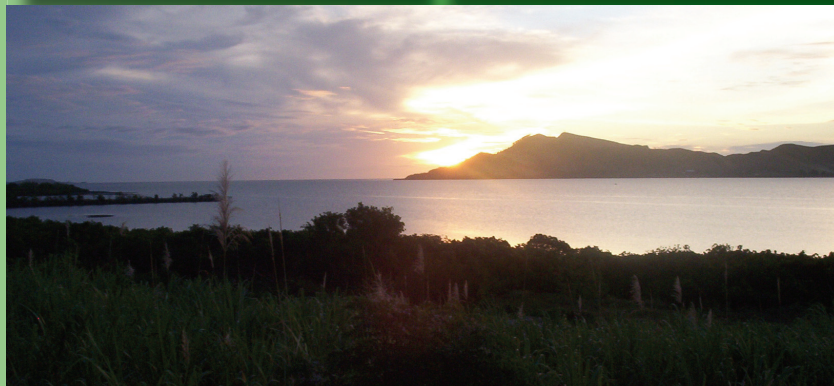


Climate Change The Fiji Islands Response

**Fiji's First National Communication
Under the Framework Convention on
Climate Change
2005**





Government of the Fiji Islands
Fiji's Initial National Communication

prepared

by the

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(PICCAP) & Fiji Country Team

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PICCAP
our islands, our lives..

FOREWORD

Global warming has been linked to the large injection of anthropogenic emissions of Greenhouse Gases into the atmosphere, resulting in an imbalance in the world's climate system. Observations reveal that the earth is getting warmer and mean global temperature keeps on rising annually.

World Leaders and Decision-Makers signed the UN Framework Convention on Climate Change (UNFCCC) at the Earth Summit in 1992, Rio de Janeiro, in a bid to combat the global warming phenomenon. Fiji is a Party to this Convention having ratified it in 1993.

The Framework Convention on Climate Change came into force in March 1994. According to Articles 4 and 12 of the Convention, Parties are required to submit their Initial Communication which should include a national inventory of sources of greenhouse gases and its removal by sinks, identification of vulnerable sectors and actions to be taken for sustainable future socio-economic developments without a further increase in the emissions of Greenhouse Gases.

In 1998, the Pacific Islands Climate Change Assistance Programme (PICCAP) received financial assistance from UNDP through the Enabling Activities of the Global Environment Facility (GEF). This financial assistance has allowed Fiji to prepare its Initial Communication.

It gives me great pleasure to present the Initial Communication of the Republic of the Fiji Islands to the UNFCCC Secretariat for onward transmission to the Conference of the Parties.



Hon. Col. Pio I Wong

**MINISTER FOR LOCAL GOVERNMENT, HOUSING, SQUATTER
SETTLEMENT AND ENVIRONMENT**

EXECUTIVE SUMMARY

INTRODUCTION

During the 1980s there were growing international concerns that changes in the atmospheric concentrations of a number of gases had potential to affect world climate. In 1988 the United Nations General Assembly recognised the need to manage human activities that were affecting, or had potential to affect, the world's climate patterns. Following international negotiations the United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature in 1992. Fiji signed the convention at its launch in 1992 and ratified it in 1993.

The objective of the UNFCCC is to stabilise the concentrations of greenhouse gases in the atmosphere at levels that prevent dangerous interference with the world's climate. This should be done within a time frame that will allow ecosystems to adapt naturally to climate change, to ensure food production is not threatened and to enable economic development to proceed in a sustainable manner (Article 2 of the UNFCCC).

This national communication has been prepared to fulfil Fiji's obligations under Articles 4 and 12 of the UNFCCC. These require that all signatories to the UNFCCC communicate to the Conference of the Parties (COP) National Greenhouse Gas Inventories and develop national plans to mitigate climate-change impacts and promote measures to facilitate adequate adaptation to climate change within three years of the convention coming into force. Because of limited national capacity and financial constraints Fiji has not been able to meet this requirement until now.

This communication has been prepared in accordance with guidelines issued following the 2nd Conference of Parties (COP2) to the treaty. It presents an overview of national circumstances, particularly aspects that relate to climate-change issues, presents a GHG inventory, and analyses mitigation strategies, vulnerability assessment and adaptation assessments and options. An overview of policies and programmes relating to the implementation of the convention is presented, including identified project concepts for further refinement and funding.

Fiji has been enabled to meet its national obligations under the UNFCCC through support received through the Pacific Islands Climate Change Assistance Programme (PICCAP). PICCAP is a three-year programme funded by the Global Environment Facility (GEF), executed by the United Nations Development Program (UNDP) and implemented through the South Pacific Regional Environment Programme (SPREP), in close collaboration with the UNITAR-administered CC: TRAIN.

The implementation of PICCAP in Fiji commenced with the formation of the National Climate Change Committee (NCCC) in 1998. The NCCC was established to advise the government on matters relating to climate change during the UNFCCC process, and draws on expertise within key government departments. The committee facilitates the work of a technical team comprising a National PICCAP Project Coordinator and technical staff drawn from relevant sectors to participate in the CC:TRAIN training programme. The project coordinator is based with the Fiji Department of Environment.

For the purposes of reporting and future monitoring and as is required by the UNFCCC guidelines 1994 was used as the base year for the Greenhouse Gas Inventory for this national communication to the COP.

NATIONAL CIRCUMSTANCES

Background

Fiji comprises more than 300 islands, and has a total land area of approximately 18 300 km² and a population of about 773 000 (1996 estimate). The largest island is Viti Levu (10 429 km²), which covers 57% of the total area, and Vanua Levu covers 5 556 km². Viti Levu is the center of politics and economy of Fiji, having Suva (the capital), Nadi (the center of tourism) and farming land for sugarcane as the major crop. Over 90% of the population, both rural and urban, can be considered coastal dwellers, where the vast majority of services, infrastructure, agricultural production and social centres are located.

Climate

The climate of Fiji is generally categorized as an oceanic tropical climate in which the dry season is from May to October and rainy season from November to April. Fiji's relative location has a strong influence on both seasonal and interannual variations in climate, particularly rainfall where the southeasterly tradewinds carries moist air into the islands. Fiji is also prone to EL Nivo events and tropical cyclones relative to the positioning of the South Pacific Convergence Zone (SPCZ). During an El Nino-Southern Oscillation (ENSO) event, conditions drier and hotter than normal can be expected from June to August. During the November–April wet season Fiji is normally traversed by tropical cyclones as it lies directly in their normal path.

Economy

Fiji's economy has a very narrow base with its performance largely determined by the success of the sugar and tourism sectors. Over the last few years both local and foreign investment have been comparatively low but have started to increase; private investment has continued, mainly concentrating in tourism, construction, garment and mining sectors. The tourism sector has grown significantly over the years and recently a number of additional hotels have been built in the country. In 1998, total tourism earnings were estimated at F\$527.1 million. Employment in the tourism sector is approximately 40000 and this stands to increase in the near future with the building of more hotels and resorts.

NATIONAL INVENTORY OF GREENHOUSE GASES - 1994

One of Fiji's obligations to the UNFCCC is the completion of an inventory of greenhouse-gas sources and sinks.

Based on the six major greenhouse gases covered in the Kyoto Protocol, namely carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and

sulphur hexafluoride, the main sources of major greenhouse gases in Fiji were found to be:

- Carbon dioxide from burning of fossil fuel and biomass
- Methane – emission from animal and human wastes and flooded rice fields
- Nitrous oxide from burning of biomass and incomplete combustion of fossil fuels

	Total National Emissions and Removals (Gg)	CO ₂	CO ₂	CH ₄	N ₂ O	NO _x	CO	NMVOC	SO ₂
		Emission	Removal						
			7019	31.7	0.13	4.8	110	5.5	0.03
1	Energy								
	A. Fuel Combustion Activities	776							
	1. Energy Industries	36	Nil	NE	NE	NE	NE	NE	NE
	2. Manufacturing and Construction	125	Nil	NE	NE	NE	NE	NE	NE
	3. Transport	528	Nil	NE	NE	NE	NE	NE	NE
	4. Other Sectors	87	Nil	NE	NE	NE	NE	NE	NE
	5 Other	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2	Industrial Processes	45	Nil	Nil	Nil	Nil	Nil	5.5	0.03
3	Solvent and Other Product Use	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
4	Agriculture	Nil	Nil	22	0.09	3.3	58	Nil	Nil
5	Land-Use Change and Forestry	Nil	7019	6	0.04	1.5	52	Nil	Nil
6	Waste	Nil	Nil	3.7	Nil	Nil	Nil	Nil	Nil
7	Other	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	[NE: Not Estimated]								

Use the IPCC notations provided in the Revised 1996 IPCC guidelines.

MITIGATION

In spite of Fiji being a minor emitter on a global scale, it is of significant importance that it continues to take measures in mitigation of greenhouse-gas emissions. Apart from this being part of its obligation to the UNFCCC, mitigation measures will enable the country to participate in technology-transfer opportunities, especially when it is reasonable to assume that emissions will continue to increase in the future.

The energy sector is the major source of GHG emissions in Fiji, with emissions dominated by the transport and energy industries. Therefore, to have a significant reduction in the national emissions of GHG gases, mitigation measures will need to target the release of carbon dioxide from this sector.

There are three basic policy options available for the mitigation of greenhouse gases:

1. Demand-side options: reduce energy consumption while maintaining the level of service desired by the user;
2. Supply-side options: increase energy-conversion efficiencies, or replace fossil fuels with renewable energy; and
3. Development of sinks, such as afforestation and sustainable forest management, to remove greenhouse gases from the atmosphere.

In Fiji, the various government departments (Energy, Environment and Forestry) have collaborated closely with the other regional organisations and the private sector, in setting policies that encompass the above policy options available for the mitigation of greenhouse gases.

VULNERABILITY ASSESSMENT

The Likely Impacts of Predicted Climate-Change Scenarios

Coastal Resources

Climate change is likely to affect the coastal resources of Fiji in a variety of ways.

- Sea-level rise (SLR) may lead to increases in coastal erosion and coastal inundation, increased exposure of beaches to wave action (as coral growth lags behind sea-level rise), and in some cases the retreat of mangroves.
- Increased sea surface temperatures may lead to an increase in coral bleaching. This, together with the lag in coral growth, may lead to a reduction in reefal sediment production necessary for maintaining shoreline stability. Coral bleaching is also likely to have adverse effects on coastal biological diversity and fisheries.
- Changes in the patterns of storminess, such as an increase in the frequency or intensity of tropical cyclones, may cause greater incidence of coastal inundation and erosion events. These processes may be exacerbated by reduced reef protection.

Fiji, especially Viti Levu, already suffers from human-generated effects on the coastal zone. High population growth rates, intensive urban development, deforestation of catchments, pollution and increased exploitation of biological and physical coastal resources have exposed large areas of coast to erosion and inundation events. Accordingly,

- Coastal systems have reduced resilience to cope with climate variability,
- Coastal systems have reduced capacity to adapt to climate change, sea-level rise and human activities, and
- Coastal populations and their assets are exposed to higher vulnerability to extreme events such as storm surges, tsunamis, and high tides, apart from sea-level rise.

Impacts on the Suva Peninsula and Rewa Delta are likely to include:

- Raised water tables in low-lying areas,
- Reduced efficacy of in-ground septic systems and inundation of sewer pumping systems,
- Overtopping of the shore protection in downtown Suva during the more extreme wave events under a 25 cm SLR scenario,

- Serious flooding in large parts of Suva Point and downtown Suva even during moderate tropical cyclones under a 100 cm SLR scenario,
- Shoreward retreat of mangroves in the Rewa Delta, and
- Increased sedimentation in the channels of the Rewa Delta and increased flood susceptibility.

Water Resources

On Viti Levu it is important to distinguish between the southeast of the island, which is exposed to the prevailing tradewinds and is characterised by a moist climate, and the northwest which is the leeward, rain-shadow side and much drier. Usually, droughts have much greater impact on the drier, western side of the island.

The effects of climate change on water resources depend on the Global Circulation Model) GCM used. The CSIRO scenario indicates an increase in maximum and minimum stream flows, while the DKRZ model suggests the converse. It is possible that, as a result of climate change, extremes will be intensified. That is, low river flows will become lower and high flows will increase in volume, which implies higher risks of droughts and floods.

Agriculture

Sugar cane

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:

- 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.

The outcome under this scenario would be an overall shortfall in excess of one-quarter of expected production. It implies economic difficulties for the large sector of the population in the agricultural sector dependent on sugar production and associated industries.

Root crops

Using the PLANTGRO model the following patterns were projected for dalo (*Colocassia esculenta*) and yams (*Dioscorea* sp.):

- 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 a halving of the land area providing high yields. It is likely that yam production will also 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.

Health

The study concluded that the afflictions for which a clear link to climate change can be established are:

- Dengue fever,
- Diarrhoeal diseases,
- Nutrition-related illness.

Changes in dengue-fever epidemics were modelled using PACCLIM. It was found that climate change, through increasing temperature, would lead to increases in the risk of dengue-fever epidemics.

These findings suggest that climate change could result in:

- An increase in the frequency of epidemics
- A change in the timing (seasonality) of epidemics so they may occur in any month
- A larger number of people being affected by each epidemic. Under the B2 scenario numbers affected may increase by 40% by 2100, while under the A2 scenario the increase may be in the order of 100%.
- Increased number of fatalities
- Dengue becoming endemic (occurring all the time) rather than occurring in epidemics

Diarrhoeal disease may become more common if Fiji becomes warmer and wetter (as under the CSIRO scenario) and if droughts and tropical cyclones occur more frequently, disrupting water supplies and sanitation systems.

Nutrition-related illnesses are most likely to be affected by increases in frequency and/or magnitude of tropical cyclone and drought events. Further, it is also likely that if climate change leads to economic and social disruption and environmental degradation, disadvantageous effects on health may be serious.

ADAPTATION ASSESSMENT

The following were identified as various adaptation options for the four sectors evaluated in the assessment.

Coastal Resources

Options for adaptation to coastal effects of climate change include:

- Improved understanding of the coastal system;

- Examination and evaluation of coastal protection options, including those which can be implemented at the community level as well as engineering schemes;
- Land-use policies encouraging settlement away from low-lying coastal areas, consistent with cultural practices and land tenure systems;
- Mangrove and reef protection, including education, public awareness and legislative measures, such as penalties for mangrove and reef destruction;
- Controls on pollution from residential, tourism, commercial and industrial areas;
- Exploring the use of artificial reefs as a means of enhancing coastal protection and increasing biological diversity and populations at present reef sites;
- Making use of alternative sources of construction aggregate rather than coral;
- Reducing the reclamation of mangrove areas for residential, commercial, tourism, or industrial purposes and discouraging the cutting of mangrove for other purposes;
- Mangrove rehabilitation; and
- Water-catchment management and soil-conservation measures to reduce erosion and sedimentation.

Water Resources

Adaptation options for water resources fall into three broad categories.

- Flood-control measures to cope with extreme high-rainfall events include such measures as 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.
- Drought-alleviation measures include management of water resources (e.g. reduction of leakage), water legislation, development of alternative water resources such as groundwater and the use of roof catchments, and consumer charges for water use.
- Catchment management including reforestation, land-use controls, protection of wetlands and soil conservation. Flood-damage potential can be reduced by regulating development on flood plains and promoting flood-proof building design. Various activities at community level can improve awareness of water conservation and emergency response.

