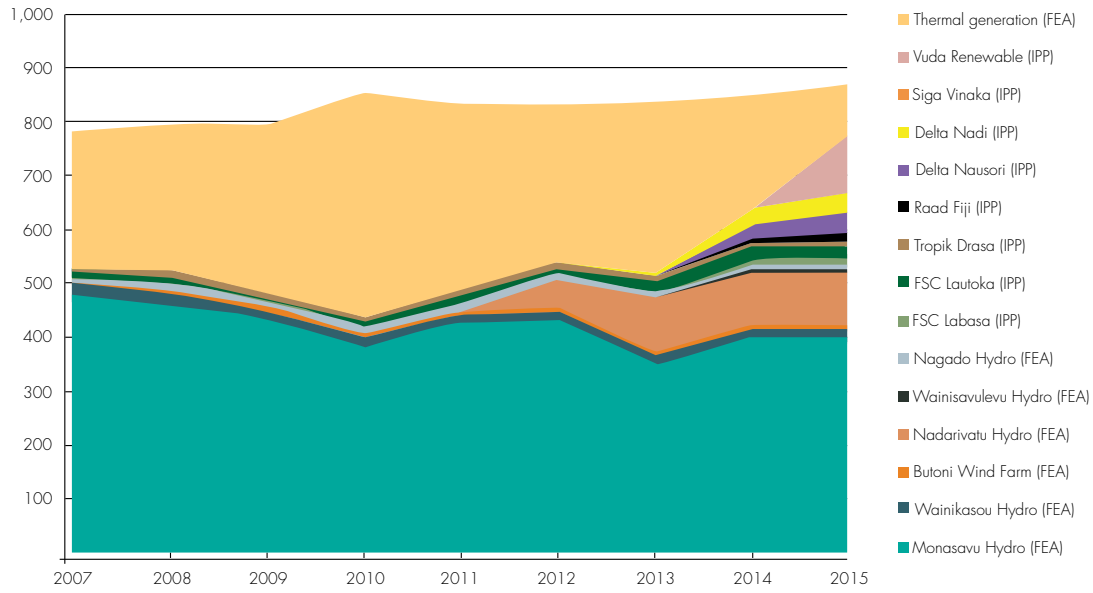


Figure 5.2 FEA's projection for supply-demand balance (not including the new solar unit). (Source: SE4ALL, 2013)

At the end of 2011 the energy mix for the national grid electricity sector was mostly met by 63.6 % hydro, 1 % wind energy, 2.4 % independent power generators (Tropic wood and FSC) with the rest met by use of fossil fuels (FEA, 2013). Table 5.1 also highlights the fact that inclusion of new renewables in the generation mix has lowered the use of fossil fuels helping achieve the FEA renewable energy target of being 90 % renewable by 2015 *(FEA, 2013)*.

The energy mix provided by the REU is a mix of mostly small scale hydro, biofuel and diesel generators and solar home systems. Apart from FEA and REU some of the local stakeholders reduced the dependence on fossil fuels and migrated to the use of renewable sources to meet their energy demands. The other local stakeholders include the IPP, Tropik woods and FSC, and some of the local companies as mentioned in under power generation, contribution from other sectors.

RELEVANT REGIONAL AND LOCAL ENERGY POLICIES

Regional Policies

The first regional energy policy, Pacific Islands Energy Policy and Plan (PIEPP) developed in 2002 *(Singh et al., 2012)* was to act as a guideline for the development of national energy policies and a means of coordinating energy programmes for pacific islands countries. A review by the developers' Council of Regional Organizations of the Pacific (CROP) Energy Working Group (EWG) and PICs in 2004 show the PIEEP being split into Pacific Islands Energy Policy (PIEP) and a Pacific Islands Energy and Strategic Action Plan (PIESAP) *(Wade, 2005)*. Endorsed in 2005 and revised in 2007, the Pacific Plan for Strengthening Regional Cooperation and Integration (PPSRCI) included strategies to promote and make available reliable, affordable and environmentally sound energy options. It also indicated that adaptation and mitigation efforts should be linked to the Pacific Climate Change Framework for Action on Climate Change - 2006-2015 as well to facilitate international financing on climate change.

PIEP was replaced in 2009 by the Framework for Action on Energy Security in the Pacific (FAESP) due to urgent needs to increase energy security and efficiency. FASEP is based on 11 guiding principles, taking into account sustainable livelihoods, climate change, and gender and cultural issues as well as the need for improved planning, capacity development and energy efficiency, allowing stakeholders and PICs to work as one.
In order for successful implementation and achievement its objective and key priorities,

FASEP is associated with the Implementation Plan for Energy Security in the Pacific (IPESP) which links directly to the implementation of FASEP. IPESP comprises of indicators, set targets and milestones for specific regional strategies under each theme.

National Energy Policies

The first National Energy Policy (NEP) for Fiji was developed with the help of PIESAP *(Zieroth, 2008)* and approved by the Fijian Cabinet in 2006. It provided a mutual framework for all energy sectors, both private and public, to move forward in the direction of achieving overall growth and development of the economy by optimum use of energy resources (Fiji National Assessment Report, 2010) focusing on energy planning and security, ensuring a 100 % electrification rate, involvement of private sectors in energy production and focusing on providing incentives for proper use of renewable energy sources. The NEP states that

> *"national leaders have attributed the slow growth in the economy to the unsustainable fuel price increases… prompt(ing) the Government to look for viable alternative energy sources available locally" (Department of Energy 2006: 7). Energy security and renewable energy are two of the four pillars of the National Energy Policy."*

Review of the 2006 NEP is currently underway with a draft submitted in July 2013. It sets out the Fiji Governments direction, reflecting on recent changes and trends, in the energy sector. *(Draft NEP, 2013)*. The main goal of the NEP is Affordable energy for all, ensuring that all Fijians have access to affordable and reliable modern energy services. While the other two goals keep in mind sustainability of energy supplies, by establishing environmentally sound and sustainable systems for energy production, procurement, transportation, distribution and end-use, and reduction of import bill by lowering fossil fuel imports which can be realised by encouraging efficient use of energy and the use of indigenous energy sources. *(Draft NEP, 2013)*. The draft highlights the increasing demand for energy and lack of improvement in Fiji's energy efficiency, untapped RE potential in Fiji and the high dependability of the transport sector on fossil fuels. To combat these issues the targets have been set which are aligned with the SE4All initiative as well as setting out specific policies in the respective areas of Grid based power supply, rural electrification, Renewable Energy, Transport, Petroleum and substitute fuels and Energy Efficiency.

The draft NEP is accompanied by the Draft Strategic Action Plan, which highlights the strategies needed to implement the respective polices, the agencies responsible and the time frame for the implementation (Draft Strategic Action Plan, 2013). Overall there are four main strategy areas which the draft looks at:

Strategy 1: Promotion of private investment in electricity generation
Strategy 2: Strengthen transparency and effectiveness of regulation
Strategy 3: Encourage investment in small-scale renewable energy generation
Strategy 4: Improve the efficiency and effectiveness of management of the electricity grid

Apart from the NEP the Rural Electrification Policy (REP) had been approved by the Fiji cabinet in 1993. To facilitate the REP, FDoE setup the Rural Electrification Unit (REU). The policy stated that rural villages or settlement could request the Fiji government for rural electrification which could be in the form of:

1. FEA grid extension or government station mini-grid to provide 24 hours per day service;
2. a diesel generator with mini-grid system for evening lights and small electrical appliances; and
3. Use of locally available renewable energy systems for electricity generation.

Renewable Energy Based Rural Electrification with Participation of Private Enterprise(REBREPPE) charter, approved February 2003 by Cabinet, incorporated measures to stimulate private sector participation as well as use of indigenous renewable energy resources for provision of rural electrification services and funding from international institutions. The act defined FDoE's role as technical regulator, helping setup quality and safety standards, technical specifications, and ensuring quality of systems by conducting equipment testing. The act incorporated the Renewable Energy Service Companies (RESCO) model currently used in the implementation of solar home systems and applied it to other RE sources and diesel schemes allowing for hybrid systems as well.

The Fiji Electricity Authority (FEA) was established, incorporated and constituted under the provisions of the Electricity Act of 1966 and began operations from August 1st of that year. FEA is responsible for generating, transmitting and retailing electricity in Fiji (Electricity Act Cap 180, 1985).

Environment Management Act (EMA)

To deal with issues pertaining to the protection of the environment, and provide legislative framework for the sustainable development of land and water resource management Fiji has an Environment Management Act (EMA,2005). Key features of the EMA 2005 are:

1. coordination and formulation of environment related policies and plans by the National Environment Council (NEC);
2. Permits to discharge waste and pollutants into the environment;
3. The condition that the Environment Impact Assessments be binding on all stakeholders including the government;
4. Declarations, enforcement orders, stop work notices to ensure environmental compliance in accordance with the laws.

National Climate Change Policy (NCCP)

The National Climate Change Policy was endorsed by Fiji cabinet in 2007, formulated based on Climate Change Policy Framework. It was aligned to the Roadmap for democracy and sustainable socioeconomic development 2009–2014, which highlighted the need for priority protection for the environment, sustainable management and utilisation of natural resources.

The framework identified the position and the need for all stakeholders to work together on the issues and to combat the consequences of climate change. A review of the framework in 2011 reflected the current and evolving issues on climate change at both local and national level as well as international. This review led to the development of National Climate Change Policy, in accordance with the 2011 Corporate Plan of the Department of Environment under its Climate Change Programme. This policy was than endorsed by cabinet on 19th, January 2012. The policy had a clear vision

"A responsible and exemplary Fiji, leading the Pacific in combating climate change and achieving resilience, while attaining sustainable development."

To realize this vision the policy has eight objectives with specific strategies to implement them. One of these objectives is Mitigation

"Reduce Fiji's greenhouse gas emissions and implement initiatives to increase the sequestration and storage of greenhouse gases."

Reserve Bank of Fiji Import Substitution Policy

Under this policy, import substitution concessional funding is available to businesses involved in renewable energy activities. This funding attracts an interest rate of only 2%.

Renewable energy related products are also exempted from import duty. A 10 year tax holiday is available to anyone undertaking a new activity in processing agricultural commodities into biofuels 1 January 2009 to 31 December 2014.Also, The diesel used for blending with biodiesel attracts a duty of only $0.05/L compared to the normal duty of $0.18/L.

EXISTING MITIGATION ACTIVITIES

Fiji has been fortunate to have abundant renewable energy (RE) sources which can be and are being utilized to offset the use of imported fossil fuels. The main RE sources available to Fiji are hydro, solar, wind and Biomass. The main energy stakeholders are from the electricity generation sector and are summarised in the following sections. Mitigation activities are mostly carried out in the energy sector.

Resource Assessment

One of the most important requirements for the development of renewable energy is the detailed assessment of resource available within the country. Following are some of the activities that are taking place in this field:

Fiji Department of energy (FDoE)

FDoE has set-up wind measurement equipment at many sites around Fiji. Table 5.2 shows their locations

Table 5.2: FDoE Wind monitoring stations

Location	Descriptor	Latitude	Longitude	Height (mAGL)	Measurement Period	Ave. Speed m/s	Prevailing Direction
Southern Viti Levu:							
Gamu	Pacific Harbour 2 km Inland and 120 m ASL	180 15′	1780 02′	10	2/95 to 11/95	5.5	97"
Gamu	Pacific Harbour 2 km Inland and 120 m ASL	180 15′	1780 02′	10	2/95 to 11/95	5.5	97"
Vunatovau	3 km North of Sigatoka 6km inland and 183 m ASL	180 06.8′	1770 29′	10 21	12/94 to 3/97	5.4 5.7	129" 126″
Waibogi	Detween Vunatovau and Coast 80 m ASL	180 09′	1770 30′	10	1/95 to 1/96	4.9	
West Coast Viti Levu							
Kavukavu	Momi Bay & Likuri Harbour 3 km inland and 300 m ASL	170 58′	1770 18′	40	8/00 to 9/00 5-Jan 8/01 to 9/01 10/01 to 11/01 4/02 to 6/02	5.1 0.8 5.1 4.7 4.7	191″
Nothern Viti Levu							
Tamuka	In Rakiraki 163 m ASL	N/A	N/A	48	7/99 to 10/99 12/99 to 2/00 7/00 to 10/00 12/00 to 2/01 9/01 to 11/01 11/02 to 1/03	6.3 4.8 6 4.8 6.6 7	136″
Yaqara (new 8/02)	Tuidreke St in Rakiraki 258m ASL	170 27′	1770 59′	20			
Kadavu							
Vunisea		190 03′	1780 10′	30	5/00 to 9/00	4.8	134"
Lomaiviti							
Vadravadra, Gau		N/A	N/A	27	03/03 to 11/05	6.2	103"
Nacamaki, Koro		N/A	N/A	30	07/06 to 01/08	6.1	111"
Vanua Levu							
Wainiyaku, Taveuni		N/A	N/A	19	06/05 to 02/07	5.7	120"
Benau, Savusavu				22	12/04 to 01/05 09/05 to 03/06 07/06 to 03/07 07/07 to 01/08	4.3	134"

Source: FDOE and UNESCAP

Following are some sites being monitored currently.

Table 5.3 FDoE Current monitored stations

Location	Latitude	Longitude	Height (m ASL)	Ave. Speed m/s
Tabiany (Rabi)	160 32 05 S	1790 58 49 E	60	3
Duavata Junior School (Cakaudrove)	160 13 08 S	1790 51 03 E	54	8
Kadavu Provisional High School	180 59 20 S	1780 26 15 E	30	0.9
Vunivaivai	180 72 32 S	1780 33 01 E	35	1.2

Fiji Meteorological Service (FMS)

The FMS has been monitoring wind at the following sites:

- Nabouwalu Government) Station
- Nadi Airport
- Nausori Airport
- Rotuma Government Station
- Suva at University of the South Pacific
- Vunisea Government Station

The FMS also records solar insolation using pyronometer at the following sites:

Table 5.4 FMS monitoring sites

Name	Island	Latitude (S)	Longitude (E)	Elevation (m)	Measurement Period
Nadi Airport	Viti Levu	17:45	177:27	16	1972-2001
Vaturu Dam	Viti Levu		177:40		1982-1987
Monasavu Dam	Viti Levu		178:03	808	1980-1987
Nacocolevu Research Station	Viti Levu	18:06	177:32	11	1987-1995
Koronivia Research Station	Viti Levu	18:03	178:32	15	1987-1995
Laucala Bay	Viti Levu	18:09	178:27	6	1983-2001
Vanuabalau	Lau Group	17:14	178:57 (West)	830	1990-1998
Dreketi	Vanua Levu	16:35	178:51	8	1987-1995
Seaqaqa Agricultural Station	Vanua Levu	16:28	179:10	6691	1987-1999
Nabouwalu Hybrid P.S	Vanua Levu	17:00	178:42	66	1996-1999

University of South Pacific (USP)/ KOICA project

The South Korean government funded USP/KOICA renewable energy project has established a number of wind energy assessment equipment at many sites in Fiji. These sites are in Rakiraki, Laucala Bay, Kadavu and Vanua Levu. Apart from wind assessment the project is also looking at the ocean energy potential using Directional Wave Recorder (DWR), Waverider Buoys and CTD equipment. The data recorded is transmitted to a server located at the USP main campus. There are a number of solar radiation sensors and an Automatic Weather Station (AWS) established on campus, recording the solar insolation. The wave rider buoys were deployed in collaboration with FDoE in December 2012 to carry out tidal current assessment in the northern division. The table below gives a summary of the assessment.