Institutional development such as the creation of catchment and water authorities would help build capacity to improve the management of water resources.

Agriculture

Generic Adaptation Options

- Research into more-flexible farming systems that are tolerant to climatic variability
- Development of sustainable production systems

- Farming systems research including evaluation of the sustainable qualities of traditional agricultural systems and developing appropriate approaches to intensive commercial agriculture where appropriate

Specific Adaptation Options

The following recent developments in Fiji should be supported:

- Establishment of an Agricultural Diversification Scheme (formerly the Commodity Development Framework);
- Cessation of sugarcane production on marginal sloping land and coastal lands;
- Irrigation (intensified) of sugar-cane production on better lands (this option hasn't worked too well in the past; no data available although FSC did irrigate their crops during the 1993 drought;);
- Strengthening of Land Use Planning Section of MAFF to enable better identification of areas most suitable for different commercial and subsistence crops;
- Root-crop breeding programmes; and
- Development of improved irrigation systems for dalo production

Health

Dengue Fever

The adaptation options for the effective control of dengue fever include:

- Improve vector-control programme;
- Encourage preventative exposure measures;
- Improve quarantine measures;
- Implement epidemic preparedness and response; and
- Implement proper development policies.

Diarrhoeal Disease

Key options which would reduce the climate-change-related effects on the incidence of diarrhoeal disease would include:

- Improved reliability and safety of water supply;
- Improved sanitation;
- Improved refrigeration and storage of perishable foods;
- The preparation of emergency strategies to cope with the effects of floods and droughts; and
- Improved provision of, and access to, primary health care.

POLICIES AND PROGRAMMES TO IMPLEMENT THE CONVENTION

Sustainable Development

Overexploitation of resources and unsustainable management practices will affect the socio-economic fabric of Fiji as well as reducing the resilience of the environment and increasing its vulnerability to the adverse effects of climate change. Therefore the Fiji government has developed and will be developing various sustainable management policies with the realisation that such polices will be the

most beneficial response strategy to help cope with climate change and other environmental and socio-economic problems.

This strategy is in line with the Principles contained in Article 3 of the UNFCCC which refers to the development of policies and measures related to sustainable development, by parties, to protect the climate system against human-induced change, and these should be integrated with national development programme.

Fiji's sustainable development policies are categorized under six broad areas, namely:

- Macro Economic Stability;
- Natural Resource Utilization;
- Physical Infrastructure;
- Social Development and Affirmative Action;
- Protection of the Environment; and
- External Relations.

Sectoral Policies

Land Resources

The Department of Land Planning and Development undertakes planning, development and management of land resources. A land-use plan is expected to be completed for the whole country by 2010.

Policies for the sustainable development and management of land resources are:

- Ensuring sustainable utilization and development of land;
- Creating a leasing system that is mutually beneficial to both land owners and tenants;
- Minimising degradation of land; and
- Consolidating and updating all land databases and information.

Marine Resources

For sustainable development of fisheries and marine resources, the following policies are being pursued:

- Enacting Sustainable Development Bill provisions relating to fisheries resources;
- Promoting production and export of value-added fisheries products;
- Providing appropriate institutional and physical infrastructure to support development in the sector; and
- Increasing community participation through ownership in fish-processing companies.

Watershed and Freshwater Management

The National Environment Strategy provides a strategic approach to water management. With the assistance of the Japanese Government, Fiji is finalizing a watershed management plan, in particular to address flood control and protect arable land.

Forestry

Policies for sustainable forest management include:

- Ensuring sustainable development and management of forestry resources;
- Promoting of community-owned and managed forestry processing and value- adding facilities based on indigenous forests and community-owned plantations;
- Providing the appropriate institutional and physical infrastructure to support the development of the sector; and
- Promoting the production and export of value-added timber products.

Water and Sewerage

The Government, through the Water and Sewerage Section of the Public Works Department (PWD) of the Ministry of Works and Energy, is responsible for the construction, operation and maintenance of water supplies and sewerage services.

The two priorities in the sector are:

- Providing access to reliable and adequate supplies of clean water for both urban and rural dwellers through expanding the rural water-supply scheme and the extension and upgrading of major urban and regional water schemes as outlined in their respective master plans; and
- Providing access to sanitary and environmentally safe sewerage waste systems and treatment facilities.

Energy

The Department of Energy (DoE) is responsible for policy and planning, the development of renewable energy resources, energy conservation and coordination of the rural electrification scheme. The policy priorities in the sector include:

- Ensuring access to reliable and affordable energy supply;
- Assisting rural communities acquire electricity for both social and economic development; and
- Developing cost-effective renewable energy sources for energy supply through undertaking technical and economic feasibility.

Health

The policies in the sector are:

- Providing efficient and adequate primary and preventative health services;
- Providing efficient curative (hospital) health care services;
- Maintaining appropriate level of human resources/staff;
- Maintaining appropriate infrastructure and facilities; and
- Building a management culture that promotes and supports continuous quality improvement.

Disaster Management

Reduction of the vulnerability of rural communities to disasters, such as cyclones and tsunamis, is undertaken through the Disaster Management Office under the National Disaster Management Act of 1998.

The priorities for the sector are:

- Mainstreaming Disaster Management into the national development decision making process;
- Ensuring the establishment of a comprehensive hazard and risk management plan;
- Improve community awareness of risk, preparedness and response; and
- Investing in infrastructure to mitigate the impact of disasters

Protection of the Environment

The proper management of the environment and sustainable use of its natural resources is critical for sustainable development of Fiji's largely natural-resource-based economy. The Department of Environment is responsible for better coordination, effective formulation and implementation of national environmental policies.

Policies for the sustainable management of the environment include:

- Minimizing degradation of natural resources and protecting Fiji's biodiversity;
- Promoting and supporting sustainable waste management;
- Mitigating the effects of climate change;
- Enactment of the Sustainable Bill; and
- Public Awareness and Education

Fiji is committed to implementing adaptation measures on the effects of climate change at the community level and is now involved in an adaptation project, funded by the Canadian government. The project is being executed by SPREP, that implements adaptation measures as highlighted in the PICCAP programme. Part of this commitment is the empowerment of the vulnerable communities to adapt to the changing climatic conditions to sustain their livelihood in the long run. Results of studies done on the effects of climate change and their integration into development policies and plans form part of a broad climate-change response strategy.

Proposed Projects

The following are proposed projects that have been identified for implementation, subject to the availability of resources and funds.

Institution Strengthening

Project 1:

Establishment of a Climate Change Unit within the Department of Environment

Objective

The objective is to establish the Unit so that it is able to provide policy and technical advice, which the GOF will need, to implement the climate-change programmes and fulfil its obligations under the UNFCCC. .

Expected Outputs

The project will ensure the sustainability of the climate-change programme, through institutional strengthening, provision of resources and capacity building, and hence in the medium and long term avoidance and mitigation of the adverse effects of climate change.

Mitigation of GHG Emissions

Project 2:
Promotion of Renewable Energy

Objective

To reduce the emissions of GHG by enhancing the use of renewable energy and at the same time improve quality of life of people in rural areas.

Expected Outputs

The main outputs are the decreased dependence on fossil fuels, facilitation of the removal of barriers to the adoption of renewable energy and improvement of the quality of life of rural people.

Adaptation to the Effects of Climate Change

Project 3:
National vulnerability and adaptation assessment study – Phase II

Objective

To expand the information available on the potential effects of climate change to enable the Fiji Government to identify appropriate policies and strategies to effectively respond to the effects of climate change and sea-level rise.

Expected Outputs

- The research will characterise projected impacts arising from climate change and the individual and integrated consequences of those impacts.
- The research will enhance understanding of the processes contributing to coastal erosion, and lead to the identification and implementation of appropriate strategies and technologies to protect valuable coastal habitats and infrastructure.
- The interchange of traditional adaptation measures can be of great benefit and be cost effective to the communities.
- The research will ensure that the emerging adaptation technologies will be ecologically sound and socially acceptable and applicable to the needs and circumstances of the people of Fiji.
- The research will ultimately provide increased understanding of the linkages between climate change and its effects.

Project 4:

Watershed management for the sugarcane drought-prone areas

Objective

The introduction of ecologically sound natural-resources management and soil-conservation practices by sugarcane farmers to improve productivity and reduce the adverse effects of climate change.

Expected Outputs

- Adoption of natural-resource conservation resulting in maintenance of catchment water recharge and biodiversity
- Adoption of soil-conservation measures resulting in adequate soil-water conservation and fertility improvement
- Conservation and demarcation of protected areas
- Capacity building on watershed management

Project 5:

Integrated Coastal Zone Management Programme for Fiji

Objective

To provide an appropriate context for sustainable development in the assessment, protection and monitoring of coastal and marine ecosystems and provide a policy framework upon which all developments within the coastal zones are assessed and regulated.

Expected Outputs

- Conservation and demarcation of protected areas
- Resource assessment and surveys
- Establishment of natural-resources inventories
- Benefits from appropriate capacity-building programmes

Public Awareness, Education and Training

Education initiatives and enhanced public awareness and action are recognised as key elements of a national strategy for addressing climate-change and SLR issues. The focus of future activities will be directed at strengthening the coverage or inclusion of climate change in the following areas.

Building Partnerships

As part of the ongoing education and awareness programme, partnerships will be strengthened with the government and non-government organisations. Each organisation can share in the dissemination of information.

Informal Education

In the short term, one option is for informal education to be project based, as project managers can justify allocation of funds for this important component.

This would include information being translated and distributed in the vernacular languages using various media, to ensure that information filters through to the rural areas and that the wider population has access to climate-change information.

Formal Education

It is important that the future populations will be able to understand and have informed views on the implications of climate change. Therefore, the advancement of formal education will be included in the medium and long term, such as including climate change in the current primary and secondary curricula of the formal education system.

Systematic Observations and Research

Climate monitoring

The Fiji Meteorological Service (FMS) is in the process of reviewing and formalising its climate-observing network known as the National Climate Monitoring Network (NCMN). The main purpose of NCMN is to improve and enhance the climate-observing network for Fiji in order to improve or complement climate variability and trends studies. FMS is also in the process of establishing a Meteorological GIS Environment for Risk Reduction. The visual spatial distribution of the stations will allow FMS to identify and fill gaps in the observing network. This whole process will further improve FMS's drought and climate forecasting system.

Greenhouse gases and aerosols

At present, for academic purposes, USP measures concentrations of methane, carbon monoxide and non-methane hydrocarbons, as well as aerosol properties in the atmosphere. Measurements of the complete chemistry of the atmosphere over Fiji have been conducted by NASA in 1997 and 1999.

Stratospheric ozone monitoring

Measurements of ozone are conducted at the Laucala Bay campus of USP for academic purposes. This is a joint project between NASA and the USP Chemistry Department. Activity includes the monitoring and archiving measurements of stratospheric and tropospheric ozone, including vertical profiles and other trace species, aerosols and UV-B monitoring.

Sea-Level Monitoring

The National Tidal Facility (NTF) of the Flinders University of South Australia, with assistance from the Fiji Meteorological Service and Marine Department, is responsible for sea-level monitoring, using the equipment based at the Suva and Lautoka wharves. This monitoring of sea level is funded and managed by the South Pacific Sea Level and Climate Monitoring Project developed as a response to

concerns raised by members of the South Pacific Forum countries about the potential effects of the Greenhouse Effect on climate and sea level in the region.

Hydrology

The Public Works Department (PWD) Hydrology Section operates 56 Water Level Recording Stations and well over 100 rain gauges throughout Fiji. These are in addition to and complementary to the Fiji Meteorological Service rainfall stations. USP, conducts rain and surface-water chemistry analyses on a periodic basis mainly for teaching and learning, and conducts collaborative research with the PWD in areas such as floods, droughts and natural disasters.

Oceans

At present sea surface temperatures are not monitored in Fiji, but satellite data from National Oceanic and Atmospheric Administrations (NOAA) and Need to have this in full-- ORSTOM are available on the World Wide Web. Periodic in-situ measurements of sea surface temperature and water chemistry are conducted by USP for academic research. A brief oceanographic survey was conducted in the 1990s for marine disposal of mining waste in the Beqa Passage, south of Viti Levu.

FINANCIAL AND TECHNOLOGICAL NEEDS AND CONSTRAINTS

Future research is needed to address the gaps and uncertainties so that planners and policy makers can have the ability to develop and implement appropriate responses that address climate change and related issues. Examples of research that will help reduce uncertainties in crucial areas are:

- research leading to the development and refinement of national climate impact models;
- research, including appropriate field studies, that will enhance understanding of the processes contributing to coastal erosion, and to the identification and implementation of appropriate strategies and technologies to protect valuable coastal habitats and infrastructure;
- research leading to the development of a model to assess the vulnerability and adaptation of the main crop, sugarcane, to different climate-change scenarios;
- research into the genetic improvement of crops with characteristics such as, higher water-use efficiencies, salt tolerance or more tolerance to extreme weather events; and
- research, including appropriate field studies, leading to the determination and application of locally applicable greenhouse-gas-emission factors for the main activity areas.

Currently the Fiji government does not have the financial resources to effectively finance mitigation and climate change impact related research and assessment

surveys nor effectively fund projects, that have been identified herein, that address current climate- change impacts. Therefore, Fiji in the short and medium term, will need assistance through the financial mechanism of the convention, supplemented by other donor assistance.

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ABBREVIATIONS

COP	Conference of the Parties
DOE	Department of Environment
DoE	Department of Energy
<hr/>	
ENSO	El Nino- Southern Oscillation
FEA	Fiji Electricity Authority
FIJICLIM	Fiji Climate Impact Model
FIT	Fiji Institute of Technology
FMS	Fiji Meteorology Service
FSC	Fiji Sugar Corporation
GDP	Gross Domestic Product
GEF	Global Environment Facility
GCMs	Global Circulation Models
GHGs	Greenhouse Gases
GOF	Government of Fiji
IGCI	International Global Change Institute
IPCC	Intergovernmental Panel on Climate Change
MAFF	Ministry of Agriculture, Fisheries and Forest
NACCC	National Advisory Committee on Climate Change
NTF	National Tidal Facility
PACCLIM	Pacific Climate Impact Model
PWD	Public Works Department
RESCOS	Renewable Energy Service Companies
SLR	Sea Level Rise
SOI	Southern Oscillation Index
SPCZ	South Pacific Convergence Zone
SPREP	South Pacific Regional Environment Programme
UNCED	United Nations Conference on Environment and Development
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
USP	University of the South Pacific

TERMS

Adaptation	Adaptation refers to changes in technologies, practices and policies that can prepare a country for the impacts of climate change.
Enteric Fermentation	The digestive processes that take place inside cattle and other livestock that lead to the release of methane.
Greenhouse Gas	A gas that is transparent to incoming solar radiation but capable of absorbing and re-emitting radiation in the infrared wavelengths.
GHG source	An activity or sector of the economy that releases emissions of GHGs.
Sinks	A system that acts as a reservoir for GHGs. Key sinks for carbon dioxide are the oceans and biomass (e.g. plants)
Vulnerability	The severity of impacts of climate changes on the natural environment, economic activities, human health and society.