Table 5.5 summary of Tidal assessment in northern division

Site	Time of Measurement	GPS coordinates	Current Speed (m/s)	Depth (m)
1	12:18	16°56'27.60"S	1	31
		178°59'4.70"E		
2	12:27	16°56'32.00"S	1	26
		178°59'16.20"E		
3	12:30	16°56'34.50"S	1.2	21
		178°59'25.70"E		
4	12:34	16°56'32.40"S	1.2	23
		178°59'40.40"E		
5	12:37	16°56'37.68"S	0.8	35
		178°59'48.54"E		
6	12:42	16°56'49.90"S	0.9	28
		178°59'58.50"E		

Power Generation

FEA Mitigation Activities

FEA is the local grid electricity provider in Fiji, supplying the two main islands (Viti Levu and Vanua Levu) and Ovalau with electricity. The main source of power generation by FEA is from hydro and the second being from fossil fuels. Solar and wind contributed to a minute 5 % of the power generation mix at the end of 2011. It can be seen from table 5.1 that a vast percentage of electricity generation comes from renewable sources with FEA increasing such systems in order to meet the demands with a goal to be 90 % renewable by 2015.

This goal is becoming realistic after the commissioning of the Nadarivatu 40 MW hydro, which shows the FEA energy mix was approximately 75.9% renewable with the rest met by fossil fuels (Commerce commission report) at the end of 2012.

Apart from electricity generation by hydro, diesel and wind FEA also buys energy from independent power producers. The independent power producers Tropik woods and Fiji Sugar cooperation mainly use biomass for power generation. As mentioned above, newer player (mainly solar based) have recently joined the IPP family in Fiji.

FDoE

The areas not covered by the FEA grid are serviced by Rural Electrification Unit of FDoE. REU uses a vast mix of energy sources to generate electricity ranging from imported diesel to locally available energy sources. As mentioned earlier REU uses the RESCO model for all its energy shows some of the FDoE renewable initiatives. Note that most of these systems have been installed in rural areas with no access to the grid electricity.

Table 5.6 FDoE RE systems [22]

System installed Approx.	Site Name/Location	Installation date	Installed Capacity	Total Funding ($FJD)
Solar Home System (SHS)	Bua, Macuata, Cakaudrove, Ba, Ra, Nadroga, Navosa, Lomaiviti, Kadavu, Lau, Rewa and Rotuma	2002 - ongoing	1,600 SHS x 100 watts 2000 SHS x 135 watts 1000 SHS x 270 watts	14,800,000
Solar Light Jetties	Koro Island	2008		
Biofuels	Koro (2010), Rotuma (2011) &Cicia (2011)	2010 -ongoing	Rated capacity is 1 ton copra/day i.e. 600L of CNO per day. Annual Diesel demand for 3 mills is 230,000 L/year and blending at 80:20 ratio (R20) will save 46,000L of diesel per	1,200,000 (Private Companies, Ministry of Works
Biogas Project	Waila, Namatakula, Nasau, Wainiyabiya, QVS, RKS, Deepwater, Waimaro, Natovi, Natalasese	2008	2 x 4 cubic meters, 5 x 8 cubic meters and 3 x 15 cubic meters biogas digesters	308,000
Mini Hydro	Buca Micro Hydro Project, Buca, Cakaudrove, Vanua Levu	Jul-10	30 kW	900000 (Turkish Government) [23]

Apart from the biofuel projects mentioned above FDoE has biofuel plants in Gau, Moala, Matuku, Rabi, Lakeba and Vanuabalavu with supply potential as summarised in below.

Table 5.7 FDoE Biofuel Potential [24]

	Shed Cost	Builder	Equipment Cost	Supplier	Copra Capacity (Tons/24 hr)	Supply (Biofuel liters/month)
Gau	296,152.00	Fortech Construction	≈40,000	GEMCO (China)	3	Potential 1400
Moala	219,507.04	Fijiana Builders	≈106,535	Kumar Metal Ptv Industries (India)	5	Potential 1400
Matuku	220,972.04	Fijiana Builders	≈106,535	Kumar Metal Ptv Industries (India)	5	Potential 1400
Rabi	305,595.00	Fortech Construction	≈106,535	Kumar Metal Ptv Industries (India)	7	Potential 3000
Lakeba	307,484.00	Fortech Construction	≈106,535	Kumar Metal Ptv Industries (India)	7	Potential 5000
Vanuabalavu	325,232.70	Modern Investment	≈106,535	Kumar Metal Ptv Industries (India)	7	Potential 5000

[22] Data collected from FDoE using mitigation matrix
[23] This project was initially funded by the S.Korean Government.
[24] 1 ton copra = 550 liters oil, Biofuel mix – 20% CNO & 80% Diesel

Contribution from private sectors

Stakeholders ranging from big corporate companies like Vodafone to hotels to small village communities are working hand in hand with the government to reduce GHG emissions. Summarized below are some of the contributors to this reduction effort. It should be noted that no matter how minute the contribution is it still helps in working towards the bigger goals to reduce GHG's and dependency on fossil fuels.

Vodafone Fiji

Vodafone Fiji plays a major part in reduction of GHG emissions by employing the use of RE to run its communication repeater station. This helps Vodafone not only reduce GHG's but also their costs. The fossil fuels had to be transported up to the stations as they are mostly on top of mountains and are hard to access shows Vodafone Fiji's contribution to mitigating the use of fossils in Fiji.

Table 5.8 Vodafone systems [25]

Type of Hybrid Installed (Solar/ Wind)	Site Name/ Location	Installation date	Status (Present)	Outputs (Watts)	Total Funding ($FJD) Approx.
Solar	Mavana (Vanuabalavu)	May-02	Operational	6.13KWp	150-250k
Solar	Muani (Kadavu)	Oct-02	Operational	5.0KWp	150-250k
Solar	Nagani	Apr-03	Operational	4.95KWp	150-250k
Solar	Qalaira (Kadavu)	Dec-03	Operational	4.98KWp	150-250k
Solar + Standby Generator (4.5KVA–TR2)	Muanidevo (Vanua Levu)	Jun-04	Operational	6.44KWp	150-250k
Solar + Standby Generator (4.5KVA–TR2)	Dreketi (Vanua Levu)	Sep-04	Operational	6.93KWp	150-250k
Solar	Nacula (Nacula Island)	Nov-04	Operational	5.95KWp	150-250k
Solar	Yanuca	Jan-04	Operational	7.51KWp	150-250k
Solar + Standby Generator (11KVA)	Rabi	Sep-05	Operational	6.13KWp	150-250k
Solar	Matanuku (Kadavu)	Oct-09	Operational	6.6KWp	150-250k
Solar + Standby Generator (11KVA)	Vanira (Vanua Levu)	Nov-09	Operational	5.62KWp	150-250k
Solar	Gau (Vione)	Dec-10	Operational	7.9 KWp	150-250k
Solar	Lakeba	Oct-10	Operational	5.8KWp	150-250k
Solar + Standby Generator (11KVA)	Ono	Mar-10	Operational	5.8KWp	150-250k
Solar + Standby Generator (7.5KVA)	Naviti	Jan-11	Operational	4.2KWp	150-250k
Solar + Standby Generator (22KVA)	Buaxite (Vanua Levu)	Aug-12	Operational	4.05KWp	150-250k
Solar + Standby Generator (11KVA)	Nayavu	Jul-13	Operational	5.8KWp	150-250k
Solar + Standby Generator (7.5KVA)	Bukama	May-13	Operational	4.2KWp	150-250k

[25] Data collected from Vodafone using mitigation matrix

Fiji's other mobile communication company, Digicel Fiji, operating in Fiji is also working towards using renewable energy resources for its repeater station.

Tourism forefront

Resorts in Fiji and the tourism industry in general play a very important role in supporting Fiji's economy. This sector is also active in using climate friendly technologies (mainly solar PV) to promote eco-tourism and provide a "Green vacation" to guests (Table 5.9). The installation varies in size, from below 1 kW to a substantive 228 kW. In some cases, small systems installed previously have been and are being upgraded once the confidence in RE was proven to be a success.

Table 5.9 Systems installed in hotels [26]

Type of Hybrid Installed (Solar/Wind)	Site Name/Location	Installation date	Outputs (kW)	Total investment($FJD) Approx.
Solar/wind	Nukubati Private Island, Great Sea Reef, Fiji Islands, Labasa,Vanua Levu	1992	10 (hybrid solar wind)	Not available
Solar	Kulu Bay Resort (Beqa)	Feb-04	0.11	Owners
Solar	Palmlea Lodges and Bure Villas, Labasa,Vanua Levu,	2005	2 (upgraded in 2012)	Owner (Joe& Julie Smelser)
Solar	Matava Fiji's Premier Eco Resort PO Box 63, Vunisea, Kadavu Island	May-10	2	12000 (owners)
Solar, Hydro, Wind	Nakia Resort & Dive Fiji PO Box 204,Waiyevo,Taveuni, Fiji		Hydro- 2.5 Solar – 1.6 Wind turbines-max. of 48 volts to 240 with a 5000 watt inverter.	Not Available
Solar	Fijian Shangri'la Resort, Yanuca Island,Fiji	Nov-10	1	7,533.79
Solar [27]	Port Denarau Marina	Feb-13	122	Not Avalable
Solar	Turtle Island Resort, Mamanuca Island Group in partnership with Inovatou Solar LLC	Jun-13	228 (produces 1100kWh, 968 Solar PV Panels,228 KW Solar plant,384 batteries)	1.5 Million - Turtle Island Resort & Partners

Teaching and research Organisations

Apart from the government and the private business sector the two universities in Fiji are also implementing RE systems. USP through international funding has setup a significant amount of RE system which not only provides electricity to its Laucala campus but also provide a training ground. The summary of the USP RE systems is provided in Table :

[24] Data collected from Vodafone using mitigation matrix
[27] Data from Fiji Sun (other smaller systems PV are planned for the future as well

Table 5.10 USP RE systems

Type of Hybrid Installed (Solar/Wind)	Site Name/Location	Installation date	Installed capacity(kW)	Total Funding ($FJD) Approx.
Solar/wind	USP campus, Laucala	Feb -09	1.2	16 000
Solar	USP campus, Laucala	April 2010	1.2	40 000
		November 2011	45	~ 600,000 [28]
		August 2012	2.6	40,000
		November 2012	3	30,000

The biofuel standards have been adopted and used as benchmark forall biofuel products in Fiji. For this reason, a Biofuel testing laboratory has been set-up at the USP in collaboration with the FDoE to test the compliance status of the biofuels produced and sold locally.

The Fiji National University has also established two hybrid systems at their Samabula campus for teaching and demonstration purpose.

Transport Sector

For the transport industry, biofuels have been used mainly to offset the use of imported fossil fuels as well as to run diesel generators. The production and sale of biofuels is regulated and controlled by the biofuel policy. The two main companies responsible for the sale of biofuels to be used in diesel vehicles without modification in Fiji are Niu industries and Biofuels Fiji Limited.

Niu Industries, located in Walu Bay, was established in 2009 and produces approximately 240 000 litres of biodiesel annually. The biofuel industry in Fiji has a common objective

"To recognize and fulfill any and all Fiji's needs in domestic oil requirements, cut domestic diesel costs for Fiji by 25%, Contribute to Community and National Development,

The fuel produced by the Niu industries is called Niu 80 nex-gen Biodiesel and consists of a blend of 80% coconut oil, 20% diesel and 750 mils catalyst. The fuel was sold at a price of $1.68 per litre [29], in 2009, on the main island and slightly higher in the islands due to the transportation costs involved [30]. Niu 80 Nex-Gen Biodiesel conforms to ASTM D 975 (Std Reference), and is made without the esterification process, eliminating cost, logistical and environmental problems associated with esterification (Richard, 2012).

Biofuels International, an international company, partnered with Bio-Agrotech, has a stated goal of reducing the world's reliance on fossil fuels by implementing renewable energy projects (Biofuels International, 2008). The company received approval in 2009 to operate in Fiji, aiming to reduce the diesel importation cost by approximately 25 % at the same time working towards to contributing to community and national development of the island nation. The approval allowed more than 500,000 hectares of "Pongamia Pinnata trees", Castor and other varieties of oil producing crops to be planted throughout Fiji from which oil would be extracted and converted to bio-fuel with an expected production of 800 million litres annually. According to the developers, this oil will yield a clean burning energy source powering diesel engines which will produce zero emissions from the engines at the same time allowing the engines to run with much more efficiency.

A project by United Nations Development Programme (UNDP), Promotion of Environmentally Sustainable Transport in PICs (PESTRAN), is currently in justification process and aims to mitigate climate change in the PICs by promoting environmentally sustainable ground transportation systems for improving energy efficiency in transport, and for improving public transportation systems (reference). It aims at reducing emissions in the transport sector by

a) Reduction of fuel consumption in transport sector
b) Implementation of energy-integrated transport policy-based infrastructure development, encouraging use of non-motorized transport and public transportation;
c) Implementation of energy-integrated urban transport plans resulting in improved urban mobility and increased public transport reliability;
d) Improved capacity of national and local governments in policy-making and enforcement on transport technology and non-technology measures;
e) Improved technical capacity of

[28] This is 2011 cost. The solar module prices have fallen significantly since.
[29] Diesel price is currently FJD$ 2.36
[30] Price on –2013

urban planners on integrated land use planning and management activities that lead to cost-effective and sustainable transport systems;

f) Improved technical capacity for stakeholders in the government, private sector and NGOs on improving and maintaining transport vehicle energy efficiency performance; and

g) Increased public awareness on benefits of non-motorized transport and public transportation and effect on global climate change.

Other initiatives to reduce GHG's and fossil fuel dependency

Apart for reducing the use of fossil fuels for power generation other mitigation initiatives are also being considered such as planting more trees to act as carbon sinks, increasing efficiency on both supply and demand side or to capture escaping gases (from water treatment plants for example) to be used for cooking or power generation. Even though they are on a small scale they add up to the common goal of mitigating climate change.

Carbon sinks

1. One such initiative is the Beqa Adventure Divers - Mangroves for Fiji that believes that mangroves are nature's answer to Global Warming. Mangroves serve as natural armour against climate change and at the same time contributing towards the global reduction of greenhouse gas emissions. Participating businesses aim to at completely offset their own carbon emissions by promoting and sponsoring the planting of mangroves in Fiji. The partner organisations in this project are Department of Environment, Department of Forestry, Department of Fisheries, and Marine Ecology Consulting. The various location and activities are summarized in Table 5.11.

2. REDD+ initiativess.

REDD+ now forms a key component of the activities of a number of organizations in Fiji with a significant financial contribution from the Fiji Government starting in 2012.

REDD+ was identified as a potential climate activity for Fiji in 2008 and a scoping workshop was carried out by a number of international consultants in late 2009 to identify the actual feasibility, scope and components of a possible REDD+ project for Fiji. The workshop included wide consultations with various key stakeholders such as the Ministry of Agriculture, the Department of Forests, Department of Environment, the Climate Change Unit, the Fijian Land Administration, Landowner groups, NGOs, and many others. It also involved an assessment of possible sources of emission from the forest sector, potential REDD+ activity types, current data and data collection, storage and processing capacity and capabilities to identify data and capacity gaps and needs. The report from this scoping mission forms the basis and foundation for all other REDD+ work that is carried out in Fiji the very first of which was the development of the Fiji REDD+ Policy in 2010.

The Fiji Government endorsed the Fiji REDD+ Policy in December 2010. The Fiji REDD+ Policy was then launched by the Permanent Secretary for Fisheries and Forests with the presence of a number of media organizations and with other key stakeholders in early 2011. In 2012, the Fiji Government started its financial commitment towards the project with the translation of the Fiji REDD+ Policy into the Fijian vernacular language, and the finalisation of the Fiji REDD+ Strategy. With the establishment of the Fiji REDD+ Steering Committee, reporting to the Fiji Forestry Board and the National Climate Change County Team, REDD+ now forms a key component of Fiji's climate change mitigation effort.

Carbon measurement and monitoring permanent plots had been established throughout the main islands of the country covering the bulk of Fiji's land mass, with the first assessment of Fiji's national forest carbon stock already undertaken including Fiji's forest cover change assessment. REDD+ Pilot sites had been established and field works are now ongoing.

Table 5.11 mangroves for sinks

Project Title Contact	Locations	Outputs
Beqa Adventure Divers - Mangroves for Fiji	Viti Levu: 3 locations in Galoa Village, Culanuku Village, Waicoka Village, Vatutavui Village, Namatakula Foreshore, Nakorovou Village, Vunaniu Village, Serua Island	For this project, it is assumed that one hectare of Mangroves (= 10,000 Mangrove trees) sequesters one metric ton of Carbon every year.
	Lau Islands: Lomati Village	
	Vanua Levu: Naibulu Village	the participating Planters who are either active or have already completed their task; and the Businesses who have decided to participate in the aim of offsetting their Carbon Footprint and are either engaged in, or have competed their individual projects and are entitled to call themselves Carbon Neutral Businesses under this project.

Table 5.12 below lists projects that support REDD+ in Fiji: (Pages 108-111) [31]

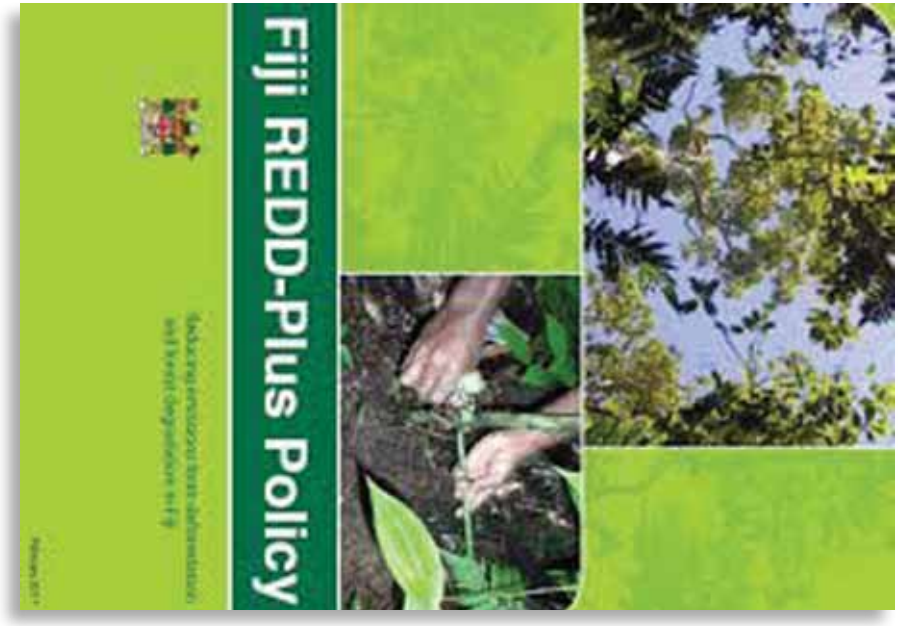
Project Title Contact	Locations/ Duration	Themes and Objectives	Activities and Outputs	Lead organization	Partner organizations	Donors
Fiji-German Forestry Projectz	Dur: Jan 85-jan89 4 years	Sustainable Forest Management (SFM)	Pine Extension (with Forestry Department and Fiji Pine – handed over to Fiji Pine), Agroforestry/Extension Trials & Awareness (with the Ministry of Agriculture)	Department of Forestry	Ministry of Agriculture	German Federal Ministry for Economic Cooperation & Development
Fiji - German Forestry Project	Loc : Nakavu Dur: Mar-90-dec 94 4 years		The Nakavu Sustainable Forest Management Pilot Project is established and research work undertaken			German Federal Ministry for Economic Cooperation & Development
Pacific German Regional Forestry Project (PGRFP)	Dur: 1994-1996 Ist Phase 2 years		The FAO/UNDP South Pacific Forestry Development Programme (SPFDP) is selected as an interim co-operation partner	Department of Forestry	FAO,UNDP	FAO/UNDP
SPC/GTZ Adaptation to Climate Change in the Pacific Island Region Project (ACCPIR)	Dur: Jan-09-dec-02 3 years	Reduction of GHGs	'Adaptation Project'' with the exception from Fiji- REDD+	SPC	GTZ, Department of Forestry	German Federal Ministry for Economic Cooperation & Development
1995 – 1st regional planning workshop	Start Date: 1995		The identification of Drawa as a pilot site for sustainable forest management. Application of SFM prescription derived from Nakavu research site. SPC becomes regional partner, thus the SPC/GTZ Pacific German Regional Forestry Project	SPC	GTZ, Department of Forestry	GTZ
ACCPIR expanded to SPC/GIZ Coping with Climate Change in the Pacific Island Region	Dur Jan-11-dec-15 4 years	Reduction of GHGs	Development of a picture-based outreach toolkit/ resource of climate change for the education sector. Provision of TA to national govt to develop and launch Fiji's natural CC Policy. Designing a CC Database & database websites for Fiji.	SPC	GIZ, Department of Forestry	German Federal Ministry for Economic Cooperation & Development
Vunivia Watershed	Dogotuki,Macuata, Vanua Levu Proposed site Start: Sep-12	Reduction of GHGs	To calculate a site specific forest carbon calculation of the forest of Vunivia and to establish project permanent sample plots.	Department of Forestry	Fiji REDD+ Steering Committee: - MOFA - TLTB - TAB	

[31] Data collected using mitigation matrix

Project Title Contact	Locations/ Duration	Themes and Objectives	Activities and Outputs	Lead organization	Partner organizations	Donors
			TTraining of local field assistants will be conducted from 1st to the 5th of October. Inventory work will take place from 8th to 26th October. Field survey team will include: Fiji Forestry Department Vunivia Mataqali members/landowners who will be taking part in the surveys as guides, field assistants and resource persons Drawa Experts. Cultural mapping – Ministry of iTaukei Affairs 2. Socio-economic survey – Forestry Dept., Ministry of iTaukei Affairs, Department of Culture, Department of Agriculture, SPC, GIZ, other (early 2013) 3. Biodiversity (flora, fauna, avifauna, invertebrates, fish, insects, reptiles etc.) – USP, local experts 4. Archaeological mapping – Fiji Museum		- DoE - Lands & Mineral Resource - DOAgri - Provincial Development - REDD+ Resource Owner rep. - CI - LLEE - Fiji Sawmillers Association - Fiji Pine Limited - Fiji Hardwood Corporation Ltd - Fiji Mahogany Trust - Fiji Pine Trust - SPC - USP - IAS - GIZ	German Federal Ministry for Economic Cooperation & Development
Mataqali Emalu	Loc: Draubuta Village,Navosa, Viti Levu Dur: 2009- Policy making, Phase 1-July 2012,Phase 2- Survey and Logistics March 2013	Reduction of GHGs To survey and demarcation of village boundaries. The collation of traditional knowledge will also be associated with the mapping exercise.- To calculate a site specific forest carbon calculation of the forest of Emalu and to establish project permanent sample plots.	Socio-economic survey,Biodiversity survey,Cultural mapping,Forest inventory, and Carbon measurements	Department of Forestry	Fiji REDD+ Steering Committee: - MOFA - ILTB - TAB - DoE - Lands & Mineral Resource - DOAgri - Provincial Development - REDD+ Resource Owner rep. - CI - LLEE - Fiji Sawmillers Association - Fiji Pine Limited - Fiji Hardwood Corporation Ltd	German Federal Ministry for Economic Cooperation & Development

Project Title Contact	Locations/ Duration	Themes and Objectives	Activities and Outputs	Lead organization	Partner organizations	Donors
					- Fiji Mahogany Trust - Fiji Pine Trust - SPC - USP - IAS - G12	
Drawa	Loc Vanua Levu Dur: 2009- Policy making, Phase 1-July 2012,Phase 2- Survey and Logistics March 2013	Reduction of GHGs To survey and demarcation of village boundaries. The collation of traditional knowledge will also be associated with the mapping exercise.- To calculate a site specific forest carbon calculation of the forest of Emalu and to establish project permanent sample plots.	Socio-economic survey,Biodiversity survey,Cultural mapping,Forest inventory, and Carbon measurements	Department of Forestry	Fiji REDD+ Steering Committee: - MOFA - ILTB - TAB - DoE - Lands & Mineral Resource - DOAgri - Provincial Development - REDD+ Resource Owner rep. - CI - LLEE - Fiji Sawmillers Association - Fiji Pine Limited - Fiji Hardwood Corporation Ltd - Fiji Mahogany Trust - Fiji Pine Trust - SPC - USP - IAS - G12	German Federal Ministry for Economic Cooperation & Development
SPC/GTZ Pacific German Regional Forestry Project	1997-2000 2nd Phase 2000-2003 3rd Phase (2002 Project Evaluation) 3 years		Review (March 2000) recommend Project phase to continue for another 4 years due to work in progress			German Federal Ministry for Economic Cooperation & Development
	2003-2006 4th Phase (later extended to 2007-2008)5 years		Evaluation in 2002 recommend Project continuation and increased activities in SLM			

Project Title Contact	Locations/ Duration	Themes and Objectives	Activities and Outputs	Lead organiza-tion	Partner organizations	Donors
			Increased involvement of SPC-LRD and other agencies (increased membership from other sectors in SFM Working Committee) in Project activities.			
SPC/GIZ Climate Protection through Forest Protection in Pacific Island Coun-tries project	Nov-10-mar-15 5 years	Sustainable Forest Management (SFM)/ Reduction of GHSs				Federal Ministry for the Environment, Nature Conservation and Nulcear Safety, International Climate Initiative (ICI)



Energy efficiency and other initiatives

It has been long recognized that energy efficiency activities are the cheapest way to mitigate climate change. The reduction in energy consumption by using energy efficient appliances and processes can help reduce the dependency on fossil fuels by reducing energy demand. In order to cater for this, the "Minimum performance standards and labelling programme", started in 2012, has been implemented to regulate the electrical goods that are being brought into the country and ensure that only energy efficient and complaint products are sold in Fiji. The programme ensures that appliances are AS/NZ compliant (AS/NZS 4474.1 AS/NZS4474.2) at the same time eradicating of the dumping of energy hungry models of freezers and refrigerators into Fiji.

The programme is carried out in 4 stages mentioned below:

1. Screening of applications for import prior to giving approval.
2. Inspection at the border for confirmation of only compliant appliances being imported.
3. Awareness programs on the MEPSL program and the conservation of energy
4. Promoting energy efficient appliances into Fiji

The main implementers of this AUSAID funded programme are SPC, Australian Department of Climate Change and Energy Efficiency, Retailers of household freezers and refrigerators, Solicitor General's Office and Fiji Revenue and Customs Authority.

UNDP also has various projects to target energy efficiency, ranging from educating the public, enhancing access to financing to for improving energy service and efficiency to encourage use of non-motorized vehicles for transportation and helping governments in improve their policies. The full details of theses aims and efforts are as tabulated below.

Table 5.13 UNDP energy efficiency [32]

Project Title Contact	Locations	Status	Objectives	Outputs	Total funding (in FJD)
UNDP-Regional Programme for Poverty Reduction	Country: 10 PICs Fiji, FSM, Kiribati, Nauru, RMI, Palau, Solomons, Tonga, Tuvalu, Vanuatu	Closing Stage	Contributes To climate change mitigation. Contributes towards achievement of MDGs target, through broad-based interventions in three thematic areas of priority: improving access to energy services; promoting efficient use of energy; and increasing access to financing for sustainable energy.	a) Regional knowledge platforms on integrating energy-poverty linkages into development policy planning to improve access to energy services of 'un-served' and poor; b) SMEs capacity for efficient use of energy enhanced; c) Enhanced access to financing and financing options for improved energy services and energy efficiency; and d) Advocacy materials: Energy opportunities in the Pacific.	Donors - UNDP
UNDP-Promotion of Environmentally Sustainable Transport in PICs (PESTRAN): PDF-A	Fiji, Samoa, Vanuatu	Justifying stage: Project Information Form (PIF) submitted under GEF-PAS, but did not receive endorsement/ commitment from two pilot countries	Contributes to climate change mitigation. Aims to reduce GHG emissions from transport sector of PICs, commencing with three pilot countries (Fiji, samoa and Vanuatu). Promotes environmentally sustainable ground transportation systems for improving energy efficiency in transport, and for improving public transportation systems	MSP/PIF with highlights of main deliverables: a) Reduced fuel consumption in transport sector resulting in reduced CO_2 emissions; b) Implementation of energy-integrated transport policy-based infrastructure development, encouraging use of non-motorized transport and public transportation; c) Implementation of energy-integrated urban transport plans resulting in improved urban mobility and increased public transport reliability; d) Improved capacity of national and local governments in policy-making and enforcement on transport technology and non-technology measures; e) Improved technical capacity of urban planners on integrated land use planning and management activities that lead to cost-effective and sustainable transport systems; f) Improved technical capacity for stakeholders in the government, private sector and NGOs	Donors - GEF-USA-2,932,000 (US$25,000: PDF-A, US$1,000,000: MSP, Co-financing: US$1,907,000)
				on improving and maintaining transport vehicle energy efficiency performance; and g) Increased public awareness on benefits of non-motorized transport and public transportation and effect on global climate change.	