1.0 INTRODUCTION

1.1 Background

During the 1980s there were growing international concerns that changes in the atmospheric concentrations of anthropogenic greenhouse gases had potential to affect world climate. In 1988 the United Nations General Assembly recognised the need to manage human activities that were affecting, or had potential to affect, the world's climate patterns. Following international negotiations the United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature in 1992. Fiji was the first country to sign the convention at its launch in 1992 and eventually ratified it on 25th February 1993.

The objective of the UNFCCC as set out in Article 2 is to stabilise the concentrations of anthropogenic greenhouse gases in the atmosphere at levels that prevent dangerous interference with the world's climate. This should be done within a time frame that will allow ecosystems to adapt naturally to climate change, to ensure food production is not threatened and to enable economic development to proceed in a sustainable manner.

This national communication has been prepared to fulfil Fiji's obligations under Articles 4 and 12 of the UNFCCC. These require that all Parties to the UNFCCC communicate to the Conference of the Parties (COP) National Greenhouse Gas Inventories, and develop national plans to mitigate climate change and promote measures to facilitate adequate adaptation to climate change within three years of the convention coming into force for each Party. Because of limited national capacity and financial constraints, Fiji has not been able to meet this requirement until now.

This communication has been prepared in accordance with guidelines issued following the 2nd Conference of Parties to the Convention (COP2). It presents an overview of national circumstances, particularly aspects that relate to climate-change issues, presents a GHG inventory, analyses mitigation strategies, vulnerability assessment and adaptation assessments and options. An overview of policies and programmes related to the implementation of the Convention is presented, including identified project concepts for further refinement and funding.

1.2 Process for development of this national communication

Fiji has been enabled to meet its national obligations under the UNFCCC through support received through the Pacific Islands Climate Change Assistance Programme (PICCAP). PICCAP is a three-year programme funded by the Global Environment Facility (GEF), executed by the United Nations Development Program (UNDP) and implemented through the South Pacific Regional Environment Programme (SPREP), in close collaboration with the UNITAR-administered CC:TRAIN.

The implementation of PICCAP in Fiji commenced with the formation of the National Climate Change Committee (NCCC) in 1998. The NCCC was

established to advise the government on matters relating to climate change during the UNFCCC process, and draws on expertise within key government departments. The committee facilitates the work of a technical team comprising a National PICCAP Project Coordinator and technical staff drawn from relevant sectors who participated in the CC:TRAIN training programme. The project coordinator is based with the Fiji Department of Environment.

Initial PICCAP activities focused on enhancing the understanding of climate change issues and future scenarios by the NCCC members and key staff within key government and statutory agencies. To encourage broader awareness of climate-change issues, NCCC monthly meetings were held and workshops were conducted for key stakeholders and the technical team.

1.3 Base year

As required by the COP2 guidelines for the preparation of initial communications from non-Annex I Parties, 1994 was used as the base year for the Greenhouse Gas Inventory for this national communication to the COP.

2.0 NATIONAL CIRCUMSTANCES

2.1 Background

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. The group is located about 2,100 km north of Auckland, New Zealand. 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.



Figure 2.1 The Fiji Islands (Fiji Visitors Bureau, 2000)

2.2 Geography

The Fiji islands are 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.

2.3 Climate

The climate of Fiji is generally categorised as an oceanic tropical climate. The South Pacific Convergence Zone (SPCZ), a zone associated with high rainfall, fluctuates northeast and southwest of Fiji. Its location relative to the Fiji islands has a strong influence on both seasonal and inter-annual variations in climate, particularly rainfall. The El Niño-Southern Oscillation (ENSO) phenomenon influences the positioning of the SPCZ relative to Fiji. Fiji is also affected, often severely, by tropical cyclones.

2.3.1 Rainfall

The positioning of the SPCZ has a strong influence 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 (Fig. 2.2).

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.

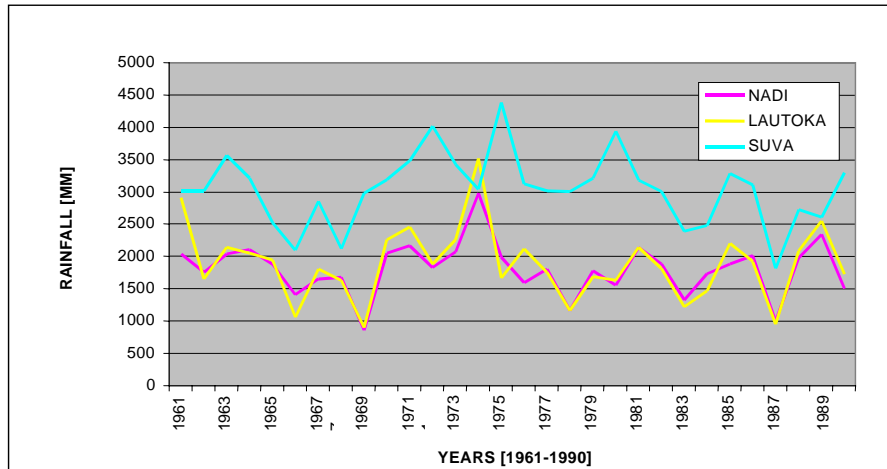


Figure 2.2 Rainfall pattern for 30-year climate baseline (1961 –1990) based on data from 3 stations

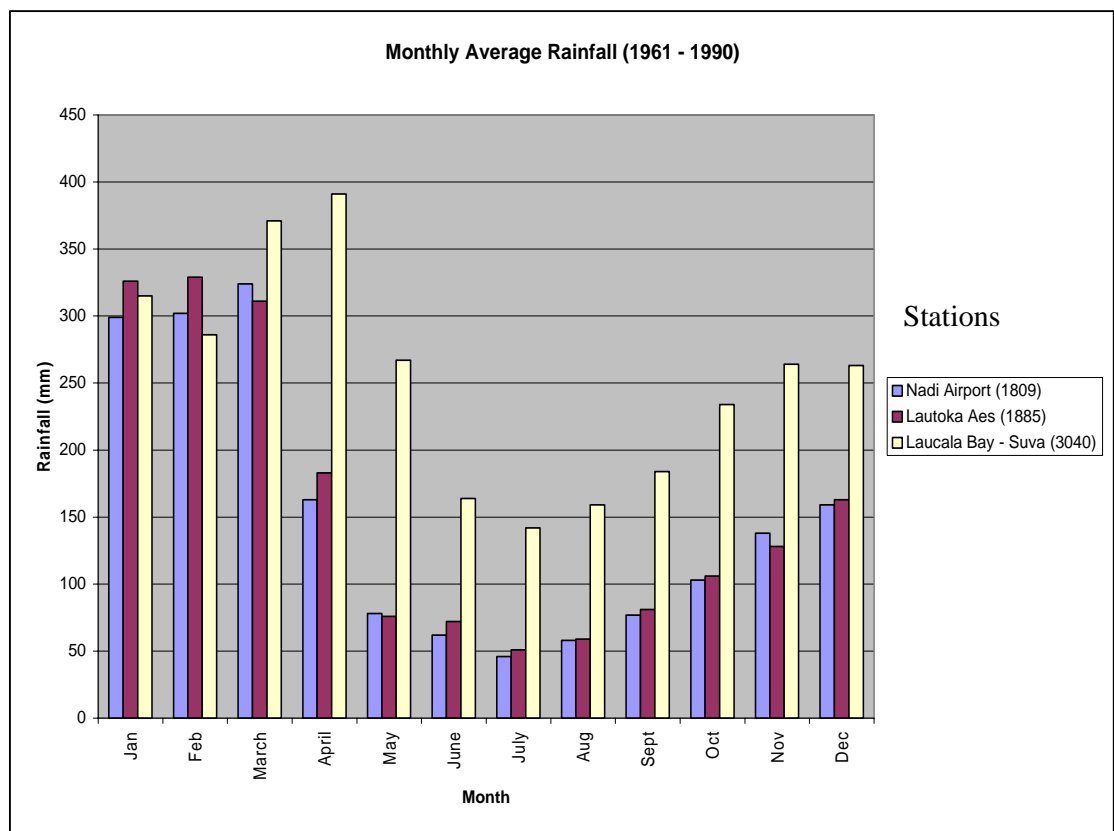


Figure 2.3 Monthly average rainfall (1961 –1990)

2.3.2 Temperature

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

temperature are relatively low, ranging from $\pm 0.5^{\circ}\text{C}$ about the long-term mean.

2.3.3 El Niño

El Niño events, which lead to a northeast positioning of the SPCZ, are 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 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.

2.3.4 Cyclone

Fiji lies in an area normally traversed by tropical cyclones mostly during the November-April wet/cyclone season. Cyclones bring about flooding and multiple landslips which have major impacts on the economy and infrastructure, and many adverse effects for the people of Fiji. More detailed information on the frequency, severity and impacts of cyclones is provided in the Chapter on Vulnerability and Adaptation.

2.4 Social Setting

2.4.1 Population

The Fijian population comprises several ethnic groups - Fijians, Indo-Fijians, Europeans, Chinese and others. The 1996 Population Census recorded a count of 775 057 residents - an increase of 59 682 persons over the 1986 figure of 715 375, providing an average annual population growth rate of 0.8%. The population on Viti Levu in 1996 was 594, 891, 77% of the total population. Fiji has a relatively young population with 53% below the age of 25. This value has declined from 58.7% in 1986. Sixty-seven percent of the population was economically active in 1996. The number of people aged 60 and over was estimated at 47 027 or 6% of the population. Dependency ratio was 68% in 1996 compared to 71% in 1986.

2.4.2 Population Distribution

Over 90% of Fiji's population in both rural and urban areas can be considered coastal dwellers where the vast majority of services, infrastructure, agricultural production and social centres are located.

There has been an increasing trend towards urbanisation in recent years. The increasing urbanisation has led to the development of squatter settlements around the major towns. Despite the increasing urbanisation, the rural sector is still the largest sectoral component in Fiji, containing over 60% of the population. The rural sector plays an important part in the economy of Fiji. However, the sector remains the most economically depressed in terms of employment and income distribution.

2.5 The Economy

2.5.1 Gross Domestic Product

Fiji's economy has a very narrow base with its performance largely determined by the success of the sugar and tourism sectors. Figure 4.5 shows the contribution of various sectors towards the national GDP as it was recorded in 1996. Over the last few years both local and foreign investment had been comparatively low but have started to increase. Private investment has continued but has mainly been concentrated in tourism, construction, garment and mining sectors.

Fiji's real economic growth between 1993 and 1996 averaged 2.7% per year. Following the good growth of 6.2% in 1992, real GDP grew by only 1.6% in 1993 due to the devastating effects of Tropical Cyclone Kina. Real economic growth increased in 1994, resulting from good performances by the sugar and tourism sectors. Also, there was a higher growth recorded in agriculture, fisheries and forests sectors as these sectors recovered from the effects of the cyclone. The economy again slowed in 1995 due to a decline in sugar production by 0.6%. The GDP growth in 1996 increased to 3.1% mainly due to strong performance from tourism, mining, garment manufacture and livestock production.

Real economic growth in 1998 declined by 2.5%. This followed a decline of 1.7% in 1997. The decrease in output was mainly recorded in sugarcane production, mining and quarrying, retail trade, manufacturing, construction, processed sugar, finance, insurance and real estate. Most of the slowdown in 1998 was observed to be due to the adverse weather conditions faced during that year.

The tourism sector has grown significantly over the years. Recently, a number of new tourist hotels have been built in the country. The figure for visitor arrivals has recorded a steady growth in the same period, except in 1995 when tourist arrival declined – a decline attributed to the nuclear testing in Tahiti. However the industry remains active and is considered one of the largest foreign earners. Tourism earnings increased by 6.2% over 1995 to F\$430 million in 1996. In 1998, total tourism earnings were estimated at F\$527.1 million. Employment in the tourism sector is

approximately 40 000. Its contribution to production in the economy was around 17% in 1998.

The garment and footwear industries have been increasing since the introduction of the Tax Free Factory/Zone (TFF/TFZ scheme). Preferential access to the Australian and New Zealand markets, under SPARTECA, and the US market, under the Multi-Fibre Agreement, has had a significant bearing on the viability of the industries.

The mining industry on the other hand did not have the same success as those mentioned above. The output was low from 1993 to 1995 and then recorded a substantial increase due to improved performances of the Emperor Gold Mines and the commencement of operations at Mt. Kasi Mine.

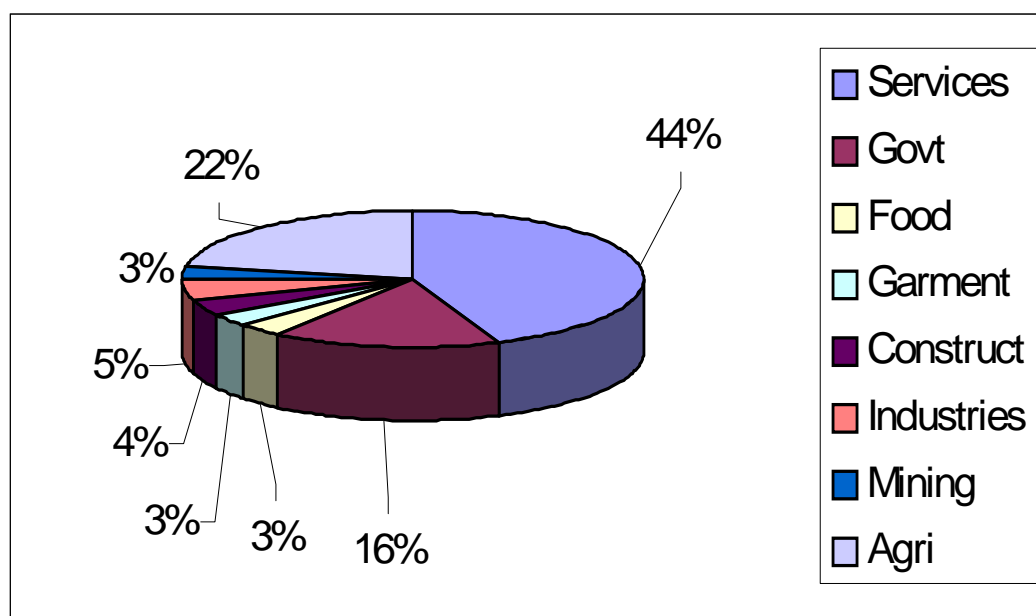


Figure 2.5 GDP by sectors – 1996

2.5.2 Imports and exports

External trade plays an important part in the Fiji economy. Economic growth over recent years has been possible through the adaptation of an export-led growth policy and increased facilitation of private-sector development. Exports have been rising but have also been affected by the effects of cyclones, drought and falling world prices. Domestic exports increased to F\$821 million in 1996, representing an annual average growth rate of 1.4% from F\$593 million in 1993. Sugar, gold and garments remain the main export items. Recently kava and taro have increased as exports in response to increasing demand from overseas markets.

2.5.3 Key Sector in Fiji's Economy – Agriculture

Of Fiji's total land area only 16% is suitable for farming and is found mainly along coastal plains, river deltas and valleys of the two main islands, Viti Levu and Vanua Levu. The rest can be found in the smaller, outlying islands of the

Fiji group.

Of the arable land, 24% is under sugar cane, 23% coconut and the remaining 53% under other crops.

Agriculture has always been the largest sector in Fiji's economy, accounting for 43% of Fiji's foreign exchange earnings in 1999. It provides 50% of the country's total employment and contributes 19% to Fiji's GDP. The decline in production of sugar (Fiji's largest agricultural export) due to the 1997-98 drought, created an economic crisis sending the economy into negative growth of 4%. With the crop back to normal in 2000, the economy as a whole recovered with a 3-3.5% growth that year. Similar patterns have emerged in previous years when good sugar production has been reflected in healthy economic growth overall.