[32] Data collected from Vodafone using mitigation matrix

Other activities

The UNDP RESCO project that ended in 2005 was aimed at removing barriers in the implementation RE systems for rural electrification by developing regulatory framework for implementation by the Government of Fiji. The regulatory framework will provide the legal and economic guidelines required for the establishment of sustainable renewable energy service companies (RESCOs) for the rural sector. This allowed RESCO to have a major role in renewable energy-based rural electrification which has already been highlighted in the REBREPPE charter. Also a part of this project currently in running stage is the preparatory phase of the Fiji Biofuel Industry Development Programme. This project involves fuel efficiency testing of diesel and coco diesel fuel. This was brought about by the declining preferential EU prices for sugar, increase in fuel prices and the consecutive increase in demand for energy. Coconut oil and ethanol from sugar showed promising potentials to meet the energy demand on environmental, economic and social levels. The preparatory phase focuses on further establishing priority areas of intervention by various stakeholders in light of future implementation. Project reports with highlights of main deliverables:

a) National Energy Dialogue concept and project proposal
b) Bio-fuels Blends Testing Programme project document;
c) Bio-fuels for electricity generation in Viti Levu strategy;
d) Coconut oil use strategy document for Vanua Levu;
e) Action plan for Partnerships Strategy
f) Terms of Reference for the Biofuels Coordinating Committee
g) Capacity Building Programme project document; and
h) EU Sugar Industry Diversification project proposal.

The FDoE apart from providing rural base electrification through REU was involved in other projects that help mitigate climate change. The first project which covered a time frame of 4 years, from 2008-2012, was the Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP). The outputs of the project were to carry out RE assessment and create a database, detailed designing of hydro & wind (hybrid with diesel) projects, establishment of the Biogas Market, holistic training provided to all those that are involved in renewable energy developments, including rural communities, Renewable Energy Advocacy Programme and establishment of a Renewable Energy Information Centre (PIGGAREP outputs to be confirmed by Navinita).

The second project was FREPP in conjunction with UNDP, starting October 2011. This project focused on the removal of barriers (policy, regulatory, market, finance and technical), to the wide-scale use of renewable energy resources for grid-connected power generation in Fiji. Four main components and outputs highlighted in FREPP are:

1. *Energy Policy and Regulatory Frameworks* with outputs including Enactment and Enforcement of Fiji Energy Act and Enforcement of Implementing Rules and Regulations for the Fiji Energy Act
2. *Renewable Energy Resource Assessments and Renewable Energy-based Project Assessments*
   - Establishing a Centralized Energy Database System
   - Completion and Publishing of Renewable Energy Resource Assessments in Fiji
   - Completion of Feasibility Assessments of Renewable Energy Investments
3. *Renewable Energy-based Power Generation Demonstrations*
   - Designing and Implementation of Renewable Energy-based Power Generation Demonstration
4. *Renewable Energy Institutional Strengthening*
   - Completion of Training Programme on Integrated Energy Planning and Administrative Policy for Government Personnel
   - Completion and Approval of National Electrification Master Plan

Further expectation from FREPP is the facilitation of RE based power generation investments in Fiji in order to make use of the countries RE resources at the same time reducing GHG Emissions.

CDM projects

The Clean Development Mechanism (CDM) is a market based mechanism under the Kyoto Protocol for developing climate change mitigation projects in developing countries. The Pacific island Countries have not been able to take advantage of the clean development Mechanism due to several reasons, lack of human capacity and small sizes being the main issues. In recent years, special measures have been put in place to encourage PICs too fully part. Fiji is among the only two PICs to have CDM projects registered- a bundled small scale hydropower project and a methane recovery/combustion project.

A CDM Policy Guideline for Fiji was drafted in 2010 under the CDM sub-component "Capacity Building related to Multilateral Environmental Agreements (MEA) in African, Caribbean and Pacific (ACP) Countries project". It is intended to act as an aid in administering, managing, facilitating and controlling CDM Processes in Fiji. There is a substantial potential for GHG reduction in Fiji making the country suitable for implementation of small/micro/programmatic CDM projects. Like other PICs (except PNG) there is no scope for single large scale CDM project however the CDM potential could be realised in many small scattered CDM projects. The CDM project both existing and proposed are indicated in table 5.14

Table 5.14 CDM projects [33]

Project Title Contact	Locations	Status	Crediting Period	Duration	Sector	Objectives	Activities	Outputs
Renewable Energy								
Water And Sewage Department(WSD) -Kinoya Sewage treatment Plant GHG Emission Reduction Project	Kinoya	Registered 3-May -11	15 Apr 12 - 14 Apr 22 (Fixed)	Jan-08-apr-22 14 years	Biomass	To reduce the GHG by converting methane to carbon dioxide by flaring	Involves the introduction of methane recovery and combustion system to the existing and proposed anaerobic sludge treatment units(anaerobic	Annual CERs 22,471/ tCO_2e/yr)
Methane Capture and Flaring at Naboro Landfill	Naboro	PIN stage			Biomass (Methane Capture)	It aims to reduce methane emissions to the atmosphere through landfill gas(LFG) recovering and flaring; estimated annual emissions reductions of approximately		Annual CERs 15,000 / tCO_2e/yr)
Biogas Cogeneration-Fiji Sugar Cooperation		PoAs at PIN stage			Biomass (Reduction of Methane Emission)	The proposed PoA will contribute to reduction of methane emissions from untreated household and agricultural and livestock waste; plan to install 5 to 10 new projects; the estimated annual emission reductions from the first CPA is 500tCO_2e; the project additionally shall be demonstrated by carrying out barrier analysis		Reduction from first CPA:500 /tCO_2e/yr)
Sewerage Treatment -National Biogas Programme of Activities in Fiji	Navakai Wastewater Treatment Plant,Nadi	PoAs at PIN stage		Nov-12 (28 years)	Biomass (Reduction of Methane Emission)	utilise the oil extracted from plentiful vegetable oil resources (mainly coconut oil and palm oil) in Fiji for electricity generation and transportation lowering the greenhouse gas emissions; estimated annual emissions reductions of 800tCO_2e; project meets the criteria of additionally for micro scale project activity		Reduction from first CPA:16,625 /tCO_2e/yr)

[33] Data collected from Vodafone using mitigation matrix

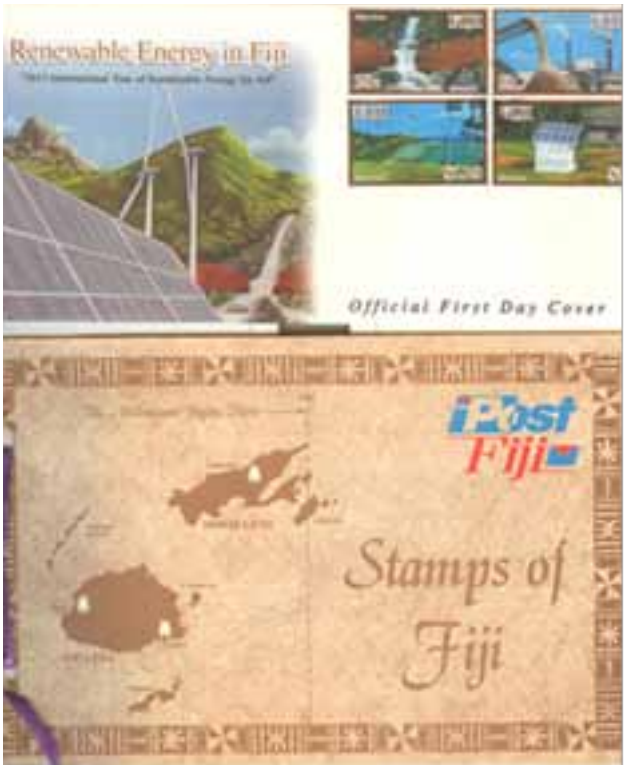
Project Title Contact	Locations	Status	Crediting Period	Duration	Sector	Objectives	Activities	Outputs
Renewable Energy								
Tropix Biomass Power Generation Project		PoAs at PIN stage			Biomass	The proposed project activity will reduce CO_2 emissions through displacement of more carbon intensive fuel based electricity generation; project installed capacity is 9.3MW;estimated annual emissions reduction of 30,000 tCO_2e; the project additionally shall be demostrated by carrying out barrier analysis		Reduction from first CPA:30,000 /tCO_2e/yr)
Plant Oil Power Generation for maritime communities		PoAs at PIN stage			Biofuel	utilise the oil extracted from plentiful vegetable oil resources (mainly coconut oil and palm oil) in Fiji for electricity generation and transportation lowering the greenhouse gas emissions; estimated annual emissions reductions of 800tCO_2e; project meets the criteria of additionally for micro scale project activity		Estimated annual emission reduction of 800 / tCO_2e/yr)
Fiji Electricity Authority Nadarivatu Hydropower Project	Nadarivatu	Registered May-10		Oct-07-jan-11 4 years	Hydro	Reduce fossil fuel consumption	to attain affordable, stable and secure source of energy for the future economic growth and prosperity of Fiji	Annual CERs 51,459/ tCO_2e/yr)
Fiji Electricity Authority (Vaturu and Wainikasou small) – scale Hydropower Project)	Vaturu, Wainikasou	Registered 1-Oct-05	01-Jun-05 -31 May 12(Renewable)	Oct-05-may12 7 years	Hydro	They are small scale run of river hydro projects in Fiji implemented by Sustainable Energy Limited(SEL),a joint venture between the FEA and hydro project developer,Pacific Hydro Limited (PHL). Annual average CERs from the project activity is 57,564 tCO_2e/year		Annual CERs 51,459/ tCO_2e/yr)

Project Title Contact	Locations	Status	Crediting Period	Duration	Sector	Objectives	Activities	Outputs
Renewable Energy								
Qaliwana Hydro-power Project	Qaliwana	PDD stage			Hydro	To ensure that the people of Fiji attain affordable,stable, and secure source of energy for the future economic growth and prosperity of Fiji;18 MW hydropower scheme		Annual CERs 19,717 / tCO_2e/yr)
Fiji Tourism Energy Efficiency Invest-ment Project		PDD stage			Energy Ef-ficiency	It aims to work with the tourism sector to identify solutions to increase energy efficiency in hotels and resorts and reduce impacts on the environment; project activity meets the criteria of additionality for micro scale project activity		Annual CERs 4,847 / tCO_2e/yr)
National Grid-connected Hydro-power		PoAs at PIN stage			Hydro	The proposed PoA will contribute to reduction of CO_2 emissions avoiding usage of diesel for equivalent electricity generation: the estimated an-nual emissions reductions from the first CPA is 57,564 tCO_2e; the project additionality shall be demostrated by carrying out barriers analysis		Reduction from first CPA:57,564 /tCO_2e/yr)
Lighting Energy Efficiency	Hotels & Resorts: Castaway, Intercon-tinental, Lomani, Mercure Nadi, No-votel Nadi, Novotel Suva, Out-rigger, Plantation, Raffles, Warwick, Tanoa Nadi	PoAs at PDD stage		Nov-12	Energy Ef-ficiency	To use energy efficient lamps(Compact Fluorescent Lamps) to replace 100,000 incadescent Lamps used in resi-dential lightning,commercial and street ligheiing in Fiji;estimated annual emission reductions of 6,000 tCO_2e;project activity meets criteria of additionality for micro scale project activity		Estimated annual emission reduction of 4714 / tCO_2e/yr)

RE Awareness Initiatives

A number of activities under PACE-SD, Project DIREKT, USP /KOICA project, DOE Energy efficiency campaigns. As part of the Project DIREKT awareness and a direct result of its workshops a basic but highly informative text was produced which aimed at providing the local individual with knowledge of RE resources and system. Added to these is the marking of earth hour organised by WWF, initiated in 2009, which aims at highlighting the actions taken by people, businesses and governments worldwide in to reduce environmental impact.

In 2012, Post Fiji in collaboration with the USP brought out a set of 4 stamps promoting renewable energy to commemorate the UN Year of Sustainable Energy and create RE awareness amongst the general populace.



6 OTHER INFORMATION

ACTIVITIES RELATING TO TECHNOLOGY TRANSFER

Background

In order to address climate change mitigation and adaptation, the need for development of new technologies and transfer of existing appropriate technologies cannot be overstated. New and clean energy technologies need to be developed to reduce greenhouse gas emissions while technologies also need to be developed to address climate change. Development and technology transfer is one of the four pillars of the Bali Action Plan and that they are critical to the achievement of both adaptation and mitigation initiatives.

Pursuant to decision 4/CP.7, its annex and the implementation of Article 4, paragraph 5 of the Convention, non-Annex 1 Parties are encouraged, in the light of their economic conditions to provide information on activities relating to the transfer of and access to environmentally sound technologies and know-how; the development and enhancement of endogenous capacities, technologies and know-how; and measures relating to enhancing the enabling environment for the development and transfer of technologies.

Decision 4CP/7 further defines the technology needs assessment (TNA) process as a set of country-driven activities that identify mitigation and adaptation technology priorities for developing countries and noted that technology transfer has five key elements:

1. assessing technology
2. improving access to technology information
3. strengthening local capacity
4. creating enabling environment
5. instituting technology-transfer mechanisms

The Climate Change Unit has conducted as assessment of technology needs for Fiji as part of its Second National Communication.

Purpose of the technology needs assessment

Technology Needs Assessment is to help identify and analyze priority technology needs, practices and policy reforms. This in turn underpins a portfolio of environmentally sound technologies programmes which can facilitate knowledge and technology transfer in order to address climate change mitigation and adaptation

TNA approach

The Climate Change Unit consulted different stakeholders about potential barriers to technology transfer and trying to address these barriers through sectoral analysis. It addresses hard and soft technologies such as mitigation and adaptation technologies and identifies regulatory options.

The climate Change Unit also reviewed relevant policies and annual corporate plans and considered vulnerability and adaptation assessments, mitigation studies, energy planning studies and national or sectoral development plans in order to identify and determine those that promoted technology transfer and addresses technology needs assessment.

Institutional and Policy Framework

In Fiji, a few existing or planned national policies, legal and institutional frameworks facilitate the implementation of decision 4/CP.7 in the areas of technology needs and needs assessments, technology information, enabling environments, capacity building and mechanisms for technology transfer. However, they will need to be reviewed and strengthened in order to be effective. These sector specific key Acts and Policies include:

Table 6.1: Sector Specific; Key acts and policies in Fiji

Sector	Legislation, Policies, Plans and Programmes
Agriculture	• The National Climate Change Adaptation Strategy under development will contain sector specific strategies and actions to allow adaptation of the agricultural sector to climate change.
Health	• Public Health Act (Cap.111) 2002 • The ministry of Health is working with the World Health Organization to address climate change impacts on public health.
Biodiversity/ Environment	• Environment Management Act, 2005 • Endangered and Protected Species Act, 2002 • Endangered and Protected Species Regulations,2003 • The Department of Environment is developing the National Biodiversity Strategy and Action Plan and the National Biodiversity Strategy and Action Plan Implementation Framework. • The national climate change adaptation strategy under development will contain sector specific strategies and action to address climate change impacts on terrestrial biodiversity. • National Environment Strategy, 1993
Marine and Fisheries	• Fisheries Act,1988 • Fisheries Act (Amendment) Decree,1991 • The integrated Coastal Management plan currently under development may address the impacts of climate change on water catchments and coastal environments.
Forestry	• Forest Act, 1979 • Forest Decree, 1992 • Fiji Forest Policy under review 2004 • A Mangrove Management Plan for Fiji, Phase1 -1985 and Phase2- 1987
Water Resources	• Draft National Resources and Sanitation Policy • Draft Rural Water Policy
Land Management	• Native Lands (Ed.1978) • Native Lands (Amendment) Act,2002 • Native Land Trust (revised edition, 1985) • Native Land Trust(Amendment) Decree, 1988 • Native Land Trust (Amendment) Decree,2000 • Native Land Trust(Amendment) Act,2002 • Irrigation (revised edition, 1985) • Land Conservation and Improvement (revised edition 1985) • Land Development Act (revised edition, 1985) • Draft National Action Plan under the UNCCD (NAP) • Draft Rural Land Use Policy (2nd edition) • Fiji Mineral Policy 1997
Disaster Management	• Natural Disaster Management Act, 1998 • Disaster Risk Reduction and Disaster Management: A framework for action 2005-2015

Existing technology to support Climate Change response

The transfer of appropriate and best available technology (BAT) in Fiji is mainly promoted through the Clean Development Mechanism which involves dealing with technologies supporting GHG emission reduction leading towards Low Carbon Development. These include technologies such as renewable energy, energy efficiency, waste to energy and sustainable transport.

The following criteria are used to assess the promotion of the transfer of appropriate and BAT:

- Best available technology in advanced industrial economies
- Best available technology and technology well proven
- Best available technology and technology can easily be maintained locally
- Best available technology and technology appropriate for local economic and social conditions.

Challenges faced with the existing technology

There are a number of challenges to the successful implementation and demonstration of new technologies including technology transfer aspects in Fiji as well as in the region. These challenges are general to advancement of developmental projects and are represented by factors including financial, legislative, and regulatory & policy, institutional, technical, market and access to information and public awareness. Other barriers are directly attributable to the technology transfer process itself. There are also barriers that are independent of any sector or the process.

Lesson learnt from using the appropriate technology to support the implementation of the project

- Need to build capacities and raise awareness on identification and development of projects in potential sectors among the government, non-government& private sector stakeholders.
- Mobilise appropriate support to develop new policy and regulatory framework for technology transfer which supports and encourages the private investors as well as foreign direct investments.
- It is also suggested to review the relevant existing policies and acts in order to revise them and make them more conducive for the uptake and development of new technologies and projects.
- Develop long term regulations/mechanisms such as mandatory targets, grants, subsidies or tax incentives, to give priority to technology transfer projects thereby increasing investor confidence.
- Need to promote the development of industry associations and private sector engagement to stimulate discussion about technology transfer project ideas.
- Need to use local companies to install and maintain equipment/technology
- Reduce reliance on international experts to install/maintain equipment/technology

Barriers to acquiring these appropriate technologies

- Lack of appropriate policies and regulations – Need for appropriate policies and relevant regulatory frameworks supporting technology transfer (Some of the policies are not yet effective or not yet developed).
- Transfer of skills for use and maintenance of technology sometimes do not happen.
- Limited access to finance for private project developers - loans are very difficult to obtain, high interest rates, and minimal support from the government.
- Lack of confidence among private investors in the market – it is necessary for the government set up a risk abatement system.
- Lack of resources to effectively study the feasibility of different potential technology transfer initiatives;
- Fiji needs financial and technical support to conduct detailed studies to fully understand the feasibility of different technology transfer options.
- Lack of technical and regulatory support to review opportunities to use the tax and fiscal mechanisms to encourage greater up-take of technology transfer projects.
- Lack of technical expertise and resources to handle new technologies.

INFORMATION ON EDUCATION, TRAINING & PUBLIC AWARENESS

Activities undertaken to implement Article 6 of the Convention, in particular the New Delhi Work Programme

Various activities were carried out by Government Organizations and NGOs throughout Fiji with regards to the implementation of Article 6 of the Convention.

One of the milestones for Fiji is the development of the National Climate Change Policy which outlines the policy implementations framework.

In compliance with the National Climate Change Policy, various agencies were prompted to carry out activities which are of vital importance to this global issue. Various government ministries and NGOs carry out different activities which range from:

- identifying traditional methods of preserving food and food crops that can be staple food, extension of village boundaries, relocation of villages
- organizing Climate change Summit, workshops and training of provincial administrators, land owners and other key stakeholders
- creating awareness during the Agriculture Show and Hibiscus Festival
- Observing National Environmental day where public, schools and stakeholders access information of CC and have the understanding of what is going on in Fiji and around the globe. NGOs information on CC and CCA were available to the public, especially for school children.
- Conducting public awareness programmes on climate change and its effects by various Government organisations such as the Department of Environment, Department of Energy, Ministry of Agriculture, Ministry of Information, Ministry of I'Taukei Affairs, Climate Change Unit of the Ministry of Foreign Affairs, Ministry of Agriculture, Tertiary Institutions such USP, PACE-SD, FNU and NGOs such as PACC, SPC, FSPI, SOPAC, WWF, and Live & Learn etc. using the Fiji government Online portal - www.fiji.gov.fj , texts (pamphlets, posters, banners etc.) Video, TV and radio talk back show etc.
- Coordination of climate change adaptation projects and awareness by PACE –SD which are funded by AusAID, EU, JICA and USAID.

Incorporatation climate change into the primary, secondary and tertiary education programmes

The Government of Fiji National Climate Change Policy 2012 which outlines a policy implementation framework under Objective 4; on Education and Training with the following strategies:

- Strategy 4.1 to review and update current school curriculum to ensure inclusion of local, accurate, climate change information, and to encourage student research around the issue of climate change;
- Strategy 4.1.1 Curriculum Development Unit (CDU) to assess and review teaching materials on climate change regularly, given the dynamic nature of climate change science, research and international progress and
- Strategy 4.2 to develop appropriate educational materials and learning tools on climate change for children with special needs in early intervention programmes, in special and mainstream schools and in tertiary institutions.

In 2012, the Ministry of Education in collaboration with GIZ/SPC Coping with Climate Change in the Pacific Island Region, Climate Change Policy and relevant partners helped develop a framework to integrate climate change and disaster risk reduction information into the current school curriculum.

This effort involved an audit of the existing curriculum which identified relevant topics such as climate, weather and climate variability and others that needs to be integrated in the current syllabus. One of the outcomes of that process was for CC and DRR topics to be introduced from class 7 onwards. The new curriculum is currently awaiting the National Consultation for validation before its introduction into the formal school system.

A concurrent collaboration effort between CDU, GIZ/SPC and Mareqeti Viti resulted in the production of an alphabet poster and Pou & Miri to provide primary school students a basic understanding of the relationship that exists between the environment they live in and the changing climate. The University of the South Pacific (USP) through the Pacific Center for Environment and Sustainable Development (PACE–SD) in collaboration

with United Nations University (UNU), Royal Melbourne Institute of Technology University (RMIT University) and United Nation Environment Programme (UNEP) recently developed a Post Graduate Diploma in Climate Change Programme targeting environmental managers in the Pacific. As of December 2012 a total of 29 students have completed the PG Dip course and 2 students have completed their Masters as of December 2012. All are awaiting graduation in April, 2013. The Pacific Partnership Network for Disaster Risk Management (PPNDRM) through its Training and Capacity Building Working Group (TCBWG) has successfully provided technical support towards the development of tertiary education programmes at the Fiji National University (FNU) and USP.

In 2012, the Fiji National University (FNU) rolled out a Post Graduate Certificate in Disaster Risk Management Programme at the College of Medicine, Nursing & Health Sciences (CMNHS) in partnership with the South Pacific Geoscience Commission (SOPAC) Division at the Secretariat of the Pacific Community (SPC/SOPAC) targeting disaster risk management officers from the region. The number of student enrolled in 2012 was 6, while in 2013 it has increased to 22.

Scholarship Programmes/Grants Available To Students Pursuing Climate Change Studies At National And International Level

Local scholarships are available from the Ministry of the I Taukei Affairs and Public Service commission for students interested to pursue Undergraduate, Post Graduate Certificate and Post Graduate Diploma courses in the Environmental Science and Climate Change Programme at the tertiary level.

Table 6.2: PSC Scholarship summary: (a detailed table is attached in the annex)

YEAR	Trade Cert	Diploma	BSc	Postgraduate	Masters
2007	1		9		
2008		2	9		
2009			1		
2010		3	14	1	1
2011		6	11		
2012		3	14		
Total	1	14	58	1	1

Source: PSC Scholarship unit

Table 6.3 EUGCCA scholarship summary

	Courses		Total
Year	Post graduate Diploma	Masters	
2010			
2011			
2012	22	13	
2013	21	16	
Total	62	38	

Source: EUGCCA annual report

The Education, training and public awareness campaigns launched

National Summit for Building Resilience to Climate Change

With the theme "Stregthening Community Adaptation and Mitigation Measures to Effects of Climate Change in Fiji" the first ever national Summit on Climate Change was held in Labasa town, Vanua Levu from the 23rd to the 25th of October 2012

The objective of the Summit was to strengthen resilience by developing a forum for information and knowledge sharing as a means of addressing gaps, fostering partnerships and promoting local climate – smart solutions.

The importance of mainstreaming Climate Change was brought to the forefront of all participants. Real life Climate Change mainstreaming experiences were highlighted. The integration of Climate Change into the formal curriculum, the status quo of Climate Change awareness carried and the importance of training in the field of Climate Change were revealed on day 2. Climate Change mitigation and adaptation strategies were also highlighted.

More than 200 people who attended the Summit, heard first-hand information on the work of including Climate Change and Disaster Risk Reduction topics into the school curriculum.

Table 6.4 : planned and launched Climate change activities

Organization	Activities		Website
	Launched	Planned	
Civil society		I taukei: To promote the iTaukei glossary	
	Department of Environment host the National environmental day where public, schools and stake-holders has access to information of CC		www.environment.gov.fj/
	PACC Project • awareness in communities within pilots sites using pamphlets, posters and banners as tools of communication and video	PACC Project • Community Empowerment – gender based strategy focus on youth and women • Awareness and Education materials supported by GIZ for CC modules in the Fiji Curriculum – improved • Capacity building within communities in terms of management, training and monitoring skills on CCA - sustainability	http://www.sprep.org/pacc-home
NGO	Sandwatch Initiative		http://portal.unesco.org/en/ev.php-URL_ID=42966&URL_DO=DO_TOPIC&URL_SECTION=201.html
	RiverCare Initiative		• http://www.unesco.org/csi/smis/siv/Pacific/Fiji-act2_river.htm • http://www.livelearn.org/projects/rivercare-fiji
	Kids to Forest initiative		http://www.spc.int/lrd/index.php?option=com_content&view=article&id=876:spc-and-fao-support-kids-to-forest-initiative-of-live-and-learn-environmental-education&catid=164:public-awarenesseducation-and-extension&Itemid=29
	Building Resilience: Strengthening Community Adaptation Measures to Effects of Climate Change in the Fiji Islands		http://www.wwfpacific.org.fj/what_we_do/climatechange/ausaid__building_resilience/ http://www.ausaid.gov.au/Publications/Pages/4920_8334_8788_9708_8899.aspx http://awsassets.panda.org/downloads/building_resilience_flyer_email.pdf
		Pilot effective models for governance and implementation of REDD in Small Islands Developing States to provide equitable benefits for forest-dependent local and indigenous people	http://www.livelearn.org/projects/redd-pilot-project

Organization	Activities		Website
	Launched	Planned	
	• Climate Change Adaptation Awareness Workshop • Disaster Management and First Aid Training		http://www.fspi.org.fj/
	• developing training and providing first line technical support to communities • development of IEC materials		http://ukinfiji.fco.gov.uk/ennews/?view=News&id=858142382
Private Sector/ institution	AusAID Future Climate Leaders Project (FCLP): provides Pacific Island students with knowledge, expertise & education in climate change that builds capacity for the whole region		http://www.usp.ac.fj/index.php?id=11868
	USP-EU GCCA project: provides support through capacity building, community engagement and applied research		http://www.usp.ac.fj/index.php?id=10769
Media	Engaged through print mode, radio & TV (refer to annex)		• http://www.fiji.gov.fj/index.php?option=com_content&view=article&id=140:ministry-of-information-national-archives-and-library-services-of-fiji&catid=76:department&Itemid=171 • www.fbc.com.fj/ • fijitv.info/ • www.fijitimes.com/ • www.fijisun.com.fj/

Gaps in Climate Change Education (Formal) and Training

While the process of integrating Climate Change into the school curricula has been on-going, it is also important to build the capacity of Curriculum Development Unit (CDU) and Technical Vocational Education Training (TVET) Officers in terms of Climate Change and Disaster Risk Reduction. The Officers need to be well versed with all aspects of Climate Change.

After the integration of Climate Change into the school curriculum, there is a need to train the teachers who will be teaching Climate Change subjects included in the prescriptions. Teachers need to be trained in relation to whatever Climate Change topic has been integrated into their curriculum so that they are familiar with the topics that they are going to teach their students.

The production of resources to supplement the teaching of Climate Change topics that will be in the school curriculum. This will involve the printing of materials that have been developed by organisations and government departments or the development of new materials or teaching aid. This will ensure that when the Climate change topics are taught, the teachers are well supported with resources that they can use in the teaching and learning process.

The CDU officers lacks monitoring framework for an effective review process for the proposed teaching material on CC and DRR.

The teacher training program lacks components of teaching and transfer of knowledge skills and techniques of climate change and DDR information.

There is a lack of climate change and disaster risk management courses at undergraduate level. PACE-SD with support from SPC/SOPAC is currently finalising its Post Graduate Diploma Programme in Disaster Risk Management and has existing plans in place to develop bridging courses targeting individuals around the region who have been involved in climate change work but do not possess undergraduate qualification. This is currently awaiting endorsement of the USP Council.

Gaps in Climate Change Education (informal) Training

There is a gap in developing an approach that ensures sustainability of the principles and concepts associated with Climate Change Awareness programmes. To date, most climate change awareness is carried out by NGO's, given the knowledge, skills and resources available and these organizations have created a milestone of understanding in the communities. However, for each of these, the approach is different and the materials used to transfer the knowledge are based on specific concepts. This must change as climate change is a cross cutting issue and it affects food security, national security, community psyche, relocation and disaster awareness which are not isolated issues. Therefore the approach to climate change must be holistic and strategic. The success of the approach demands collaboration and partnerships between NGO's and government agencies to allow for monitoring and to ensure that there is no duplication on the ground.

Need for Government Departments, NGO's, Private Sectors, Companies, Civil Society and CSO's working on Climate Change Projects/Units/Sections/ Program to present their information and data based on their target groups, area of work, population size, types of project & activities implemented, fund/ donor supporting the project and etc, this will ease the flotation of information from a organization and will also avoid the duplication of work in one area from Organisations and Departments and of course will minimize the use of resources (manpower, financial, technical and education wise).

For the technical/ field staff, there is a gap in the ability to demarcate what is CC related and what is a natural occurrence

Communities seek assistance but agencies need to practice a similar ethos to DRM of Doing No Harm. Whilst we install tanks, solar water pumps, etc, we do not sufficiently undertake measures for the sustainability of the system

CAPACITY BUILDING

Mitigation related capacity development activities

A number of capacity building activities are underway to help develop and expand sustainable energy resources. Some of them are mentioned below.