2.5.4 Key Sector in Fiji's Economy – Tourism

Tourism is now Fiji's most important industry and the largest foreign exchange earner. The industry provides employment directly and indirectly to an estimated 40 000 people (15% of the labor force) and contributes approximately 17% of total production in the economy.

The tourism industry achieved a record number of visitors and foreign exchange for 1998, the eighth year in a row. The country hosted 371 342 visitors with foreign exchange earnings expected to be over the half billion mark, \$527.1 million dollars for the year.

Government upgraded the Tourism Department to ministry status in 1994 as a reflection of the importance of the tourism industry in the economy. The Ministry of Tourism is geared towards assisting the industry in increasing visitor arrivals, primarily through the continuation of government's support in the international marketing of tourism, the development of 'Eco Tourism' in rural areas, and encouraging private investment in the sector.

Table 2.1 Selected Economic Indicators

	UNIT	1990	1994
Population	000	736	784
GDP at market prices	F\$M	1811	2519.5
GDP at Factor Cost	F\$	842.5	1778.9
Breakdown (as % of total)			
- Agriculture, Forestry and Fishing	%	21.7	20.9
- Mining & Quarrying	%	0.2	2.6
- Manufacturing	%	11.8	15

- Electricity, Water, Gas	%	1.3	3.8
- Construction	%	3	4.4
- Trade, Hotels, Cafes, etc.	%	22	15.3
- Transport & Communication	%	14.2	11.5
- Finance, Insurance, etc.	%	12.6	14.4
- Community & Social Service	%	16.5	18.9
		4.9	2.2
GDP growth rate (from previous year)	F\$	1144	2269
Per capita GNP	F\$M	-265.4	-326.7
Visible Trade Balance	F\$M	55.5	-16.6
Balance of Payments	F\$M	381.2	384.8
Gross Foreign Reserves	%	1986 census = 38.7	1996 census=46.4
Urban population as % of total population			
Labour Force	000	253	272
Employment	000	236	256

2.6 Energy

Domestic energy requirements are met from a number of sources including hydro-electricity, fuel wood, bagasse, coal and petroleum products. Of these major energy sources, coal and petroleum products are imported, while others are produced locally.

Analysis of Fiji's energy balance (converting all energy supplied, transformed and consumed into common units) shows that in 1990, 65 percent of energy requirements was met from local resources and 35 percent was imported.

The Fiji Electricity Authority is responsible for electricity supply to all recognised urban areas including areas such as Korovou, Deuba/Navua, Rakiraki and Vatukoula.

Rural electrification schemes are normally diesel powered, and are installed and maintained by PWD. Local communities contribute to capital and maintenance costs, and pay fuel bills. The generators remain the property of government.

2.7 Transport

As an island nation with an open economy, Fiji is heavily dependent on transportation services. The transport sector accounts for around 12 per cent of GDP.

Government's major role in the transport sector is through the development of infrastructure (roads, jetties and airstrips), and providing the regulatory framework for the operation of all transport modes. Statutory bodies run the major airports and ports. Transport services are mainly provided by the private sector, though government is also involved in inter-island shipping, shipbuilding and ship repair. As a shareholder in the airline industry, government also assumes a planning role in relation to the various transport modes.

3.0 NATIONAL GREENHOUSE GAS INVENTORY

3.1 Introduction

In 1990 the Intergovernmental Panel on Climate Change (IPCC) recognised human activities as a major catalyst to the increasing amount of greenhouse gases (GHGs) in the atmosphere.

There is a concern that the addition of such gases will cause a further warming of the earth's surface and atmosphere. This would have an adverse effect on humans and the natural ecosystems, and would possibly cause a sea-level rise in the future if the current warming trend continues.

In compiling this inventory, Fiji would meet the requirements of information under Articles 4 and 12 of the Convention.

Because of limited information and data, Fiji's priority was to develop an inventory for CO₂ and CH₄ based on 1994, while minimal data are presented for other GHG gases such as N₂O, NO_x and CO.

3.2 Greenhouse Gases

Naturally existing greenhouse gases are water vapour (H₂O); carbon dioxide (CO₂); methane (CH₄); nitrous oxide (N₂O); and ozone (O₃).

Man-made compounds such as chlorofluorocarbons (CFCs), their substitute hydrofluorocarbons (HFCs), and perfluorinated carbon (PFCs) also act as greenhouse gases. Other gases such as carbon monoxide (CO), oxides of nitrogen (NO_x) and non-methane volatile organic compounds (NMVOC), contribute indirectly to the greenhouse effect. Concentrations of these gases have been increasing significantly in the atmosphere since the industrial revolution, due to human activities. The massive injections of these GHGs into the atmosphere may upset the radiative balance of the atmosphere and could have severe effects on the climate system.]- This section is good but is not related to the Inventory work so I suggest deletion of this section.

3.3 Inventory Process

3.3.1 Methodology

The first emission estimates, presented in this initial communication, were calculated according to the Revised 1996 IPCC Guidelines for National Greenhouse Gases Inventory, to ensure that the emission inventory is consistent and comparable across sectors and between Parties. The IPCC guidelines have been followed and default values have been used, otherwise specified.

Both the top-down and bottom-up approach have been used for the preparation of the national inventory within the energy sector.

3.3.2 Sources of Data

The data for the inventory have been obtained from the following sources:

- Fiji Customs Department;
- Bureau of Statistics;
- Ministry of Agriculture, Fisheries and Forests;
- Department of Energy;
- Fiji Industries Limited; and
- Fiji Sugar Corporation.

Data for particular items were obtained from two or more sources at times. Discussions were held among concerned parties to arrive at the most reliable information.

3.3.3 Organisation

The National Inventory has been organised into six parts corresponding to the six major source categories, as described in the IPCC 1996 Guidelines. This is not necessary as you have already stated that you are using the Revised 1996 IPCC guidelines. Suggest delete.

- I. Energy Activities
 - A. Fuel Combustion Activities
 - Energy Industries
 - Transport
 - Manufacturing Industries and Construction
 - Other Sectors
 - Other
 - B. Fugitive Emissions
 - C. Memo Items
- II. Industrial Processes
- III. Solvent and Other Product Use
- IV. Agriculture
 - Enteric Fermentation
 - Manure Management
 - Agricultural Soils
- V. Land Use Change and Forestry
 - Managed Lands
 - Grassland Conversion
 - Managed Forests
 - Clearing Forests

- VI. Waste
 - Solid Waste Disposal on Land
 - Waste Water Handling

3.4 Emissions

I. Energy sector

GHG emissions were mainly from two fossil fuel types: liquid and solid fuel categories. Liquid fossil fuels consisted of gasoline, jet kerosene and other kerosene, gas/diesel oil, liquefied petroleum products (e.g. LPG) and lubricants. Bituminous coal was the most commonly used solid fossil fuel.

The total amount of carbon dioxide emissions for the Energy sector was 776 Gg. This represented 94.5% of total emissions of carbon dioxide gas emissions, when including the land use change and forestry sector and its high sequestration.

Public Electricity

The supply of electricity to consumers in Fiji is split into that supplied by the Fiji Electricity Authority (FEA) and that supplied to rural consumers by the Public Works Department (PWD) and private companies. The former is by far the largest, accounting for all major grid areas in the main islands.

Between 1982 and 1983 the major hydro-electricity scheme at Monasavu on Viti Levu came into operation. Prior to 1982 the demand was met by diesel-based generators. In 1991, the Monasavu hydro-electricity dam, having a generating capacity of 80 MW, supplied 97% of all the electricity needs in Fiji.

Rural electrification includes both FEA grid extensions and stand-alone generation.

The resulting CO₂ emission from this activity totalled 36 Gg, representing 4.4% of the total CO₂ emissions.

Transport

The transport sector includes both domestic aviation and road transport. Domestic aviation produced 12 Gg and road transport produced 516 Gg of CO₂ emissions. The combined CO₂ emission is 528, which represented 68% of the total CO₂ emission of the energy sector and approximately 64% of the total carbon dioxide emission.

Manufacturing and Construction Industries

The major industries in Fiji comprised the following:

- Sugar
- Cement industry
- Timber processing

- Stone crushing and block-making
- Fish canning industries and
- Beverages and allied industries.

In the sugar industry, bagasse is the main source of energy.

Electricity is the main source of energy for driving motors, lighting and air-conditioning. CO₂ emissions accounted for about 5% of the total emissions from this sector and were estimated at 36 Gg.

Residential/Commercial Sectors

Energy needs in the residential/commercial sectors, herein categorised as Other Sectors, were mainly met from the following sources:

- Kerosene
- LPG
- Fuel wood and
- Electricity

Both the residential and commercial sectors relied heavily on electricity for lighting and air-conditioning purposes. Cooking needs were satisfied mainly from LPG while fuel wood was mainly used in rural areas.

CO₂ emission accounted for about 11% of the total emission from this sector and was estimated at 87 Gg.

Carbon Stored in Products

Bitumen and lubricants have been imported for non-energy application sectors such as road construction. The carbon stored has been estimated at 3.11 Gg.

Product	Carbon Stored (Gg)
Lubricant	1.95
Bitumen	1.16
Total	3.11

Fugitive Emissions

Mining, handling, production, processing, transport and use of coal, oil and natural gas, as well as the non-productive combustion and conversion of crude petroleum into a variety of sub-products associated with fugitive emissions, are not carried out in Fiji. Therefore fugitive emissions from fossil fuels are nil.

Memo Items

International Bunkers

International bunkering accounted for 229.76 Gg of CO₂ emission in 1994 and the details are given in the table below.

Fuel type	CO ₂ emission (Gg)
Gasoline	0.21
Jet Kerosene	27.18
Gas/Diesel Oil	43.56
Residual Fuel Oil	35.69
Lubricants	0.18
Other Kerosene	122.94
Total	229.76

II. Industrial Processes

Greenhouse gases are also produced as residues of various non-energy-related activities. These gases are emitted directly from the process itself but not as a result of energy consumption during the process.

The production processes of interest to Fiji are:

- Lime production in the cement industry
- Asphalt, used for tarring roads, and
- Food and Beverages

The above-mentioned activities are carried out on a very small scale and contribute to the following emissions.

GHGs	Amount (Gg)
Carbon Dioxide	45
Nitrous Oxide	Nil
Oxides of Nitrogen	Nil
NM VOC	5.5
SO ₂	0.03

III. Solvent and Other Product Use

Solvents and other chemical products can produce emission of some greenhouse and photochemically important trace gases. Emission from this sector has not been calculated due to lack of sufficient data.

IV. Agriculture

Fiji is concerned with only enteric fermentation, manure management, rice cultivation and field burning of agricultural residues.

Emissions from this sector comprise the following:

	Amounts (Gg)
CH ₄	22

N ₂ O	0.09
NO _x	3.3
CO	58

Agricultural Soils

Nitrous oxide can be produced from agricultural soils through various activities such as application of synthetic fertilizer, animal waste, nitrogen-fixing crop residues, and through indirect emissions from atmospheric deposition. The N₂O emissions have not been estimated from agricultural soils for Fiji.

V. Land Use Change and Forestry

A wide variety of carbon and nitrogen trace gases are either emitted or absorbed in the biosphere. Any changes in the biosphere, through land-use changes and forestry activities, will modify the natural balance of these trace gases both in emission and uptake. On the global scale the human activity which most affects the biosphere is deforestation, especially in the tropical region.

In this sector, the calculation of emissions is focused on two activities, which acted either as sources or sinks:

- Changes in Forest and Other Woody Biomass Stocks, and
- Forest and Grassland Conversion

Changes in Forest and Other Woody Biomass Stocks

Forests are critical components of the climate system. Their potential for sequestering greenhouse gases is enormous, and they act as an additional "reservoir" for CO₂ emissions. Fiji has embarked on some highly successful plantation establishment programmes. The softwood plantations total over 43 000 ha and are established in the main drier climatic zones, as afforestation in areas of degraded grass and reedland. The hardwoods, principally the introduced hardwood Mahogany (*Swietenia macrophylla*) has been established with great efficiency within the existing native forest and covers some 42 000 ha. These plantation forests have an estimated sink of 9 989 Gg of CO₂.

Forest and Grassland Conversion

The rate of reduction of total forest area from 1985 to 1996 was estimated to be 2 645 ha per year. The area of production forest and non-commercial forest recorded a nett reduction in area of 13.39 kha from 1990 to 1991. In the same period, protection-forest reduction was estimated to be 1.55 kha. It was assumed that the cleared forests were mainly used for agricultural purposes.

The emission from this activity was estimated at 2 149 Gg CO₂.

VI. Waste

Methane is one of the principal sources of greenhouse gases contributing to global warming, second only to carbon dioxide. Methane emissions originate from several sources including anaerobic decomposition of organic wastes in solid waste disposal sites, in sludge and residual solid by-products. In this sector, methane emission is calculated from solid waste disposal sites and from domestic and industrial waste water handling.

Solid waste disposal site on land

Anaerobic decomposition of organic matter in solid-waste disposal sites by methanogenic bacteria results in methane emissions. The method used to calculate methane emission depends on the amount of waste disposed, fraction of degradable organic carbon, the amount which actually degrades, and the fraction of methane in landfill gas. It is assumed that the methane is released in the same year that the waste is placed in the disposal site.

There is no sanitary landfill at present in Fiji. Solid wastes are disposed of in open disposal sites for all the urban centres. Waste burning is practised in at least two of these sites. From calculations, the approximate methane emission from domestic solid-waste disposal is 3.4 Gg.

Organic Waste Water and Sludge

Domestic waste water includes all liquid wastes from factories, hotels, restaurants and residential premises. At present, most waste-water treatment works carry out only preliminary treatment, that is screening, removal of grit and disintegration of solids. The effluents are then disposed of through sea outfalls. It is assumed that methane is produced since the process is not totally operated under aerobic conditions. The methane emission has been estimated to be 0.23 Gg.