TA-7394 REG: Strengthening the Capacity of Pacific Developing Member Countries to Respond to Climate Change (Phase 1) (43071-012)

A project Strengthening the Capacity of Pacific Developing Member Countries to Respond to Climate Change project is currently in its first phase of implementation and aimed at contributing to the stronger institutional and stakeholder capacity in Fiji, Solomon Islands, and Vanuatu on CDM PoA, post-2012 carbon market mechanisms including reformed CDM, and assist in developing a cross-border

(multi-country) CDM PoA involving each of the said target countries. The specific activities/components are as follows:

Component 1: Capacity building on CDM PoA, post-2012 carbon market mechanisms including reformed CDM as well as on latest developments in CDM modalities and procedures, Nationally Appropriate Mitigation Actions (NAMA) and New Market Mechanisms (NMM) in the target countries, including hands-on training and knowledge transfer to all relevant stakeholders.

Component 2: Mapping of the CDM including Programmatic CDM related activities in the target countries. This will include: (i) determining CDM status for each country; (ii) identifying potential PoA projects (including cross-boundary program of activities) that could be developed under CDM or post-2012 carbon market regime; (iii) supporting DNA and/or Climate Change Units in target countries on revising/updating the DNA operational guidelines and climate change policy documentation; and (iv) designing appropriate tool kit to assist Programmatic CDM project development and management.

Component 3: Development of Grid Emission Factors for the target countries as per the UNFCCC approved tools and procedures. Renewable energy sector projects account for more than 90% of the registered CDM projects for carbon credits. Grid emission factor is one of the key factors to be calculated for such projects in order to estimate emission reductions. The factor could also be useful in developing GHG inventories for the host country including estimating the mitigation potential.

Component 4: Identify and support the development of one cross-border (multi-country) CDM PoA related design documentations (Programme of Activities Design Document; CDM PoA Design Document and Real Case CDM PoA Design Document) involving each of the selected target countries.

USP- KOICA Renewable Energy Project (East Asia Climate Change Partnership)

A 2 Million USD grant from the Republic of South Korea for a project entitled 'Renewable Energy Generation, Resource Assessment, and Capacity Building Programme for Sustainable Economic Development of the Pacific Island Countries' has assisted USP in undertaking a comprehensive RE capacity building initiative . This project has the following 3 main components:

1. Renewable Energy assessment in all 12 USP member countries and establishment of a Data Bank at USP.
2. Renewable energy Capacity Building in the USP region.
3. Establishment of a 45 kW grid-connected solar PV system at the USP, Laucala lower Campus and development of a renewable energy training centre.

The first component involves setting up 24 Integrated Renewable Energy Resource Assessment System (IRERAS) in USP member countries. These equipment will record major meteorological parameters required for renewable energy applications (solar radiation, wind speed etc.). There are also 5 dedicated wind energy measurements systems currently deployed at selected locations in Fiji and will be moved to other countries. The ocean energy potential in the region is being evaluated using Waverider Buoys (wave energy), ADCPs (tidal current energy) and CTD probes (OTEC potential). The data recorded is transmitted to a central server housed at USP's Japan-Pacific ICT Centre. A number of systems have already been deployed while others are in the process.

The second component comprises a number of activities. The project funds 8 regional students to undertake a Master's programme at USP. They are working on renewable energy resources assessment in their respective countries after spending initial 6 months (taking two courses) at USP. They are expected to submit their theses by mid-2013.

Under the third component, a 45 kW grid-connected PV (GCPV) system has been installed at the USP's marine campus. This is the largest system of its type in Fiji and is expected to supply about 10% of electricity requirements of the main Marine Science building. This system is also being used as a research tool where studies on PV/grid interaction are being carried out. We also plan to employ this set-up as a training centre for energy professionals from the region. A training workshop on grid connected systems will be held in November 2012.

Project DIREKT

This 1.2 million Euro ACP-EU funded project (DIREKT- small Developing Island Renewable Energy Knowledge and Technology transfer network) envisages strengthening the science and technology of renewable energy systems in the PICs and other small island countries. It will enhance cooperation between the institutes involved in renewable energy science and technology development in the ACP region and EU institutions.

This project is led by Hamburg University of Applied Sciences and the ACP region is represented by the University of West Indies, the University of Mauritius and the University of the South Pacific. The main idea behind this project is to help establish Research and Technology Transfer Centres within each of the part-

ner country. These centres will facilitate knowledge, information and know-how exchange on the assessment, production and utilisation of renewable energy in the region. USP is be leading analysis of the market-oriented research and technology transfer and capacity-building requirements for the ACP regions. This includes an analysis of the political and institutional frameworks and research policies for renewable energy in the partner countries.

One of the major activities of the project DIREKT is to help organize regional and international conferences/workshops for various stakeholders in the member countries. A number of workshops on issues like hydropower, GCPV systems and other relevant topics have been organized in Fiji, FSM and Tonga.

Development of Solar Photovoltaic and Hybrid systems

With the help of funds from the US and French governments, solar PV demonstration systems have been installed at the main USP campus. A 2.6 kW GCPV system provides lighting and serves as an electric vehicle charging station (first of its kind in the region). We have installed a solar water pumping system at Batiri Lagi School in Vanua Levu with the Taiwan government's support. French funding has also enabled us to implement a solar light micro -financing initiative where remote communities are encouraged to replace their inefficient and polluting kerosene/benzene lamps with clean/efficient solar lights.

All the above mentioned projects have a strong training/research component. Our students are closely involved in design and analysis of these systems.

Renewable Energy education and Research

USP offers a number of courses in renewable energy technologies at the undergraduate and postgraduate levels. An introductory course on RE is part of our B.Sc. (Physics) and the new BE (EE and ME) programmes. We also offer Post Graduate Diploma (PGD) and M.Sc. in RE. There are efforts underway to offer the PGD programme via online mode so that regional students can also enroll. Fiji National University (FNU) also offers undergraduate programme in renewable energy.

The Renewable Energy research group within the Faculty of Science, Technology and Environment (FSTE) at USP is actively engaged in research. Some of the areas of interest are:

- Wind energy assessment; design, development and testing of rotor blades/turbines.
- Solar Photovoltaics: Development of Dye Sensitized Solar Cells,
- Design and Performance analysis of Standalone systems, grid-connected and hybrid systems.
- Biomass and Biofuel: Coconut oil based Biodiesel, cassava based ethanol
- Ocean energy: Assessment of ocean energy potential (wave, tidal and OTEC) and design and development of energy extraction devices.
- Energy planning

Renewable energy training and certification scheme

USP has joined hands with the Sustainable Energy Industry Association of Pacific Islands (SEAIPI) to develop competency standards and accreditation for RE professionals (designers and installers). The scheme was officially launched on 18th May 2012 during the Pacific rollout of the International Year of Sustainable Energy held at USP.

Collaboration with VOCTEC programme of Arizona State University and USAID

A Regional Training Centre for Off Grid Solar PV Systems is being established at USP. This is being done in collaboration with the VOCTEC programme of Arizona State University and facilitated by the USAID. The programme will run at two levels, L2 (Training of Trainer) and L1 (technician level). USP will be running L2 training and a number of PIC participants will be invited to attend this training. The trainers are expected to run L1 training in their respective countries. The first ToT training took place in February 2013 where 15 participants including eight from Fiji received their trainer certificates. This was followed by Fiji technicians' training in July 2013. FNU is the other Fiji based partner and will also be conducting L1 trainings.

CONSTRAINTS AND GAPS, AND RELATED FINANCIAL, TECHNICAL AND CAPACITY NEEDS

7

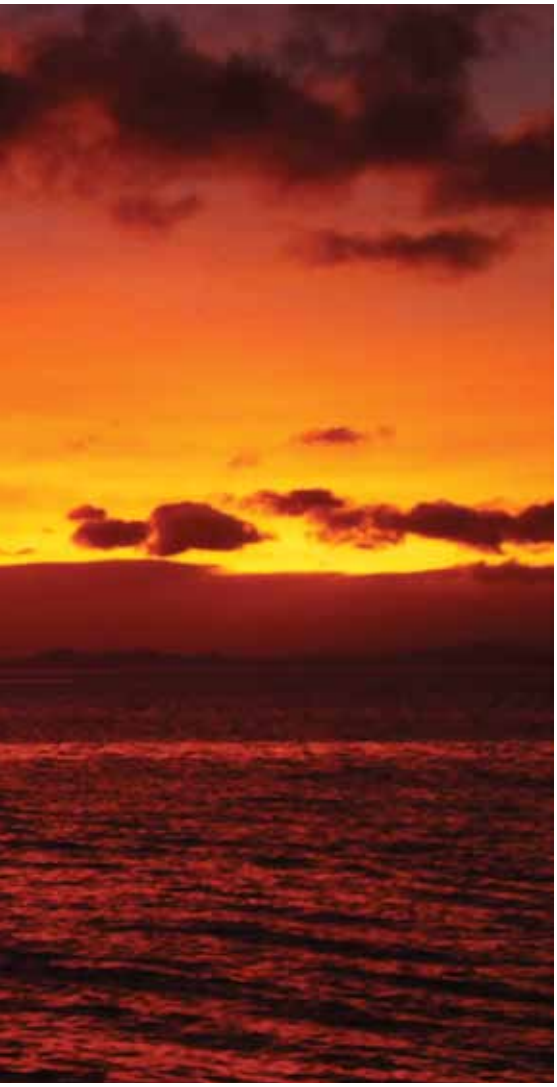
In addressing climate change in Fiji, there were a number of gaps and constraints identified. These gaps and constraints occur mainly due to the lack of existing frameworks that clearly identifies and outlines the necessary action that should be taken to effectively respond to climate change.

FINANCIAL RESOURCES AND MANAGEMENT NEEDS

In order to carry out any climate change adaptation or mitigation activities, adequate resources (including finances) are required.

Furthermore, the New Delhi Work programme recognizes the need for adequate financial and technical resources to ensure effective implementation of the activities of Article 6 of UNFCCC.

Globally, Fiji is not a major contributor of greenhouse gas (GHG) emissions so most of its focus is on climate change adaptation. UNFCCC through the Bali Action Plan also recognized the importance of funds. The review of Fiji's Climate Change Framework for the development of Fiji's National Climate Change Policy have identified strategies to ensure sustainable financing for climate change efforts. The strategies will include ensuring that national budgeting processes



include the assignment of funds for climate change mitigation and adaptation research, planning and programme implementation. The implementation framework of the policy will identify lead and implementing agencies that will ensure that the strategies are implemented.

TECHNICAL AND CAPACITY NEEDS

Briefly outlined below are some of the technical and capacity needs that were identified for Fiji;

i. The need for financial resources
ii. The need for a finance policy enabling the provision of financial and other resources to be allocated and utilized in for climate change activities
iii. To establish a pool of funds allocated by Government for the establishment of a National Trust Fund to finance adaptation and mitigation activities
iv. Long-term investment in research and developments

THE GEF, ANNEX II PARTIES, MULTILATERAL/ BILATERAL CONTRIBUTIONS

For the preparation of the SNC, GEF provided the financial support of US$405,000 while the Fiji government provided the in-kind contribution of US$100,000.

Other than providing support for the SNC, GEF, Annex II parties, bilateral and multilateral institutions have also financially supported climate change activities in Fiji. This support has been rendered mostly to the communities of Fiji either through Government or through NGOs.

- GEF
- GEF trustee
- European Union
- World Health Organization
- USAID
- UNDP
- UNEP
- UN Habitat
- UNICEF
- Government of New Zealand
- Government of Australia
- German Government
- Canada Fund
- French government
- Taiwan (ROC)
- Republic of Korea
- World bank
- ADB
- Evangelischer Entwicklungsdienst e.V. (EED)
- Secretariat of Pacific Community
- SPREP
- Rotary Pacific Water for Life Foundation
- Fiji Water

INFORMATION ON IMPLEMENTED ADAPTATION MEASURES

(Programmes containing measures to facilitate adequate adaptation to climate change 2000-2005)

Fiji like the other SIDs has been working on to implementing its adaptation measures. After ratifying the UN Framework Convention on Climate Change (UNFCCC) policies adopted by Government in Successive Development Plans have recognized the critical importance of managing the environment and natural resources, to ensure social and economic prosperity, however has not been supported with the required budget. There are a number of legislations related to the convention are being reviewed and will be amended in due course to meet its objectives that will contribute to the implementation of adaptation measures. These include the Land Conservation & Improvement Act, Agricultural Landlord & Tenant Act, Forestry Act, Tourism Development Act, Environment Management Act and the Town Planning Act to name a few.

The Environment Management Act will coordinate and facilitate collaboration among all agencies responsible for different legislations related to the use, development and management of land resources, which are administered by different government agencies and have

overlapping function.

Fiji realizes the importance of national capacity building across all sectors as this is below a critical mass. Promotion of better education and training and creation of public awareness will be an ongoing activity for quite some time. Local and national level Government, non-government agencies, civil societies and other stakeholders are all targeted in these programs. Technical and financial assistances to realize these challenges are welcome from all partners.

To ensure that all stakeholders are involved in the formulation and implementation of sustainable land management policies, strategies, the participatory and integrated approaches with multi-stakeholders consultation are always promoted.

Fiji has fully supported and participated in initiatives for sustainable land development and management for the region. As such it has participated in numerous national, regional and international projects. The availability of reliable resource based information is an integral part of all decisions related to sustainable land development and management is vital and Fiji is always striving to improve on it.

In addition to the initiatives there are still gaps and constraint that has to be overcome in order to function well. One of the major highlights is the inadequate resourcing of the Department of Environment (DoE) to carry out mandated functions under the EMA. Some of this includes:

- Lack of capacity among Government agencies to enforce relevant legislations such as the Land Conservation and Improvement Act, National Code of Logging Practice, etc.
- Addressing 'environmental' issues along sectoral lines is difficult and conflicts sometimes arise as ministries get protective when they perceive other agencies encroaching on areas they consider their sole jurisdiction;
- Lack of coordination between agencies and the current situation where the Department of Environment is reliant on other agencies to implement mitigation and adaptation measures. The DoE can provide advice on mitigation and adaptation measures but has no authority to dictate what is to be implemented;
- Lack of capacity within Government (including the Department of Environment) to fully appreciate the fundamental issues of climate change and their widespread impacts across the whole economy;
- Lack of capacity also constrains the ability of Government to draw out relevant statistics and data to fully understand the evolution of Fiji's climate and biodiversity. This lack of capacity translates into a lack of confidence by Government to commit resources for such research work given the uncertainty on the applicability and usage of the research data and outcome. Hence, the reliance on foreign aid to fund such projects;
- Lack of information, education and awareness on impacts of climate change in rural and outer islands – for instance the ordinary villager is not aware that changes affecting his everyday living (such as fishing, tending his crops etc.) are a result of the impact of activities of industrialized countries on the global climate; and
- Poor and sluggish economic performance over the past decade, coupled with political turmoil and uncertainty means a lot more emphasis is placed on economic recovery and very little attention is paid to environmental concerns.