Greenhouse Gases Sources and Sinks		CO ₂	CO ₂	CH ₄	N ₂ O	NOX	CO	NMVOC	SO ₂
	Net Total National Emissions and Removals (Gg)	Emissions	Removals						
		Nil	7 019	31.7	0.13	4.8	110	5.5	0.03
1	Energy	776	Nil	NE	NE	NE	NE	NE	NE
	A. Fuel Combustion Activities								
	Reference Approach								
	Sectoral Approach	776	Nil						
	1. Energy Industries	36	Nil	NE	NE	NE	NE	NE	NE
	2. Manufacturing and Construction	125	Nil	NE	NE	NE	NE	NE	NE
	3. Transport	528	Nil	NE	NE	NE	NE	NE	NE
	4. Other Sectors	87	Nil	NE	NE	NE	NE	NE	NE
	5 Other (Please Specify)	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil

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	B.	Fugitive Emissions from Fuels								
		1. Solid Fuels	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
		2. Oil and Natural Gas	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
2	Industrial Processes		45	Nil	Nil	Nil	Nil	Nil	5.5	0.03
	A.	Mineral Products	45	Nil	Nil	Nil	Nil	Nil	Nil	0.03
	B.	Chemical Industry	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	C.	Metal Production	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	D.	Other Production	Nil	Nil	Nil	Nil	Nil	Nil	5.5	Nil
	E.	Production of Hydrocarbon and sulphur hexafluoride	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	F.	Consumption of Halocarbons and Sulphur hexafluoride	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	G.	Other	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
3	Solvent and Other Product Use		Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
4	Agriculture		Nil		22	0.09	3.3	58	Nil	Nil
		A. Enteric Fermentation	Nil		15	Nil	Nil	Nil	Nil	Nil
		B. Manure Management	Nil		3	Nil	Nil	Nil	Nil	Nil
		C. Rice Cultivation	Nil		1.4	Nil	Nil	Nil	Nil	Nil
		D. Agricultural Soils	Nil		Nil	Nil	Nil	Nil	Nil	Nil
		E. Prescribed Burning of Savanas	Nil		Nil	Nil	Nil	Nil	Nil	Nil
		F. Field Burning of Agricultural Residues	Nil		2.8	0.09	3.3	58	Nil	Nil
		G. Other	Nil		Nil	Nil	Nil	Nil	Nil	Nil
5	Land-Use Change and Forestry		Nil	7 840	6	0.04	1.5	52	Nil	Nil
		A. Changes in Forest and Other Wood Biomass Stocks	Nil	9 989	Nil	Nil	Nil	Nil	Nil	Nil
		B. Forest and Grassland Conversion	2 149		6	0.04	1.5	52	Nil	Nil
		C. Abandonment of Managed Lands	Nil		Nil	Nil	Nil	Nil	Nil	Nil
		D. CO2 Emissions and Removals	Nil		Nil	Nil	Nil	Nil	Nil	Nil
		E. Other	Nil		Nil	Nil	Nil	Nil	Nil	Nil
6	Waste		Nil		3.7	Nil	Nil	Nil	Nil	Nil
		A. Solid Waste Disposal on Land	Nil		3.4	Nil	Nil	Nil	Nil	Nil
		B. Waste Water Handling	Nil		0.23	Nil	Nil	Nil	Nil	Nil
		C. Waste Incineration	Nil		Nil	Nil	Nil	Nil	Nil	Nil
		D. Other	Nil		Nil	Nil	Nil	Nil	Nil	Nil
7	Other									
	Memo Items									
		International Bunkers	229	Nil						
		Aviation	150	Nil						
		Marine	79	Nil						
		CO2 Emissions from Biomass	1 176	Nil						
[NE:Not Estimated]										

Suggestions for the table: please use the IPCC notation keys for "nil" and for CO2 emission from biomass (under Memo items), you could give a breakdown for bagasse and fuel wood.

4.0 MITIGATION

4.1 Introduction

Mitigation refers to measures that will reduce the national release of GHGs. Most commonly mitigation measures can either reduce people's demand for GHG-emitting products or else control their supply. They can incorporate education and awareness-raising initiatives, fiscal measures such as financial incentives, taxes and charges, legislation to prohibit certain activities and policy measures.

Under the UNFCCC convention, Fiji is obliged to develop relevant programmes seeking to lower carbon emissions, even though being a minor emitter in both a relative and absolute sense.

Fiji has followed a development path that promotes the mitigation of GHG gases. This has mainly been implemented through the following sectoral policies:

- encourage development of local energy sources; and
- establish managed forest plantations and promote sustainable forest management

The energy sector is the major source of GHG emissions in Fiji, with emissions dominantly from the transport and energy industries. Therefore to have a significant reduction in the national emissions of GHG gases, mitigation measures will need to target the release of carbon dioxide from this sector.

4.2 Mitigation options in the energy sector

4.2.1 Demand Side

On the demand side, the Department of Energy recognises the potential for demand-side management (DSM), particularly in relation to household uses. There are plans to implement a pilot voluntary labelling scheme for refrigerators and freezers, in collaboration with SOPAC.

The Department of Energy conducts energy audit studies in institutions such as hospitals with the objective of controlling inefficient use of energy.

Fiscal measures play an important role in transportation. Differential tax rates are used to encourage the efficient use of fuel. Rates for passenger vehicles start at \$44 p.a. for vehicles below 1000 cc and increase up to \$330 p.a. for vehicles in excess of 6 000 cc. Import duties have also been adjusted to favour fuel-efficient vehicles. Duties rise from 40-50% on cars of up to 1600 cc to 250% duty on cars in excess of 3 000 cc. The present tax on petrol is close to 100%.

The Land Transport Authority is currently developing policies that will ensure the control of vehicle emission. Such policies include monitoring of vehicle

maintenance through reduction of inspection period of passenger vehicles from one year to six months.

4.2.2 Supply Side

At the end of 2002, electricity accounted for 3.7 percent of GDP. The census of 1996 revealed that 87% of the total number of urban households had access to electricity supply compared to 75% in 1986. In terms of rural access, 49% of the total number of rural households had access to electricity supply in 1996, compared to 31% in 1986.

Fiji has a major hydroelectricity scheme (Monasavu) that serves the bulk of the population on the main island Viti Levu. Bagasse, a by-product of sugarcane, is used for power generation in sugar manufacturing, and wood wastes are used in saw milling. Firewood remains the leading fuel for domestic cooking. Thus, 73% of the energy supply is from domestic sources.

The Fiji Electricity Authority (FEA), a wholly Government-owned commercial statutory authority, is responsible for the generation, transmission and distribution of electricity in Fiji, while the three oil companies Shell, Mobil and British Petroleum undertake the purchase, storage and distribution of petroleum products throughout the country. Government through the Department of Energy (DoE) is responsible for national energy policy and planning, promoting the development of renewable energy resources and renewable-energy service companies (RESCOS), energy conservation and the coordination of rural electrification through the Rural Electrification Scheme.

4.2.3 Renewable Energy Resources

Hydroelectricity The Monasavu hydropower plant currently supplies 81% of Fiji's electricity needs. There are several additional sites at a scale of 5 to over 50 MW, which have the potential to be major suppliers. With a potential resource of 300 MW, hydropower will likely provide the bulk of increased generating capacity over the next several decades. Chinese and Korean funding has led to the development of several micro-hydro sites.

Biomass The biomass resource supplies approximately 64% of the energy consumed in Fiji. Rural households use firewood for domestic cooking. There is also some trade in firewood in urban areas. Coconut residues are used for copra drying. The bulk of the bagasse (~93%) available at the sugar mills is used to produce the heat and electricity for internal use. In 1999, 3% of the electricity consumed in Fiji was produced using bagasse.

Geothermal There is some evidence of geothermal resources on the two major islands. Preliminary assessments by DoE indicate that there is potential for steam generation and electricity production at two sites.

Solar The solar resource can be estimated correlating solar-radiation-satellite data to ground data obtained with pyronometers. The total installed photovoltaic (PV) capacity in Fiji is about 80 kW.

Wind DoE has pursued evaluation of wind resources in three locations. Unfortunately, the resource required for commercial development has not yet been identified. Wind regimes corresponding to annual averages of at least 7 m/s are required to produce electricity at rates that are competitive with those that are available through the national grid. A value of approximately 6 m/s is cost competitive for rural electrification in remote locations.

The Nabouwalu (Bua) pilot hybrid system includes eight wind-turbine generators amounting to an annual average of 6.2 m/s (Table 4.1). DoE plans to install similar systems in other appropriate sites, however this will depend on the availability of funds.

Table 4.1 Renewable-based Electrification Projects

Village	Province	Type	Install date	Consumers	Cost (\$)
Vatukarasa	Naitasiri	hydro(3 kW)	1993	150	150 000
Kadavu Koro	Kadavu	hydro(20 kW)	1994	250	80 000
Muana	Cakaudrove	hydro(30 kW)	1999	136	600 000
Moala	Lau	Individual lighting	Solar 1999	170	1 000 000
Vunivau(1)	Bua	Individual lighting	Solar 2000	58	130 000
Vunivau(2)	Bua	Individual lighting	Solar 2002	83	
Namara	Kadavu	Individual lighting	Solar 1994	70	40 000
Hybrid	Bua	Solar/wind/diesel	1998	100	980 000

Note: All the above projects have lights for individual houses

As Fiji has a developing economy, electricity supply is pressed to keep pace with increasing demand by industry and consumers. In 2001, the FEA purchased four new generators for this reason. Besides this, Government is evaluating 170 potential micro-hydro sites capable of being developed for electricity production.

4.3 Sinks

Fiji has approximately 36 000 ha of forest reserved as either forest reserve, or nature reserve. In addition Fiji has approximately eight times this area reserved as watershed-protection forest.

Fiji is interested in the concept of reserves of existing forest being set aside from logging as greenhouse-gas sinks. The present reserves have been created for other purposes. In these cases the Forestry Department pays lease fees to the owners as compensation for the loss of stumpage revenue from standing trees. To be able to establish any further reserves the Forestry Department would need funding from outside.

5.0 VULNERABILITY ASSESSMENT

5.1 Vulnerability assessment studies

Fiji's Climate Vulnerability and Adaptation Assessment (V&A) through the PICCAP Project began in June 1998 with two members of the Fiji Climate Change Country Team sent to the International Global Climate Change Institute (IGCI), University of Waikato, New Zealand, to participate in a CC:TRAIN/PICCAP Certificate Training Programme on 'Climate Change Vulnerability and Adaptation Assessment for the Pacific Islands'. The course was a collaborative effort between UNITAR, SPREP, IGCI and the University of the South Pacific (USP), with financial support from the New Zealand Ministry of Foreign Affairs and the Swiss Agency for the Environment, Forests and Landscapes.

The Training Component of the course on Climate Change V&A Assessment included computer-based training tools, designed for small island states. Students were trained in a manner that allowed them to draft their national V&A assessments during the training.

In September 1999, the World Bank indicated their desire to compile an Economic Report on Fiji's Climatic Vulnerability. Consultants were hired from USP, SOPAC and ICGI to complete the V&A report that would serve as the basis for the Economic Report. The final V&A and Economic Report was completed in late 2000.

Past V&A activities include the report 'Vulnerability and Adaptation Assessment of Coastal Impact of Sea level Change for Suva and Vicinity' compiled during the US Country Studies Programme. There has also been a study sponsored by Environment Agency of Japan, SPREP and Overseas Environmental Co-operation Center that contributed to coastal-zone management studies in Fiji within which there is a significant amount of coastal vulnerability and resilience assessment for the islands Viti Levu, Kadavu, Moturiki and Ovalau.

5.2 Climate-Change Scenarios

This study has adopted the results from two global circulation models (GCMs). The first of these is known as CSIRO9M2 which has been scrutinised and validated for the South Pacific region. The second GCM chosen is DKRZ, which represents a decreasing-rainfall scenario.

In addition to these two models, two emissions scenarios were adopted representing an extreme scenario (high climate sensitivity, worst case) and a mid-range scenario (best guess).

Thus, using the two models and the two emissions scenarios, a total of four different scenarios were developed for each of the years 2025, 2050 and 2100. These scenarios are summarised in Table 5.1.

Table 5.1 Summary of Temperature and Rainfall Change Scenarios for Fiji

GCM	Emissions Scenario	2025		2050		2100	
		Temp [°C]	Rainfall [%]	Temp [°C]	Rainfall [%]	Temp [°C]	Rainfall [%]
CSIRO9M2	B2 (mid)	0.5	3.3	0.9	5.7	1.6	9.7
	A2 (high)	0.6	3.7	1.3	8.2	3.3	20.3
DKRZ	B2 (mid)	0.5	-3.3	0.9	-5.7	1.6	-9.7
	A2 (high)	0.6	-3.7	1.3	-8.2	3.3	-20.3

Because the GCMs do not yet account for ENSO variability or changes in the frequency and/or magnitude of extreme climate events, analogues based on recent patterns of occurrence of events such as tropical cyclones or droughts have been developed based on a sequence of events from 1992 through 1999. Confidence in GCM projections of regional sea level remains low. Accordingly, global mean projections are used as first-order estimates of changes that could occur in Fiji. These are shown in the table below:

Table 5.2 Summary of Global Sea-Level-Rise-Projections

Year	2025	2050	2100
Scenario			
B2 (mid-range, best guess)	11 cm	23 cm	50 cm
A2 (high-range, worst case)	21 cm	43 cm	103 cm

5.3 Socio-economic scenarios

The scenarios were also developed, for a high, medium and low set of population projections. It is stressed that it is extremely difficult to develop reliable long-term population projections that are of relevance to the time scale of climate change considered in this study. However, the projections do help us to consider a range of populations upon which climate changes will be played out. It is anticipated that Viti Levu will increase its already dominant share of the national population of Fiji, and that the proportion of urban dwellers will continue to grow. Generally, existing economic and social trends are projected to continue.

5.4 The Likely Impacts under Predicted Climate Change Scenarios

5.4.1 Coastal Resources

Climate change is likely to affect the coastal resources of Fiji in a variety of ways.

- Sea-level rise may lead to increases in coastal erosion and coastal inundation, increased exposure of beaches to wave action (as coral growth lags behind sea-level rise), and in some cases the retreat of mangroves.
- Increased sea surface temperatures may lead to an increase in coral bleaching. This, together with the lag in coral growth, may lead to a reduction in sediment production necessary for maintaining shoreline stability. Coral bleaching is also likely to have adverse effects on coastal biological diversity and fisheries.
- Changes in the patterns of storminess, such as an increase in the frequency or intensity of tropical cyclones, may cause greater incidence of coastal inundation and erosion events. These processes may be exacerbated by reduced reef protection.

Fiji, especially Viti Levu, already suffers from human-generated effects on the coastal zone. High population growth rates, intensive urban development, deforestation of catchments, pollution and increased exploitation of biological and physical coastal resources have exposed large areas of coast to erosion and inundation events. Accordingly,

- Coastal systems have reduced resilience to cope with climate variability,
- Coastal systems have reduced capacity to adapt to climate change, sea-level rise and human activities, and
- Coastal populations and their assets are exposed to higher vulnerability to extreme events such as storm surges, tsunamis, and high tides, not to mention sea-level rise.

The Suva Peninsula is the largest and most populated urban area on Viti Levu. It is on the south side of the island, adjacent to the Rewa River delta (to the east). It consists of the urbanised zone from Vatuwaqa on the east side to the Royal Suva Yacht Club (Korovou) on the west, an area with coastline 18.6 km long. The area includes the downtown core of Suva along with its infrastructure of buildings, wharves, port, harbour facilities and tourist facilities.

Impacts on the Suva Peninsula and Rewa Delta are likely to include:

- Raised water tables in low-lying areas,
- Reduced efficacy of in-ground septic systems and inundation of sewer pumping systems,
- Overtopping of the shore protection in downtown Suva during the more extreme wave events under a 25-cm SLR scenario,

- Serious flooding in large parts of Suva Point and downtown Suva even during moderate tropical cyclones under a 100-cm SLR scenario,
- Shoreward retreat of mangroves in the Rewa Delta, and
- Increased sedimentation in the channels of the Rewa Delta and increased flood susceptibility.

5.4.2 Water Resources

On Viti Levu it is important to distinguish between the southeast of the island, which is exposed to the prevailing tradewinds and is characterised by a moist climate, and the northwest which is the leeward, rain-shadow side and much drier. Usually, droughts have much greater impact on the drier, western side of the island.

The features influencing the water resources of Viti Levu are:

- The prevailing Southeast trade winds;
- The location of the SPCZ;
- ENSO (which influences rainfall and sea-level change); and
- Tropical cyclones/ floods.