MITIGATION- ENERGY SECTOR ASSESSMENTS

Listed below are some of the gaps and constraints faced in the energy sector:

Grid-based power supply

Key issues to be addressed:
▶ Need to improve FEA's efficiency by building on its strong past performance
▶ Fiji still has significant unutilised renewable energy resources
▶ The enabling framework for private sector investment must be improved
▶ Regulation needs to be strengthened and removed from FEA
▶ Institutional responsibilities need to be streamlined

Rural electrification

Key issues to be addressed:
▶ Despite recent success in improving access, the sustainability of current schemes is at risk and their affordability for rural communities with limited cash income is uncertain
▶ Schemes are funded by Government (and by FEA when they are deemed financially viable) but funding over the last six years has been variable and often technology specific
▶ There is no clear and costed plan of how to provide the remaining unserved population with access to electricity or analysis of existing social and economic barriers to affordable energy

Renewable energy

Key issues to be addressed:
▶ A comprehensive assessment of Fiji's renewable energy resources and viability of different renewable technologies is needed
▶ Lack of access to resource data has been a strong impediment to private sector project development in the past
▶ Incentives for a wider participation of the population in renewable generation are insufficient

Transport

Key issues to be addressed:
▶ The transport sector is highly dependent on imported fuel
▶ More can be done to encourage fuel-efficient vehicles and vessels and a shift towards public transport and non-motorised transport
▶ Research for alternative fuels such as biofuel, electricity or gas

Petroleum and biofuels

Key issues to be addressed:
▶ Fiji needs to reduce its high petroleum import bill
▶ The viability of bio-fuels in Fiji needs to be demonstrated
▶ Maintain E 10 and B 5 biofuel standards

Energy efficiency

Key issues to be addressed:
▶ Energy efficiency is highly cost-effective, but achievements in Fiji have been minimal
▶ An energy efficiency target has been lacking

V&A SECTOR – SECTOR ASSESSMENTS

The constraint and gaps identified in the V&A sector are as follows:

Table 7.1: constraints & Gap in the V&A sector

Sector	Gaps / Constraints
Water	• Lack of a legal framework to enable 1 government institute to regulate the water sector • Lack of data on the water consumption in all sectors • No expertise on the artificial recharge • Not such information available on the ground water. These includes the number of extraction sites (both locally & commercially), actual discharge, intended use, level of ground water above sea level. • In most of the town areas the sewage & grey water discharge from residence are discharge in nature. This is because there is still no structure in place that takes in all this waste waters and treats it before releasing it. • Lack of installation of proper water supply system for remote villages to prevent water wastage. • Financial constraint and accessibility to remote villages to install water tank to save water for usage during time of natural disasters • Lack of monitoring equipment and system • Lack of awareness on recycle and reuse of waste water, grey water & storm water. • Long term monitoring data on spring usage not available.
Agriculture	• Lack of training/ awareness for farmers on organic farming practices
Coastal zone	• Lack of institutional mechanism to protect remarkable the sites along the coastal zone
Forest	• Poor implementation of the forest code • Coordination & collaboration with the inter-ministerial • Lack of mainstreaming biodiversity conservation & ecosystem management in all policy making and development of law • Overlapping of mandate of department of Forestry & Fisheries, department of Lands and Department of Lands.
Health	• Data is available but lack of financial support to analysis & publish the finding on diseases • Lack of data on the temperature related diseases e.g. water, food & vector borne diseases. (More research needed in respect to climate change and diseases in whole of Fiji.)
Tourism	• Gaps still lay in the data for the vulnerable communities/ areas in the coastal areas • Lack of data on the soft & hard measures required into vulnerable areas • Limited data on how the side effects of climate change on the coral. For example the diseases associated with climate change & coral.
Building	• There is not enough integration of climate change issues into town & Planning Act • Financial constrain for the existing building to improve the to help cope with climate change • Lack of interest from the infrastructure owners to in cooperate climate change in infrastructure planning and developing • Lack of communication, collaboration and coordination among different stakeholders • None to very few expertises in designing and construction of the climate change infrastructure. • Lack of human capacity/ knowledge in monitoring the building of the infrastructure.

PROPOSED PROJECT FOR FINANCING

Mitigation

With the growing opportunities in the area of international carbon trading, Fiji has supported the development of five PINs for regular standard CDM projects and 4 PINs for PoAs. Local and international consultants work together to build up local expertise in CDM project development and to demonstrate the benefits of CDM through project implementations.

Some of the proposed Potential CDM projects are tabulated below:

Table 7.2: Potential CDM Projects

Proposed Project (PIN Stage)	Aim	Techniques of Implementation	Proposed Outcomes
Qalilawa Hydropower Project	- To ensure that Fiji attains affordable, stable and secure source of energy for its future economic growth and prosperity. - 18MW hydropower scheme.	Micro scale project activity	Annual emission reduction of 19,717tCO_2e
Methane Capture and Flaring at Naboro Landfill	To reduce methane emissions to the atmosphere through landfill gas (LFG) recovery and flaring.	Micro scale project activity	Annual emission reduction of approximately 15,000tCO_2e
Fiji Tourism Energy Efficiency Investment Project	Work with tourism sector to identify solutions to increase energy efficiency in hotels and resorts and reduce impacts on the environment.	Micro scale project activity	Annual emission reduction of approximately 4,847tCO_2e
PoAs at PIN stage in Fiji			
Biogas Cogeneration PoA in Fiji	- reduce methane emissions from untreated households and agricultural and livestock waste - install 5 to 10 new projects	Carrying out barrier analysis	Annual emission reduction of 500tCO_2e from the first CPA
Sewage Treatment PoA in Fiji	Reduce GHG emissions (methane) in an economically sustainable manner	Micro scale project activity	-Improved digested sludge quality and reduced odor - Annual emission reduction of 16,625tCO_2e from the first CPA
National Grid Connected Hydropower PoA in Fiji	Reduce CO_2 emissions to avoid usage of diesel for equivalent electricity generation	Carrying out investment analysis	Annual emission reduction of 57,564tCO_2e from the first CPA
Tropik Biomass Power Generation	- Reduce CO_2 emissions through displacement of more carbon intensive fuel based electricity generation - installed capacity is 9.3MW	Carrying out barrier analysis	Annual emission reduction of 30,000tCO_2e
Plant Oil Power generation for maritime communities	To utilize the oil extracted from plentiful vegetable oil resources (mainly coconut oil and palm oil) for electricity generation and transportation lowering the GH emissions	Micro scale project activity	Annual emission reduction of 800tCO_2e
Lighting Energy Efficiency PoA in Fiji	To use energy efficient lamps (CFL) to replace 10,000 incandescent Lamps used in residential lighting, commercial and street lighting in Fiji.	Micro scale project activity	Annual emission reduction of 6,000tCO_2e

Adaptation

Vulnerabilities of local communities in Fiji are due to the low availability of resources, remoteness and susceptibility to natural disasters. To enable workable and effective adaptation measures, ministries, civil societies and other parties have considered integrating climate change in their planning and budgeting in all levels of decision making[34].

Table 7.3 below highlights some of vulnerable communities in Fiji and specific sectors that are vulnerable due to climate change and natural disasters. These communities have been identified after thorough consultations with climate change project and program implementing partners. Vulnerability of communities is determined through the use of Vulnerability and Adaptation assessment tools, developed specifically for Fijian communities.

Table7.3: List of Vulnerable Communities per Sector affected

Vulnerable Commmunities/ Area	Sector	Vulnerable Commmunities/ Area	Sector
Tikina Kubulau	Food security, water	Waisa	Disaster risk
Tikina Wainunu	Food security, water	Naterumia	Disaster risk
Tikina Wailevu East/ Wailevu West	Food security, water	Waisasavu	Disaster risk
Tikina Nadi & solevu (Initial stages)	Food security, water	Waitaqolo	Disaster risk
Tikina: Vuya, Dama, Bua, Navakasiga, Lekutu (planning stages)	Food security, water	Navuniyaro	Disaster risk
Tukuraki (Tikina Nalotawa)	Potential relocation	Nanukuloa	Disaster risk
Nawaqarua	Potential relocation	Naluwai	Disaster risk
Matawalu	Potential relocation	Waidracia	Disaster risk
Matawalu	Potential relocation	Nasavu	Disaster risk
Kabariki (Tikina Nabukelevu)	Potential relocation	Vunidawa	Disaster risk
Levuka (Tikina Nabukelevu)	Potential relocation	Waikalou	Disaster risk
Muainuku (Tikina Nabukelevu)	Potential relocation	Matainasau	Disaster risk
Daviqele (Tikina Nabukelevu)	Potential relocation	Nabukunivatu	Disaster risk
Lavidi (Tikina Nakasaleka)	Potential relocation	Narokorokoyawa	Disaster risk
Nakoronawa (Tikina Nakasaleka)	Potential relocation	Korovou	Disaster risk
Lomanikoro (Tikina Nakaseleka)	Potential relocation	Nasauvere	Disaster risk
Nakaunakoro (Tikina Nakaseleka)	Potential relocation	Mataiwailevu	Disaster risk
Nakaugasele (Tikina Nakaseleka)	Potential relocation	Nasava	Disaster risk
Nasegai (Tikina Ravitaki)	Potential relocation	Tubarua	Disaster risk
Tabuya	Potential relocation	Nakorosule	Disaster risk

[34]United Nations Framework Convention on Climate Change, Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries.

Vulnerable Commmunities/ Area	Sector	Vulnerable Commmunities/ Area	Sector
Muaninuku	Potential relocation	Waibalavu	Disaster risk
Kadavu Koro	Potential relocation	Nawaisomo	Disaster risk
Narikoso(with CCU)	Potential relocation	Wairuarua	Disaster risk
Waisomo (Tikina Ono)	Potential relocation	Nakida	Disaster risk
Suweni	Potential relocation	Nasalia	Disaster risk
Korotasere	Potential relocation	Laselevu	Disaster risk
Vatukura	Potential relocation	Udu	Disaster risk
Wailevu	Potential relocation	Dreketi	Disaster risk
Muani	Potential relocation	Nairukuruku	Disaster risk
Naqaravutu	Potential relocation	Navuniyasi	Disaster risk
Somosomo	Potential relocation	Taulevu	Disaster risk
Lamini	Potential relocation	Vuniduba	Disaster risk
Vunivesi	Potential relocation	Delaitoga	Disaster risk
Nacekoro	Potential relocation	Nabena	Disaster risk
Dreketi	Potential relocation	Matailobau	Disaster risk
Nakawaga	Potential relocation	Naqara	Disaster risk
Wavu	Potential relocation	Nawaka	Disaster risk
Daku	Potential relocation	Waimalika	Disaster risk
Naimalavau	Potential relocation	Sabeto	Disaster risk
Nabitu	Potential relocation	Rukuruku	Disaster risk
Buretu	Potential relocation	Navakai	Disaster risk
Draubuta	Potential relocation	Nasau	Disaster risk
Wailotua 1	Potential relocation	Careras	Disaster risk
Vaturua (with CCU)	Potential relocation	Saunaka	Disaster risk
Vanuadina (with CCU)	Potential relocation	Moala	Disaster risk
Wailotua 2	Potential relocation	Yavusania	Disaster risk
Semo	Potential relocation	Momi	Disaster risk
Nalele	Potential relocation	Nawai	Disaster risk
Nayawa	Potential relocation	Malamala	Disaster risk
Yavulo	Potential relocation	Nawaicoba	Disaster risk
Nasigatoka	Potential relocation	Rada	Disaster risk
Laselase	Potential relocation	Logi/Marasa	Disaster risk
Serua Island	Potential relocation	Yako	Disaster risk
Naivucini	Potential relocation	Namata	Disaster risk
Navatuvula	Potential relocation	Savusavu	Disaster risk

Vulnerable Commmunities/ Area	Sector	Vulnerable Commmunities/ Area	Sector
Sawani	Potential relocation	Bavu	Disaster risk
Navutu	Potential relocation	Tunalia	Disaster risk
Vuniniudrovu (with CCU)	Potential relocation	Nagado	Disaster risk
Matawailevu	Potential relocation	Vaturu	Disaster risk
Nasigatoka	Potential relocation	Nausoti Highland	Disaster risk
Nukutubu	Potential relocation	Rararua	Disaster risk
Navatuyaba	Potential relocation	Natawa	Disaster risk
Vunisei	Potential relocation	Nadi coastal areas	Disaster risk
Nabua	Potential relocation	Tubenasolo	Disaster risk
Muana	Potential relocation	Tubarua	Disaster risk
Arovudi	Disaster risk	Natao	Disaster risk
Levuka	Disaster risk	Tavasa	Disaster risk
Nauouo	Disaster risk	Nasaro	Disaster risk
Rukuruku	Disaster risk	Yavutoko	Disaster risk
Taviya	Disaster risk	Nayavulagilagi	Disaster risk
Toki	Disaster risk	Nasukamai	Disaster risk
Vagadaci	Disaster risk	Ba	Disaster risk
Vatukalo	Disaster risk	Yaloku	Disaster risk
Vuma	Disaster risk	Lovosa	Disaster risk
Wailailai	Disaster risk	Vunayawa	Disaster risk
Waitovu	Disaster risk	Durumoli	Disaster risk
Nasinu	Disaster risk	Nasama	Disaster risk
Natokalau	Disaster risk	Bilavou	Disaster risk
Tokou	Disaster risk	Waiyala	Disaster risk
Naikorokoro	Disaster risk	Vakabuli village	Disaster risk
Draiba	Disaster risk	Tavua village (Malolo)	Water
Naviteitei	Disaster risk	Narikoso village - Ono district	Relocation
Nasaga	Disaster risk	Yasawa I Rara(only assess-ment)	Water
Navuloa	Disaster risk	Teci	Water
Wainaloka	Disaster risk	Dalomo	Water
Viro	Disaster risk	Naselesele	Water, health
Tuatua	Disaster risk	Qeleni	Water, health
Lovoni	Disaster risk	Yanuca (Taveuni)	Water, health
Nacobo	Disaster risk	Nasaqalau	Coastal, water, potential relocation

Vulnerable Commmunities/ Area	Sector	Vulnerable Commmunities/ Area	Sector
Nasaumatua	Disaster risk	Vakano	Coastal, water, potential relocation
Nukutocia	Disaster risk	Dakuiloa	Coastal, water, potential relocation
Visoto	Disaster risk	Waiqori	Coastal, water, potential relocation
Vunivisavu	Disaster risk	Ogea	Coastal, water, potential relocation
Nabasovi	Disaster risk	Navai, Navudi, Rokosalase	Water, health
Nabuna	Disaster risk	Korolevu	Water, health
Navaga	Disaster risk	Kinoya	Coastal
Tavua	Disaster risk	Labasa	Disaster risk, food security
Vatulele	Disaster risk	Navua	Coastal, marine, land management
Mudu	Disaster risk	Rewa & Rewa Delta	Coastal, marine, disaster, risk, water biodiversity, food security
Nacamaki	Disaster risk	Nadi Basin	Coastal, marine& fisheries, disaster risk
Nakodu	Disaster risk	Ba and Suva Medical subdivisions (Target 'community' also includes health practitioners in the two pilot sub-divisions)	Disaster risk, health
Namacu	Disaster risk	Macuata	Disaster, risk, water
Naqaidamu	Disaster risk	Ba	Disaster, risk, water
Nasau	Disaster risk	Lami: Delainavesi, Valencina, the Central Business District, Kalekana, the Samoan Settlement and Wailekutu	Disaster, risk, water, coastal
Sinuvaca	Disaster risk	Suvavou Village, Lami Village, Qauiya Settlement, Wailada IndustriaL Area	Disaster, risk, water, coastal
* Yanuca	Disaster risk	Nakauvadra Range	Forestry, land management
Daku	Disaster risk	Natewa, Tunuloa	Forestry
Niubasaga	Disaster risk	Nabukelevu, Kadavu	Forestry
Naicabecabe	Disaster risk	Vatu-i-Ra	Forestry
Nasauvuki	Disaster risk	Mabualau	Forestry
Navuti	Disaster risk	Natewa/Tunuloa Peninsula	Forestry
Nasesara	Disaster risk	Gau	Forestry
Wawa	Disaster risk	Mataqali Emalu	Forestry
Savuna	Disaster risk	Drawa	Forestry
Uluibau	Disaster risk	Dogotuki	Forestry

Vulnerable Commmunities/ Area	Sector	Vulnerable Commmunities/ Area	Sector
Naigani	Disaster risk	Veinuqa District	Water & food security
Manuku	Disaster risk	Wailevu District	Water & food security
Mua	Disaster risk	Naikorokoro	Possible relocation
Yavu	Disaster risk	Waitovu	Possible relocation
Nataulea	Disaster risk	Tokou	Possible relocation
Waitoga	Disaster risk	Natokalau	Possible relocation
Vutuna	Disaster risk	Viro	Possible relocation
Tovualailai	Disaster risk	Rukuruku	Possible relocation
Lawaki	Disaster risk	Vatukalo	Possible relocation
Navukailagi	Disaster risk	Levuka	Possible relocation
Qarani	Disaster risk	Nasauvuki	Possible relocation
Vione	Disaster risk	Naicabecabe	Possible relocation
Lamiti	Disaster risk	Daku	Possible relocation
Lekanai	Disaster risk	Uluibau	Possible relocation
Malawai	Disaster risk	Yanuca	Possible relocation
Nacavanadi	Disaster risk	Vadravadra	Possible relocation
Vanuaso	Disaster risk	Lovu	Possible relocation
Levuka I Gau	Disaster risk	Yadua	Possible relocation
Lovu	Disaster risk	Sigatoka town	Water
Nawaikama	Disaster risk	Nayawa	Water
Nukuloa	Disaster risk	Laselase	Water
Sawaieke	Disaster risk	Yavulo	Water
Somosomo	Disaster risk	Nasigatoka	Water
Vadravadra	Disaster risk	Rakirakilevu	Water
Yadua	Disaster risk	Lawaqa Settlement	Water
Vunibau	Disaster risk	Nauria Village Water Project	Water
Sadro	Disaster risk	Vanuakula Village Water Project	Water
Sauniveiuto	Disaster risk	Nabau Distric School Water Project	Water
Nasavu	Disaster risk	Navatu District School Water Project	Water
Nakorovou	Disaster risk	Navatu District School Leveling Project	Water
Galoa	Disaster risk	Jadish Rd Water Project	Water
Draunikula	Disaster risk	Markaz Rd Water Project	Water
Wainiyabia	Disaster risk	Tunalia Borehole Project	Water

Vulnerable Commmunities/ Area	Sector	Vulnerable Commmunities/ Area	Sector
Qarasarau	Disaster risk	Thirstry Borehole Water Project	Water
Nuku Tikina	Disaster risk	Andrews Primary School Water Project	Water
Sabata	Disaster risk	Votualevu Water Project	Water
Wainadiro	Disaster risk	Emua Borehole Project	Water
Waibogi	Disaster risk	Ismail Road Water Project	Water
Naimasimasi	Disaster risk	Malamala Water Project	Water
Masi	Disaster risk	Malakua Borehole Project	Water
Serua Island	Disaster risk	Loqi Water Project	Water
Navutulevu	Disaster risk	Togo Samsola Borehole	Water
Naboutini	Disaster risk	Hydra Rd Water Project	Water
Nabukelevu	Disaster risk	Togo/ Lavusa Borehole	Water
Namaqumaqua	Disaster risk	Nawaicoba Nursing Station Borehole Water Project 1	Water
Vunaniu	Disaster risk	Tuvu Water Project	Water
Korovisilou	Disaster risk	Draa Lomolomo Rural Water Project	Water
Culanuku	Disaster risk	Johnson Rural Water Project	Water
Yanuca	Disaster risk	Nadrau Water Project	Water
Tadevo/Tokotoko	Disaster risk	Buabua Water Project	Water
Pacific Harbor	Disaster risk	Ali's Water Project	Water
Narara	Disaster risk	Vitogo Hillside Water Project	Water
Veiwawa	Disaster risk	Bukama Village School Bore-hole Projet	Water
Nakaulevu	Disaster risk	Bouwaqa Primary School Borehole Project	Water
Vakabalea	Disaster risk	Nasomolevu Catholic School Borehole Project/ Water Tank	Water
Wainidova	Disaster risk	Namatayalevu Village Borehole	Water
Rovedrau	Disaster risk	Yaqeta Village School Bore-hole Project/ Water Tank	Water
Vunimasi	Disaster risk	Rt. Mwli Memorial School Borehole / Water Tank Project	Water
Waikalou	Disaster risk	Naviti District School Borehole / Water Tank Project	Water
Nasasa	Disaster risk	Gaunavou District School Bore-hole/ Water Tank Project	Water
Rampur	Disaster risk	Waimalika Settlement Borehole	Water
Waidradra	Disaster risk	Nakavika Settlement Water Project	Water

Vulnerable Commmunities/ Area	Sector	Vulnerable Commmunities/ Area	Sector
Vietnam	Disaster risk	Bhairo Din Water Project	Water
vuninokonoko	Disaster risk	Field 27 Navatu Water Project	Water
Calia	Disaster risk	Sangeeta Women's Club Water Project	Water
Qaribua	Disaster risk	Maururu Mosque Borehole Project	Water
Naitata	Disaster risk	Korovuto Water Project	Water
Naitonitoni	Disaster risk	Shaed Hussin Sha Water Project	Water
Taiperia	Disaster risk	Puspha's Temple Water Project	Water
Raiwaqa	Disaster risk	Police Post Circular Road Water Project	Water
Tokotoko flats	Disaster risk	Supersonic Water Project	Water
Vunibuabua	Disaster risk	Sukeshwar Bir Water Project	Water
Lepanoni	Disaster risk	Chainkoti Hillside Water Project	Water
Sigasiganilaca	Disaster risk	Sarava Borehole Water Project	Water
Karachi	Disaster risk	Nakavika Water Project	Water
Lomary	Disaster risk	Nadikilagi Water Project	Water
Nabukaluka	Disaster risk	Nacaci Borehole Water Project	Water
Nauluvatu	Disaster risk	Ba Navatu Temple Water Project	Water
Navurevure	Disaster risk	Shiu Kumar Water Project	Water
Wainawaqa	Disaster risk	Nukuloa Borehole	Water
Nadakuni	Disaster risk	Sarava Borehole	Water
Lomai	Disaster risk	Raviravi Hillside Water Project	Water
Nasirotu	Disaster risk	Vatusui Tophill Water Project	Water
Nasele	Disaster risk	Raviravi Sangam School Borehole Pump	Water
Naseuvou	Disaster risk	Matanagata Back Road Water	Water
Delailasakau	Disaster risk	Waikona Water Project	Water
Delailasakau	Disaster risk	Nawaqabera	Disaster risk
Vanuakula	Disaster risk	Navutulevu	Disaster risk
Nanuqa	Disaster risk	Delaiwaimale	Disaster risk
Naqali	Disaster risk	Korovou	Disaster risk
Viria	Disaster risk	Vatulili	Disaster risk
Gusuisavu	Disaster risk	Vatukorosia	Disaster risk
Namuamua	Disaster risk	Navolau	Disaster risk

Annex 1

Scholarship	Multi Ethnic Scholarships				PSC Local Scholarships			
Institute	Fiji National University		University Of The South Pacific		Fiji National University		University Of The South Pacific	
Year	Number of Scholarships Offered	Course/ Program Name	Number of Scholarship Offered	Course/ Program Name	Number of Scholarship Offered	Course/ Program Name	Number Of Scholarship Offered	Course/ Program Name
2007	1	T Cert. Environmental Engineering	8	Bsc Environmetal Science	N/A		N/A	
			2	Bsc Marine Science				
2008	2	Diploma Environment Engineering	8	Bsc Environmental Science	N/A		N/A	
			2	Bsc Marine Science				
2009								
2010	3	Diploma Environmental Science	8	Bsc Environmental Science	N/A		N/A	
			8	Bsc Marine Science				
2011	6	Diploma Environmental Science	11	Bsc Environmental Science	N/A		N/A	
			3	Bsc Marine Science				
2012	1	Diploma Environmental Science	2	Marine Science	2	Diploma Environmental Science	4	Environmental Science
							8	Marine Science

Annex 2

1. Recorded media activities of the ministry
Fiji Government Online Portal - www.fiji.gov.fj
Same stories were loaded onto FB

1. Climate Change talks mirror Fiji's own push for awareness -7/12/12
2. G77 briefing workshop in Fiji – 18/12/12
3. Media Alert - Priority adaptations to climate change for fisheries and aquaculture in Fiji: reducing risks and capitalising on opportunities workshop - December 12, 2012
4. Youth call for more action at climate talks – 18th session of Conference of Parties to the UNFCCC – 5/12/12
5. Media Alert - National Faith – Based Organizations' Environment Stewardship Official Launch - Thursday 6th December, 2012
6. Need for more climate change awareness: Kaunisela – 3/12/12
7. Minister Kubuabola joins climate change negotiators in Doha – 1/12/12
8. Climate Change finance remains an issue at climate talks – 1/12/12
9. Fiji to push for continuation of Kyoto Protocol – 27/11/12
10. Conservation needs to become a way of life – Naupoto – 20/11/12
11. Cabinet approves iTaukei Glossary of Climate Change terms – 20/11/12
12. Climate change is inevitable – 16/11/12
13. National Climate Change Country Team 2nd meeting- November 16, 2012
14. Minister leads delegation at climate change talks – 10/11/12
15. Stakeholders showcase initiatives to climate change – 23/10/12
16. National summit for building resilience to climate change opens – 23/10/12
17. Fiji ready to host conservation meet – 22/10/12
18. Stakeholders formalise plans for GEF funding - 18/10/12
19. Fiji calls for fresh approach to sustainable development - 24/9/12
20. Fiji Foreign Secretary leads climate change delegation – 27/8/12
21. Working towards a sustainable future – 22/7/12
22. President leads climate talks – 16/7/12
23. Fiji allocated $7million for environment projects – 14/7/12
24. Government prioritise climate change – Mataikabara – 27/6/12
25. National Climate Change Policy Implementation Workshop - 28th and 29th June, 2012
26. PM's statement at the Plenary Session of the third world summit on sustainable development (Rio+20) – 20/6/12
27. Fiji voices concern at Global Climate Change Meet – 20/6/12
28. Climate change in school curriculum - 15/6/12
29. People should be aware of climate change – Kolinisau - 4/6/12
30. Fiji looks forward to positive and forward looking outcomes in UN Climate Talks – 17/5/12
31. Fiji plots Rio 20+ points, climate change policy – 17/5/12
32. Fiji participates at Climate Change meeting – 16/5/12
33. SIDS meet on sustainable energy and the Rio+20 process - 14/5/12
34. Fijian President makes historic walk for earth hour – 3/5/12
35. 'Harmony with nature' meeting at United Nations - 19/4/12
36. Fiji diplomat appointed to climate change committee – 9/4/12
37. Summary Report on climate sensitive diseases in Fiji launched - 28/3/12
38. Climate-Sensitive Infectious Diseases in Fiji: 2011 Summary Report from Fiji's Piloting Climate Change Adaptation to Protect Human Health project" - Monday 26th March
39. MSG to invest in tacking climate change - 20/3/12
40. Formalising Fiji's Climate Summit – 5/3/12
41. Keeping the Coral Coast Green – 2/3/12
42. National Policy to commit Fiji to climate change issues – 2/3/12
43. Media alert - Launch of Fiji National Climate Change Policy by Minister for Foreign Affairs – 1/3/12
44. UN Climate Change official visits Fiji - 7/2/12

45. Fiji looks at adaptation to combat effects of climate change – 1/2/12
46. MSG climate change meet ends – 30/1/12
47. Climate change action is needed now – 27/1/12
48. Cabinet approves environment, climate change meeting – 23/1/12
49. PM to officially open Pacific Green Factory and Eco Park – 19/1/12
50. Cabinet approves national climate change policy for Fiji – 19/1/12

2. Media Monitor on Climate Change

First Climate Change Summit for Fiji -

The Ministry of Foreign Affairs is stepping up its awareness campaign on climate change with a first ever National Climate Change Summit to be held in Labasa next week. This is a follow up to the commitment made earlier this year during the launch of Fiji's Climate Change Policy. Director Political and Treaties Esala Nayasi says the main purpose of the National Summit is to engage communities on a grassroots level.
http://www.fbc.com.fj/fiji/5385/first-climate-change-summit-for-fiji (Mon 10/15/2012 2:10 PM)

First Climate Change Summit for Fiji- The Ministry of Foreign Affairs is stepping up its awareness campaign on climate change with a first ever National Climate Change Summit to be held in Labasa next week. This is a follow up to the commitment made earlier this year during the launch of Fiji's Climate Change Policy. Director Political and Treaties Esala Nayasi says the main purpose of the National Summit is to engage communities on a grassroots level.
http://www.fbc.com.fj/fiji/5385/first-climate-change-summit-for-fiji , http://www.fijivillage.com/?mod=story&id=15101 21250df0bc1689717431a630d, Fiji TV 6pm News, FBC 6pm News (Mon 10/15/2012 2:10 PM)

3. Radio Talkshow on Climate Change

From: Media Monitor [mailto:mediamonitor@info.gov.fj]
Sent: Monday, January 21, 2013 3:43 PM
To: 'vtikotani@info.gov.fj'
Subject: Total talkback show on climate change by foreign affairs

22/10/12 Monday	Ministry of Foreign Affairs – Climate Change Unit	Climate Change meeting preparations, expected out-comes	Asked for Reschedule	Asked for Reschedule	Asked for Reschedule	The Climate Change unit asked for a reschedule to first week of November
06/11/12 Tuesday	Ministry of Foreign Affairs: Climate Change Unit	Outcomes from the National Climate Change Summit Achievements for the 3rd Quarter and its impact on the nation	Waisea Vosa	Manasa Katoni-vualiku	Kirti Chaya	
06/08/12 Monday	Mrs. S. Mataika-bara – Foreign Affairs	- Opening of new embassies etc - 1st and 2nd quarter achieve-ments for your ministry	Mrs. S. Matai-kabara	DS Penijamini Lomaloma	Om Goundar	

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