The models used in this study are not able to predict changes in any of these features of Fiji's climate, although some GCMs indicate a pattern more like El Niño at the regional level. Moreover, both increased or decreased mean rainfalls have been indicated, depending upon which GCM one adopts.

The effects of climate change on water resources depend on the GCM used. The CSIRO scenario indicates an increase in maximum and minimum stream flows, while the DKRZ model suggests the converse. It is possible that, as a result of climate change, extremes will be intensified. That is, low river flows will become lower and high flows will increase in volume, which implies higher risks of droughts and floods.

Using the DKRZ model to help indicate the problems that might arise from a drier future for Fiji, and projecting future demand for water resources in the Nadi-Lautoka Regional Water Supply scheme, indicate that water-supply problems are unlikely to become significant later in the 21st century. This statement assumes 100% efficiency in the Nadi-Lautoka water-supply scheme. At the moment 29% of the total water produced is lost through leakage and illegal and unauthorised connections. Without these losses there would be sufficient water for the Nadi-Lautoka area. Population growth in the Nadi-Lautoka suburban areas is very high compared to the rest of the country.

In the worst-case (A2) climate scenario and the mid-range population projection there is a deficit of 32 per cent of the total demand.

5.4.3 Agriculture

The PLANTGRO model was used to develop scenarios of crop production. This model is based on soils, topography, temperature and rainfall. It does not take changes in atmospheric concentrations of CO₂ into account. It was found that the PLANTGRO model did not give reliable results for sugar cane, and no clear patterns could be discerned for cassava production.

Sugar cane

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:

- 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.

The outcome under this scenario would be an overall shortfall in excess of one-quarter of expected production. It implies economic difficulties for a large sector of the population in the agricultural sector dependent on sugar production and associated industries.

Root crops

Using the PLANTGRO model the following patterns were projected for dalo and yams:

- 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 a halving of the land area providing high yields. It is likely that yam production will also 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.

5.4.4 Health

The effects of climate change on health occur through a number of pathways. This study identified three orders of climate-change effects on health:

First-Order Effects	<u>Injury and illness</u> resulting from increased frequency or magnitude of <u>extreme events</u> such as tropical cyclones and heat waves
Second-Order Effects	Altered distribution of communicable diseases including: <ul style="list-style-type: none">• Vector-borne diseases• Waterborne diseases• Toxic-algae-related diseases Nutrition-related diseases
Third-Order Effects	Effects of poverty, inequality, unemployment, forced migration, and other socio-economic effects of climate change

While not discounting a link between climate change and the possible introduction of malaria and effects on the incidence of filariasis and ciguatera, the study concluded that the afflictions for which a clear link to climate change can be established are:

- Dengue fever,
- Diarrhoeal diseases,
- Nutrition-related illness.

Changes in dengue-fever epidemics were modelled using PACCLIM. It was found that climate change, through increasing temperature, would lead to increases in the risk of dengue-fever epidemics.

Under 1990 baseline conditions, dengue-fever epidemic potentials are greater in coastal areas and decrease inland. There also tends to be a greater potential for epidemics in northern and western Viti Levu than in the east. The results from PACCLIM also indicated that there would be a significant change in the spatial distribution of dengue fever. In 1990, 53% of Viti Levu was found to be at low risk of a dengue epidemic with the remainder at moderate risk. By 2100, even under the moderate scenario (B2), only 21% remained at low risk, and this was the highland interior of the island. The remainder of Viti Levu was projected to be at moderate to high risk. Under

the worst-case scenario (A2) some 45% of the island was projected to be at high to extreme risk of a dengue epidemic.

		Nadi		Suva	
	Scenario	Seasonality	Epidemic Potential Index	Seasonality	Epidemic Potential Index
Epidemic risk is low when threshold values lie between 0.01 and 0.15					
1990 baseline		Seasonal		Seasonal	
2025	B2 & A2	Seasonal	0.12-0.24	Seasonal	0.08-0.19
2050	B2	Seasonal	0.13-0.25	Seasonal	
	A2	All year	0.15-0.28	Extended season	0.09-0.24
2100	B2	All year	0.15-0.29	Prolonged Season	0.10-0.25
	A2	All year	0.23-0.41	All Year	0.15-0.35

These findings suggest that climate change could result in:

- An increase in the frequency of epidemics
- A change in the timing (seasonality) of epidemics so they may occur in any month
- A larger number of people being affected by each epidemic. Under the B2 scenario numbers affected may increase by 40% by 2100, while under the A2 scenario the increase may be in the order of 100%.
- Increased number of fatalities
- Dengue becoming endemic (occurring all the time) rather than occurring in epidemics

Diarrhoeal disease may become more common if Fiji becomes warmer and wetter (as under the CSIRO scenario) and if droughts and tropical cyclones occur more frequently, disrupting water supplies and sanitation systems.

Nutrition-related illnesses are most likely to be affected by increases in frequency and/or magnitude of tropical cyclone and drought events. Further, it is also likely that if climate change leads to economic and social disruption and environmental degradation, disadvantageous effects on health may be serious.

5.5 Economic Analysis of the Effects of Climate Change: a case study for Viti Levu

The results are based on annualised averages, and where multiple timeframes have been developed, the values presented reflect 2050 (as a convenience, the midpoint for the coming century). Results are presented in current dollars (Fijian), so as to provide a comparable context for evaluating the damages relative to current economic measures such as GDP.

The results need to be evaluated with several critical caveats in mind. First, because the results are annualised, the estimates dampen the wider variability in damages that might arise, especially in terms of episodic events such as particularly severe cyclones or droughts. The fact that many of these events will arise in a sporadic temporal fashion, with economic damage levels much greater than the annualised averages in some years, has significant implications for economic planning in Fiji. For example, the national budget might incur no extreme-event costs in one or more years, and then face an especially large impact if a particularly severe drought or cyclone hits the islands.

Second, the results presented here do not indicate how adaptation strategies might reduce some of these damages. Adaptation options will impose costs of their own, but would also be expected to mitigate the level of damages in relevant categories. Likewise, economic development may provide Fiji with greater capabilities to reduce or recover from the damages associated with climate change.

Third, given that climate change will be a continuing process extending beyond the 21st century, one can envision the damages increasing over a longer time frame. Therefore, all else equal, the estimates provided here are likely to under represent the full economic impact of climate change on Viti Levu (or Fiji as a whole). On the other hand, the climate-change effects upon which these estimates are derived are based on a mix of "best-guess" and "high-guess" projections of changes in temperature and precipitation.

If a more conservative projection of climate change were applied, the losses would presumably be less than those indicated here. Even with many potentially important damages omitted from the monetizable estimates, the total values are a considerable proportion of GDP (nearly 25%). The values presented are annualised averages that dampen the sizable oscillations in damages that are likely, such that in a given year in which adverse events accumulate, damages might be larger than 25% of GDP, and may even exceed GDP. The fact that damages may be a large share of, or even surpass GDP is not infeasible, given that GDP is a flow concept and reflects only the market prices and quantities of those goods and services that are exchanged in market transactions.

The concept of economic damages, on the other hand, embodies more of a stock concept. For example, the damage to coastal infrastructure represents

damages to an accumulated inventory of buildings and other assets that would be expected to greatly exceed in value the amount spent on infrastructure in any single year. In addition, the damage categories embody numerous goods and services that are not exchanged in the market economy. These nonmarket values can be quite significant, especially in a setting such as Fiji where subsistence practices and cultural traditions include many key values apart from what is observable from market transactions.

Therefore, the potential for damages to approximate or even exceed GDP is not necessarily an indication that the estimates are exaggerated. This comparison indicates that the damages from climate change could be a considerable burden on the Fijian people and economy.

Summary of Estimated Economic Damages for Viti Levu (c. 2050) (millions of 1998 F\$)		
Damage Category	Annual Value	Comments
Cyclone severity change	-1.3 to 3.9	Model projects either decrease or increase in severity; estimates net of economic development or population growth.
El Niño-related droughts	27.5 to 81.3	Increased frequency and/or severity, based on 1997-1998 event recurring more frequently (or current frequency but higher severity).
Loss of mangroves & related services	18.0 to 50.2	Assuming 10% to 20% loss; omits several important mangrove services (see below).
Loss of coral reef & related services	47.3 to 225.7	Assuming 19% to 43% loss; omits several key services, including coastal area protection (shown in row below).
Coastal infrastructure protection reduction	89.0 to 336.4	Based on Costanza et al. (1997) values linked to coral reefs; uncertain validity of per hectare estimate for this application.
Agricultural output change due to temp. or rainfall changes	44.6 to 46.0	Dominated by sugar cane losses, but root crops show net decline regardless of precipitation change (increase or decrease).
Public safety (change in cyclone fatalities)	-0.3 to 0.8	Cyclone severity projected to either decrease or increase, based on average cyclone-related fatalities over past years.
Increased incidence of dengue fever	7.0 to 45.6	Includes lost productivity, medical costs, and willingness to pay to reduce the risk of a typical case or a fatal case of dengue fever.
Increased incidence of diarrhoea	0.6 to 1.4	Based on observed incidence in periods of both drought and extreme rainfall events, omits childhood fatalities.
Total Monetizable Damages	232.4 to 791.3	
Change in annual average precipitation	+	Precipitation may increase or decrease, damages likely > 0.
Loss of nonmonetized mangrove services	+	Biodiversity, fuelwood, nonwood products, nonuse values (bequest and existence values), and other goods and services.
Loss of nonmonetized coral reef goods and services	+	Biodiversity, ornamental fish, nonuse (existence and bequest) values, and other goods and services.
Loss of coastal lands	+	Cultural values and other losses apart from loss of infrastructure.
Agricultural output loss apart from changes in rain or temp.	+	Agricultural declines which may result from soil erosion, increased pest infestations, or other consequences of

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		climate change.
Potential increase in fatal dengue fever cases	+	The proportion of the more severe and potentially fatal form of dengue fever (DHF) is expected to increase.
Infant mortality due to diarrhoea	+	Diarrhoea can be fatal for infants and young children.
Total Damages	232.4 to >791.3	

6.0 ADAPTATION

6.1 Adaptation Response Strategies

6.1.1 Integrated Adaptation Policies

The most appropriate and effective adaptation to the effects of climate change on human health will not necessitate new or extraordinary measures, but rather take the form of an enhancement of existing measures and initiatives which contribute towards decreasing existing disease rates and ameliorating the worst effects of climate change.

Therefore effective adaptation will be highly dependent on the development and implementation of policies which are of benefit even in the absence of climate change. Such policies need to support pro-active improvement of public health in Fiji and will need to be considered in, and inform, all aspects of development planning. The most important issues which such a policy approach must support must include:

- The protection of the ecology and enhancement of land productivity;
- Provision of an adequate and healthy standard of housing for all;
- Provision of safe and adequate water supply and improved sanitation especially for those in rural areas and in peri-urban areas;
- Improved management of both liquid and solid waste;
- Employment and alleviation of poverty; and
- Improved access to quality primary health care – especially in rural areas and peri-urban areas.

Prioritising these policy goals will enable Fiji to follow a development trajectory which allow its people to be less vulnerable to the worst effects of climate change.

6.1.2 Generic Adaptation Actions

Adaptation is a process that will be ongoing, evolutionary and iterative, and implemented at a variety of levels. Adaptive actions may have widespread economic, social, cultural, political and environmental implications.

There are a number of important generic adaptation actions that need to be implemented at the non-sectoral level. These include:

- Building of public awareness. If we accept that much adaptive action will be taken not by government but by individuals, communities and businesses, it is important to build awareness of the climate-change process and effects, and the range of appropriate adaptation options.
- Sustainable development policy. Promotion of sustainable settlements, both urban and rural, sustainable coastal-zone management and sustainable agriculture would help offset a number of the effects of climate change. Moreover, economic planning and infrastructure investment should take the likely effects of climate change into account.

- Population policy. Continued population growth is likely to increase the vulnerability of communities to climate change. Many of the adverse effects identified in this report will be increased should demand for water resources, agricultural land and food, construction materials and space for settlement expand. Population policy should address not only the growth of the national population but issues also of population distribution including urbanisation, the increasing dominance of Viti Levu and the high population density in coastal areas.

6.2 Sectoral Adaptation Options

6.2.1 Coastal Resources

Options for adaptation to coastal effects of climate change include:

- Improved understanding of the coastal system;
- Examination and evaluation of coastal-protection options, including those which can be implemented at the community level as well as engineering schemes;
- Land-use policies encouraging settlement away from low-lying coastal areas, consistent with cultural practices and land-tenure systems;
- Mangrove and reef protection, including education, public awareness and legislative measures, such as penalties for destruction of mangrove and reef;
- Controls on pollution from residential, tourism, commercial and industrial areas;
- Exploring the use of artificial reefs as a means of enhancing coastal protection and increasing biological diversity and populations at present reef sites;
- Making use of alternative sources of construction aggregate rather than coral;
- Reducing the reclamation of mangrove areas for residential, commercial, tourism or industrial purposes and discouraging the cutting of mangrove for other purposes;
- Mangrove rehabilitation; and
- Water-catchment management and soil-conservation measures to reduce erosion and sedimentation.

6.2.2 Water Resources

Adaptation options for water resources fall into three broad categories.

- Flood-control measures to cope with extreme high-rainfall events include such measures as 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.

- Drought-alleviation measures include management of water resources (e.g. reduction of leakage), water legislation, development of alternative water resources such as groundwater and the use of roof catchments.
- Catchment management including reforestation, land-use controls, protection of wetlands and soil conservation. Flood-damage potential can be reduced by regulating development on flood plains and promoting flood-proof building design. Various activities at community level can improve awareness of water conservation and emergency response.

Institutional development such as the creation of catchment and water authorities would help build capacity to improve the management of water resources.

6.2.3 Agriculture

Generic Adaptation Options

- Research into more-flexible farming systems that are tolerant to climatic variability
- Development of sustainable production systems
- Farming systems research including evaluation of the sustainable qualities of traditional agricultural systems and developing appropriate approaches to intensive commercial agriculture where appropriate

Specific Adaptation Options

The following recent developments in Fiji should be supported:

- Establishment of an Agricultural Diversification Scheme (formerly the Commodity Development Framework);
- Cessation of sugarcane production on marginal sloping land and coastal lands;
- Irrigation (intensified) of sugar-cane production on better lands (this option hasn't worked too well in the past, no data available although FSC did irrigate their crops during the 1993 drought);
- Strengthening of Land Use Planning Section of MAFF to enable better identification of areas most suitable for different commercial and subsistence crops;
- Root-crop breeding programmes; and
- Development of improved irrigation systems for dalo production

6.2.4 Health

Dengue Fever

The adaptation options for the effective control of dengue fever include:

- Improve vector-control programme;
- Encourage preventative exposure measures;
- Improve quarantine measures;
- Implement epidemic preparedness and response; and
- Implement proper development policies.

Diarrhoeal Disease

Key options which would reduce the climate-change-related effects on the incidence of diarrhoeal disease would include:

- Improved reliability and safety of water supply;
- Improved sanitation;
- Improved refrigeration and storage of perishable foods;
- The preparation of emergency strategies to cope with the effects of floods and droughts; and
- Improved provision of, and access to, primary health care.

7.0 POLICIES AND PROGRAMMES TO IMPLEMENT THE CONVENTION

7.1 Introduction

Overexploitation of resources and unsustainable management practices will affect the socio-economic fabric of Fiji as well as reducing the resilience of the environment and increasing its vulnerability to the adverse effects of climate change. Therefore the Fiji government has developed and will be developing various sustainable management policies with the realisation that such policies will be the most beneficial response strategy to help cope with climate change and other environmental and socio-economic problems.

This strategy is in line with the Principles contained in Article 3 of the UNFCCC which refers to the development of policies and measures related to sustainable development, by parties, to protect the climate system against human-induced change, and these should be integrated with national development programme.

7.2 Sustainable Development

Fiji has made good progress since the UNCED. Since 1992 Fiji has signed and ratified 19 International and Regional Conventions that emanated from the Earth Summit; and formulated 17 international and regional plans of actions, 25 national policies and plans and 17 national implementation programmes addressing sustainable development.

Fiji has ratified the Convention on Biological Diversity and the Framework Convention on Climate Change. Under the Convention on Biodiversity, a Biodiversity Strategy and Action Plan was produced in 1999, recommending resource-management projects to address depleting resources, land degradation and the unsustainable use of resources.

Fiji has drafted a Sustainable Development Bill to provide a framework for the sustainable management of the environment. It is a comprehensive and integrated piece of legislation that focuses on Environmental Impact Assessments, Codes of Environmental Practice, Natural Resource Management and the establishment of a National Council for Sustainable Development to provide effective and coordinated decision making on sustainable development planning, policies and implementation of programmes. An extensive consultative process has been mounted to ensure that the Sustainable Development Bill is acceptable to all.

Fiji's sustainable-development policies are entrenched in Government's "Strategic Plan for the New Century (SP): Policies and Strategies for the Sustainable Development of Fiji" 1999, and in the "Strategic Development Plan 2002-2004 Rebuilding Confidence, Stability and Growth". The policies are consistent with the Millennium Development Goals adopted in September 2000. The two plans emphasize that sustainable development is achieved through

policies that are economically sound, socially balanced and environmentally friendly.

The sustainable policies are categorized under six broad areas, namely:

- Macro Economic Stability;
- Natural Resource Utilization;
- Physical Infrastructure;
- Social Development & Affirmative Action;
- Protection of the Environment; and
- External Relations.

Two categories that directly address the impacts of climate change are natural resource utilization and the protection of the environment.

7.2.1 Sectoral Policies and Programmes

Land Resources

The Department of Land Planning and Development undertakes planning, development and management of land resources. A land-use plan is expected to be completed for the whole country by 2010.

The increase in population over the 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.

Policies for the sustainable development and management of land resources are:

- Ensuring sustainable utilization and development of land;
- Creating a leasing system that is mutually beneficial to both land owners and tenants;
- Minimising degradation of land; and
- Consolidating and updating all land databases and information.

Marine Resources

Fiji is party to the United Nations Law of the Sea Convention (UNCLOS) and various agreements relating to the fishing of tuna stocks. Fiji is at the forefront in the regional management of tuna, and is very supportive of current initiatives taken by the Forum Fisheries Agency member countries towards the management of highly migratory fish stocks in the high seas.

The development and exploitation of fish stocks are subject to the Fisheries Act Cap 158, the Marine Species Act Cap 158A and subsidiary legislation. The Fisheries Act addresses fishing within traditional customary fishing areas. The policy on catching fish within customary fishing rights areas is that no commercial fishing activities are to be undertaken unless by consent of the traditional owners.

For sustainable development of fisheries and marine resources, the following policies are being pursued:

- Enacting Sustainable Development Bill provisions relating to fisheries resources;
- Promoting production and export of value-added fisheries products;
- Providing appropriate institutional and physical infrastructure to support development in the sector; and
- Increasing community participation through ownership in fish processing companies.

Freshwater Resources

Fiji is blessed with an abundance of fresh water (surface and underground). The purity of its water is testified to by the popularity of the Fiji Water brand. Extremes in weather patterns, however, have had serious socioeconomic and environmental consequences that require prudent macroeconomic management, proper land-use planning and sustainable water-resource development and watershed management.

All freshwater areas are covered by traditional customary fishing rights. There is no commercial freshwater fishing. A Policy on Water Quality Management needs to be formulated and implemented. The National Environment Strategy provides a strategic approach to water management. With the assistance of the Japanese Government, Fiji is finalizing a watershed management plan, in particular to address flood control and protect arable land.

Expertise in water management, however, is severely lacking in Fiji. Very little opportunity is available for locals to undergo relevant training. Increased efforts are required to create awareness about the sustainable use of fresh water.

Forestry

The inventory of Fiji's forestry resources, completed in 1999, indicates that forest cover represents 47.5% of total land area. Deforestation is becoming a threat to Fiji's biodiversity. Felling of trees is monitored through the strict enforcement of the National Code of logging practice and the attainment of "green certification" under the Forest Stewardship Council.

Policies for sustainable forest management include:

- Ensuring sustainable development and management of forestry resources;
- Promoting of community-owned and managed forestry processing and value-adding facilities based on indigenous forests and community-owned plantations;
- Providing the appropriate institutional and physical infrastructure to support the development of the sector; and
- Promoting of the production and export of value-added timber products.

Biodiversity

The National Biodiversity Strategy Action Plan outlines the state of Fiji's biodiversity and approaches to conservation. The Department of Environment works closely with the Ministry of Education's Curriculum Development Unit, NGOs and local communities to incorporate the appropriate management strategies into their respective systems. While the various government departments have databases of their own, the Department of Environment is itself preparing an environmental database focusing on an inventory of Fiji's natural resources.

Water and Sewerage

The Government, through the Water and Sewerage Section of the Public Works Department (PWD) of the Ministry of Works and Energy, is responsible for the construction, operation and maintenance of water supplies and sewerage services.

Government continues to assist the provision of water supplies to rural, maritime and mainland areas under the Self-Help Rural Water Supply Scheme and the Borehole Subsidy Scheme.

The two priorities in the sector are:

- Providing access to reliable and adequate supplies of clean water for both urban and rural dwellers through expanding the rural water-supply scheme and the extension and upgrading of major urban and regional water schemes as outlined in their respective master plans; and
- Providing access to sanitary and environmentally safe sewerage waste systems and treatment facilities.

Energy

The energy sector plays a key role in the development of the economy, as the availability of electricity effectively removes barriers to social, commercial, industrial and rural development. The Fiji Electricity Authority (FEA), a wholly government-owned commercial statutory authority, is responsible for generation, transmission, and distribution of electricity, while the three oil companies, Shell, Mobil and British Petroleum, undertake purchase, storage and distribution of petroleum products.

The Department of Energy (DoE) is responsible for policy and planning, the development of renewable energy resources, energy conservation and coordination of the rural electrification scheme. The policy priorities in the sector include:

- Ensuring access to reliable and affordable energy supply;
- Assisting rural communities acquire electricity for both social and economic development; and
- Developing cost-effective renewable energy sources for energy supply through undertaking technical and economic feasibility.

Health

Fiji has a well-developed health system with an infrastructure of base hospitals in three geographic divisions, supported by area and sub-divisional hospitals, health centres and nursing stations in the smaller towns and rural and remote areas.

Government provides primary & preventative and curative health services by providing appropriate levels of human resources, infrastructure and medication and supplies. The increasing demand and cost for health care, coupled with the availability of limited resources, requires increased attention to health financing.

The policies in the sector are:

- Providing efficient and adequate primary and preventative health services;
- Providing efficient curative (hospital) health-care services;
- Maintaining appropriate level of human resources/staff;
- Maintaining appropriate infrastructure and facilities; and
- Building a management culture that promotes and supports continuous quality improvement.

Protection of the Environment

The proper management of the environment and sustainable use of its natural resources is critical for sustainable development of Fiji's largely natural-resource-based economy. The Department of Environment is responsible for better coordination, effective formulation and implementation of national environmental policies.

Issues of serious concern include loss of biodiversity, inappropriate waste management, pollution of air and waterways, land degradation and climate change.

Policies for the sustainable management of the environment include:

- Minimizing degradation of natural resources and protecting Fiji's biodiversity;
- Promoting and supporting sustainable waste management;
- Mitigating the effects of climate change; and
- Enacting the Sustainable Bill after it has been reviewed.

Fiji is committed to implementing adaptation measures on the effects of climate change at the community level. We are now part of an adaptation project, funded by the Canadian government and executed by SPREP that implements adaptation measures as highlighted in the PICCAP programme. Part of this commitment is the empowerment of our vulnerable communities to adapt to the changing climatic conditions to sustain their livelihood in the long run. The consideration of studies done on the effects of climate change, and the integration of these as part of policy into our development plans as

part of a broad climate-change response strategy, are ongoing.

7.3 Disaster Management

Fiji is often exposed to extremely damaging natural disasters like cyclones and tsunamis. Reduction of the vulnerability of rural communities to disasters is undertaken through the Disaster Management Office under the National Disaster Management Act of 1998. Its role focuses on the promotion of rapid effective response to emergencies, investment in safe, cost-effective and strategic infrastructure to mitigate the impact of disasters and capacity building for disaster management. The Ministry of Rural Development is exploring a Comprehensive Hazard and Risk Management (CHARM) approach to disaster management.

The priorities for the sector are:

- Mainstreaming Disaster Management into the national development decision making process;
- Ensuring the formulation of a comprehensive hazard and risk management plan;
- Improve community awareness of risk, preparedness and response; and
- Investing in infrastructure to mitigate the impact of disasters.

7.4 Proposed Projects

Institution Strengthening

Project 1:

Establishment of a Climate Change Unit within the Department of Environment

Objective

Establish the Unit so that it is able to provide policy and technical advice, which the Government of Fiji (GOF) will need, to implement the climate-change programmes and fulfil the ratified agreement.

Rationale

Two of the major challenges faced in carrying out the activities required under the National Communication are the capacity for doing them and improving the availability of information and data required for reporting.

Therefore effective coordination and implementation of the identified programmes will largely depend on the very quick establishment and functioning of the Unit.

Responsible Agencies

Ministry of Local Government, Housing and Environment and the Public Service Commission

Activities

- Coordinate the activities of a multi-sectoral Country Team
- Conduct research related to the determination of national GHG emission factors
- Compile annual national GHG emissions inventories
- Collaborate with relevant agencies on GHG mitigation assessments and facilitate technology transfer
- Conduct in-depth vulnerability and adaptation assessment studies
- Coordinate climate-change adaptation projects
- Conduct public awareness and training
- Provide policy and technical advice to GOF

Resource Required

Finance, staff establishment and provision of relevant capacity-building programmes

Expected Outputs

The project will ensure the sustainability of the climate-change programme, through institutional strengthening, provision of resources and capacity building, and hence in the medium and long term avoidance and mitigation of the adverse effects of climate change.

Mitigation of GHG Emissions

Project 2:

Promotion of Renewable Energy

Objective

To reduce the emissions of GHG by enhancing the use of renewable energy and at the same time improve quality of life of people in rural areas.

Rationale

Besides fulfilling Fiji's obligation to the Convention, rising prices of imported fuel and a growing energy need highlight the prudence of developing viable alternative/renewable energy sources. As a result, Fiji has commissioned eight rural renewable-based electrification projects since 1993.

Responsible Agencies

Department of Energy and independent power producers.

Activities

- Formulate policy framework for the installation and use of renewable energy
- Facilitate financing of rural electrification
- Facilitate training and expertise in business management and marketing strategies
- Facilitate knowledge and technology transfer in design, installation, operation, and maintenance of renewable energy systems
- Provide information and awareness of the potential for

- renewable energy
- Conduct further assessment of various renewable energy sources

Resources Required

Finance and technical experts.

Expected Outputs

The main outputs are the decreased dependence on fossil fuels, facilitation of the removal of barriers to the adoption of renewable energy and improvement of the quality of life of rural people.

Adaptation to the Effects of Climate Change

Project 3:

National vulnerability and adaptation assessment study – Phase II

Objective

To expand the information available on the potential effects of climate change to enable the Fiji Government to identify appropriate policies and strategies to effectively respond to the effects of climate change and sea-level rise.

Rationale

The lack of available data and detailed information which would assist in building an accurate picture of Fiji's vulnerability or status on the impacts of climate change is an area which contributes to ineffective programme and policy development. This assessment will concentrate on more-specific and detailed assessment, rather than general overviews, of the sensitivity of environmental resources and socio-economic well-being to climate change.

Responsible Agencies

Department of Environment, Relevant Ministries and USP

Activities

- Conduct research leading to the development and refinement of models.
- Conduct detailed research, including appropriate field studies, on vulnerability and relevant natural processes, such as coastal erosion.
- Conduct research on traditional adaptation measures to climate, environmental, and socio-economic changes.
- Conduct research into, and assessment of, existing and emerging adaptation technologies.

Resources Required

Finance and technical experts

Expected Outputs

- The research will characterise projected pressures arising out of climate change and the individual and integrated consequences of those pressures.

- The research will enhance understanding of the processes contributing to coastal erosion, and lead to the identification and implementation of appropriate strategies and technologies to protect valuable coastal habitats and infrastructure.
- The interchange of traditional adaptation measures can be of great benefit and be cost effective to the communities.
- The research will ensure that the emerging adaptation technologies will be ecologically sound and socially acceptable and applicable to the needs and circumstances of the people of Fiji.
- The research will ultimately provide increased understanding of the linkages between climate change and its effects.

Project 4:

Watershed management for the sugarcane drought-prone areas

Objective

The introduction of ecologically sound natural-resources management and soil-conservation practices by sugarcane farmers to improve productivity and reduce the adverse effects of climate change.

Rationale

Land-use changes, including settlement and use of marginal lands for agriculture, are decreasing the natural resilience of environmental systems and hence their ability to accommodate the added stresses arising from changes in climate and sea level.

Fiji's cane perimeter has expanded dramatically to include large areas of marginal hill country – land which is susceptible to the effects of drought, widespread erosion and land degradation. To improve the resilience of this farming system to climate change, there is a very urgent need to introduce soil conservation measures through watershed management projects.

Responsible Agencies

Department of Agriculture and Relevant Ministries and agencies

Activities

- Coordinate stakeholder consultation
- Facilitate the development of relevant policies and legislation (e.g. Rural Land Use Policy and Integrated Water Management Policy)
- Conduct natural-resource assessment and surveys
- Facilitate and promote integrated agriculture development
- Establish soil-conservation demonstration farms
- Conduct awareness and training for farmers and rural communities

Resources Required

Finance, technical experts and relevant capacity-building programmes

Expected Outputs

- Adoption of natural-resource conservation resulting in maintenance of catchment water recharge and biodiversity

- Adoption of soil-conservation measures resulting in adequate soil-water conservation and fertility improvement
- Conservation and demarcation of protected areas
- Establishment of Inventories
- Capacity building on watershed management

**Project 5:
Integrated Coastal Zone Management Programme for Fiji**

Objective

To provide an appropriate context for sustainable development in the assessment, protection and monitoring of coastal and marine ecosystems and provide a policy framework upon which all developments within the coastal zones are assessed and regulated.

Rationale

The coastal zone is characterised by high population density, intensive urban development, pollution and increased exploitation of biological and physical coastal resources. As a consequence, the coastal systems have reduced capacity to adapt to climate change, sea-level rise and human activities.

Responsible Agencies

The Ministry of National Planning, Department of Environment, and relevant Ministries

Activities

- Conduct consultation and coordination
- Conduct resource assessment and surveys
- Establish conservation and demarcation of protected areas
- Formulate appropriate policies and legislation related to sustainable management of the coastal zone
- Facilitate the development of a Fisheries Resource Management Information System
- Facilitate the development of a National Mangrove Forest Management Plan and Programme
- Coordinate the development of monitoring programmes
- Facilitate co-operation among resource managers and owners

Resources Required

Finance, technical experts and relevant capacity building programmes

Expected Outputs

- Conservation and demarcation of protected areas
- Resource assessment and surveys
- Establishment of natural-resources inventories
- Benefits from appropriate capacity-building programmes

8.0 EDUCATION, TRAINING AND PUBLIC AWARENESS

8.1 Introduction

Climate change covers a broad range of environmental issues, hence, general environmental awareness will be vital in addressing climate-change issues.

For Fiji, being amongst the most vulnerable countries with respect to climate change, the public needs to be aware of the possible effects of climate change on their daily lives. Climate has played a major role in dictating people's evolvment and activities since time immemorial. Fijians are very strongly tied to the land and the ocean. The land allows for both subsistence and commercial farming and is the basis for the current economy of Fiji in terms of commercial agriculture. The ocean provides a rich source of protein for the country, with coral reefs also providing protection from strong waves and storm surges. Adding to that, every significant town in Fiji is located along the coast, as are most villages, fertile agricultural lands and the vast majority of the population together with industry and commerce. Therefore, it is vital that people are made aware of just how the effects of climate change such as sea-level rise, and the likely increase in tropical cyclones, droughts and flooding, will disrupt their daily lives. It is how these people respond to such external stresses as climate change that will eventually determine their vulnerability and resilience.

Therefore, it is important to educate the people at community level on climate- change concepts and instilling in them environmental responsibility so that they can manage their resources sustainably.

8.2 Activities

8.2.1 General Public Awareness Activities

During PICCAP, considerable effort by the Climate Change Unit has gone into awareness-raising and education using a variety of means including national meetings, training and consultative workshops, radio and television broadcasts, publishing of monthly climate-change bulletins and newspaper articles and reports.

At the Department level, the Department of Environment (DOE) has been actively involved in educating the public, as well as liaising closely with the relevant educational institutions and other Ministries and organisations on implementing environmental programmes and activities. Of particular significance is the Environment Week Programme, which has been a major campaign by the Department with the aim of increasing public awareness and participation on environmental issues. The Public Awareness and Education Unit makes use of existing institutions to conduct awareness activities, such as the Education Ministry with presentations to schools, and Forestry Department for Arbour Week. This approach has been successful for the department, especially in terms of reducing funding costs.

8.2.2 Formal Education

Environmental issues are currently incorporated into the primary and secondary level of education. The Public Awareness and Education Unit of DOE makes use of existing institutions to conduct awareness activities, such as the Education Ministry with presentations to schools. However, climate change as a topic, has yet to be included in the current curricula of the formal education system.

In 1999, the Climate Change Vulnerability & Adaptation Assessment post-graduate course was transferred from the University of Waikato to the University of the South Pacific. Climate change is also taught at the undergraduate level in the Geography Department within the University. The Fiji Institute of Technology (FIT) recently established a Diploma course in Environmental Science in 1999.

In the area of general environment education, the DOE coordinates appropriate training courses and workshops in the areas of waste management, EIAs, database development and policy formulation for suitable officers from various ministries. The University of the South Pacific offers diploma and degree courses in environmental science. The Fiji school of Medicine provides training to health professionals on environmental health courses such as EIA, waste management and environmental toxicology. In the agricultural sector, suitable farming practices and technologies are being promoted through applied research, crop and livestock extension programmes, practical demonstrations and the mass media.

8.3 Required Activities

Building Partnerships

As part of the ongoing education and awareness programme, partnerships will be strengthened with the government and non-government organisations. Each organisation can share in the dissemination of information.

Informal Education

In the short term, one option is for informal education to be project based, as project managers can justify allocation of funds for this important component. This would include information being translated and distributed in the vernacular languages using various media, to ensure that information filters through to the rural areas and that the wider population has access to climate-change information.

Formal Education

It is important that the future populations will be able to understand and have informed views on the implications of climate change. Therefore, the advancement of formal education will be included in the medium and long

term, such as including climate change in the current primary and secondary curricula of the formal education system.

9.0 SYSTEMATIC OBSERVATIONS AND RESEARCH

9.1 Introduction

Climate-related disasters in recent decades have been the most economically disastrous in Fiji's recorded history, with events in the last decade being the most devastating. The economical consequences have forced the Fiji Government to take Climate Change seriously especially when there is a possibility that these disasters may increase in frequency and intensity in the future.

A computer-based software program (FIJICLIM) is being developed for integrating assessments of climate and sectoral impacts to determine the sensitivity of the natural and managed environments of Fiji to climate variability and change. It is anticipated that further development of the model will be a catalyst to further collection of relevant and managed data, research and assessment.

At present the only research conducted by the Fiji Government in relation to climate change has been studies by the Department of Environment, Fiji Meteorological Service and the Department of Hydrology in collaboration with USP. In the past, the Government has also relied on private and regional organisations such as USP, SOPAC and SPREP to conduct research. Independent research conducted by these institutions has also become a source of information for the Government.

9.2 Atmospheric and Climate Observation

Modelling and Prediction

The Fiji Meteorological Services (FMS) uses two software models to predict rainfall. Predictions from these models for the following three-month period are published in the Department's Monthly Weather Summary (MWS), which is readily available to the public.

The Australian Rainman is a computer software package designed by the Australian Department of Primary Industries (Queensland) and the Bureau of Meteorology. It incorporates the use of the Southern Oscillation Index (SOI) to test its effects on the probability of rainfall in the coming season. Some of the useful features that can be utilized are: probability of monthly rainfall and box plots; seasonal rain with and without the effects of SOI, starting month and for up to 12 months, including the chances of rain; definition of drought adjustable according to region with summary and detailed list of droughts, duration and total rainfall. Rainman is used for predicting monthly rainfall for the following three months.

Fiji's Seasonal Rainfall Prediction Model: This model was the outcome of an AUSAID-funded project allowing the Australian Bureau of Meteorology's

National Climate Centre (NCC) to work with FMS to produce a stand-alone, PC-based prediction scheme for Fiji seasonal rainfall. The model is based on the models that have been running successfully in NCC for a number of years. As a result, this model now runs successfully in the Climate Division of FMS. The model is based upon the relationship between the SOI and subsequent rainfall. Initially, forecasts were provided for the Western and Northern Divisions, but 25 individual sites such as Suva and Nadi are included now. Two sets of forecasts are provided using the SOI averaged over the most recent preceding three-month period, and the SOI averaged over the most recent preceding six-month period. The success rate of the predictions for both the models ranges between 60 and 70%.

9.3 Monitoring and Systematic Observation

9.3.1 Climate Monitoring

The Climate Services Division within the Fiji Meteorological Services (FMS) is responsible for the collection, quality control, processing and archiving of climatological data which are used in a wide variety of global, national and private-sector activities, including the monitoring of climate and climate change.

FMS is in the process of reviewing and formalising its climate-observing network known as the National Climate Monitoring Network (NCMN). The main purpose of NCMN is to improve and enhance the climate-observing network for Fiji in order to improve or complement climate variability and trends studies. FMS is also in the process of establishing a Meteorological GIS Environment for Risk Reduction. The visual spatial distribution of the stations will allow FMS to identify and fill gaps in the observing network. This whole process will further improve FMS's drought and climate forecasting system.

9.3.2 Greenhouse Gases and Aerosols

At present, for academic purposes, USP measures concentrations of methane, carbon monoxide and non-methane hydrocarbons, as well as aerosol properties in the atmosphere. Measurements of the complete chemistry of the atmosphere over Fiji have been conducted by NASA in 1997 and 1999.

9.3.3 Stratospheric Ozone Monitoring

Measurements of ozone are conducted at the Laucala Bay campus of USP for academic purposes. This is a joint project between NASA and the USP Chemistry Department. Activity includes the monitoring and archiving measurements of stratospheric and tropospheric ozone, including vertical profiles and other trace species, aerosols and UV-B monitoring.

9.3.4 Sea-Level Monitoring

The National Tidal Facility (NTF) of the Flinders University of South Australia, with assistance from the Fiji Meteorological Service and Marine Department, is responsible for sea-level monitoring, using the equipment installed at the Suva and Lautoka wharves. This monitoring of sea level is funded and managed by the South Pacific Sea Level and Climate Monitoring Project developed as a response to concerns raised by members of the South Pacific Forum countries about the potential effects of the Greenhouse Effect on climate and sea level in the region. In 1991, NTF was awarded the contract to undertake the management of the Project. Records are available from 1972 to 1994 for the Suva tide gauge as it was initially funded by the University of Hawaii Sea Level Centre (UHSLC). Since 1994, NTF has taken over the gauge. Records are also available from 1994 for Lautoka (NTF) gauge.

9.3.5 Hydrology

The Public Works Department (PWD) Hydrology Section operates 56 Water Level Recording Stations and well over 100 rain gauges throughout Fiji. These are in addition to and complementary to the Fiji Meteorological Service rainfall stations. The length of record varies; some stations have been in place since the early 1970s while others have only been in place since the early 1980s. USP, for academic purposes, conducts rain and surface-water chemistry analyses on a periodic basis. In the last few years the Geography Department of USP and PWD Hydrology Section have conducted research and assessments in areas of mutual interest such as floods, droughts and natural disasters.

9.3.6 Oceans

At present sea surface temperatures are not monitored in Fiji, but satellite data from NOAA and ORSTOM are available on the World Wide Web. Periodic in-situ measurements of sea surface temperature and water chemistry are conducted by USP for academic research. A brief oceanographic survey was conducted in the 1990s for marine disposal of mining waste in the Beqa Passage, south of Viti Levu.

10.0 FINANCIAL AND TECHNOLOGICAL NEEDS AND CONSTRAINTS

10.1 Greenhouse Gas Inventory and Mitigation

There are significant gaps in Fiji's first GHG inventory due to the lack of relevant statistical data that can be fed into calculation models. Refinement of the quoted emission estimates will require the establishment of formal data banks and information-gathering mechanisms within relevant government and private institutions.

Future improvement of greenhouse-gas inventory requires research, including appropriate field studies, leading to the determination and application of locally applicable greenhouse-gas-emission factors for the main activity areas.

There are several barriers to the wide adoption of renewable energy systems in rural Fiji. These can be summarized as follows:

Incomplete assessment of renewable energy resources. The current assessment of indigenous renewable energy resources and the design-oriented analysis of the available data are largely inadequate.

Lack of financing for rural electrification. The present level of government funding is insignificant compared to the number of applications for electricity service already received by DoE.

Limited expertise in design, installation, operation and maintenance of renewable energy systems. Because Fiji has limited experience with renewable energy, there is a lack of in-country design experience as well as familiarity with state-of-the-art equipment and particularly their installation and maintenance.

Lack of expertise in business management and marketing strategy. Presently rural electrification schemes are not operated as commercial enterprises. Moreover, there is a lack of financial and fiscal incentives for the private sector to play a role in rural electrification.

10.2 Vulnerability Assessment

10.2.1 Climate-Change Models

The FIJICLIM prototype is a computer-based software program based on PACCLIM that was developed by IGCI as part of PICCAP. Both FIJICLIM and PACCLIM build directly on a comparable model developed for New Zealand, known as the CLIMPACTS system. Its core components include a graphic user interface (GUI), a customised geographic information system (GIS), and data compression routines, which have provided the basis for the development of FIJICLIM. The development of FIJICLIM is complementary to similar developments that have evolved from CLIMPACTS, for Bangladesh

(BDCLIM), Australia (OZCLIM), and for training in climate-change assessment (VANDA CLIM).

The present version of the prototype clearly points out the lack of data available. For example, the water sector only considers surface water and only two of the five major catchment systems on Viti Levu. There must be good data and a sound understanding of the parameters and boundary conditions under which they are generated, bearing in mind that they can vary significantly through time and space.

For this reason very little technical analysis (as in the use of FIJICLIM) and economic analysis can be done for Fiji. With reference to the World Bank Economic V&A report, the results should be taken only as a first estimate of the Fiji situation. Further work on the development and refinement of the model is required to improve the confidence in its application to climate-change projections and effects on natural systems.

10.2.2 Assumptions and Scenario Development

The scenarios developed for Fiji, using PACCLIM, are partly based on results from general circulation models (GCMs). While GCMs do not have the resolution to yield accurate results at the scale of Pacific Island Countries such as Fiji, there tends to be a relatively high level of agreement among the various models regarding temperature. However, the models do show some inconsistency in their projections of rainfall which range from an increase through to a decrease.

Because the GCMs do not yet account for ENSO variability or changes in the frequency and/or magnitude of extreme climate events, analogues based on recent patterns of occurrence of events such as tropical cyclones or droughts have been developed based on a sequence of events from 1992 through 1999. Confidence in GCM projections of regional sea level remains low. Accordingly, global mean projections are used as first-order estimates of changes that could occur in Fiji.

The PLANTGRO model was used to develop scenarios of crop production. This model is based on soils, topography, temperature and rainfall. It does not take into account changes in atmospheric concentrations of CO₂. It was found that the PLANTGRO model did not give reliable results for sugarcane, and no clear patterns could be discerned for cassava production.

10.3 Adaptation

There is great variety in the range of adaptive actions that have been identified. Adaptations may be differentiated on the basis of a number of criteria. Outlining these criteria can be of considerable value for policymakers in prioritising adaptation options. In so doing, it should however be stressed that adaptation is as much a complex process involving actors from individuals in the village through to government ministers and international

agencies. This process is one with numerous feedbacks and is likely to be highly iterative. Moreover, it is a process that may well alter through time as knowledge of climate-change effects builds, as information about the range of adaptive options improves and as the effects of climate change are manifested.

Therefore to be able to co-ordinate an effective climate-change programme, a core of trained staff, having the appropriate skills, is required.

For Fiji, what is required is human resource development along with strengthening of institutional capacity across a wide spectrum of decision-making and management sectors. On an operational level, further training in vulnerability and adaptation assessment, integrated coastal management systems and technology transfer and assimilation is required to improve Fiji's ability to respond effectively to future climate change and sea-level rise.

10.4 Systematic Observation and Research

Future research is needed to address the gaps and uncertainties so that planners and policy makers can have the ability to develop and implement appropriate responses that address climate change and related issues. Examples of research that will help reduce uncertainties in crucial areas are:

- research leading to the development and refinement of national climate impact models;
- research, including appropriate field studies, that will enhance understanding of the processes contributing to coastal erosion, and to the identification and implementation of appropriate strategies and technologies to protect valuable coastal habitats and infrastructure;
- research leading to the development of a model to assess the vulnerability and adaptation of the main crop, sugarcane, to different climate-change scenarios; and
- research into the genetic improvement of crops with characteristics such as, higher water-use efficiencies, salt tolerance or more tolerance to extreme weather events.

10.5 Financial Assistance

Currently the Fiji government does not have the financial resources to effectively finance mitigation and climate change impact related research and assessment surveys nor effectively fund projects, that have been identified herein, that address current climate-change impacts. Therefore, Fiji in the short and medium term, will need assistance through the financial mechanism of the convention, supplemented by other donor assistance.

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