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DEVELOPMENT AND CLIMATE CHANGE IN FIJI: FOCUS ON COASTAL MANGROVES

by

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FOREWORD

This document is an output from the OECD Development and Climate Change project, an activity being jointly overseen by the Working Party on Global and Structural Policies (WPGSP) of the Environment Directorate, and the DAC Network on Environment and Development Co-operation (DAC-Environet). The overall objective of the project is to provide guidance on how to mainstream responses to climate change within economic development planning and assistance policies, with natural resource management as an overarching theme. Insights from the work are therefore expected to have implications for the development assistance community in OECD countries, and national and regional planners in developing countries.

This report has been authored by Shardul Agrawala and Tomoko Ota. It draws upon three primary consultant inputs that were commissioned for this country study: "Case Study on Mangroves in Fiji" by James Risbey (Monash University, Australia); "Analysis of GCM scenarios and Ranking of Principal Climate Impacts and Vulnerabilities in Fiji" by Stratus Consulting, Boulder, USA (Marca Hagenstad and Joel Smith); and "Review of Development Plans, Strategies, Assistance Portfolios, and Select Projects Potentially Relevant to Climate Change in Fiji" by Maarten van Aalst of Utrecht University, The Netherlands. An additional contribution "Mainstreaming Climate Responses in Development Planning and Assistance: Case Study of Fiji" was provided by Kanyathu Koshy and Biman Prasad from the University of South Pacific (USP), Fiji.

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EXECUTIVE SUMMARY

This report presents the integrated case study for Fiji carried out under an OECD project on Development and Climate Change. The report is structured around a three-tier framework. First, recent climate trends and climate change scenarios for Fiji are assessed, and key sectoral impacts are identified and ranked along multiple indicators to establish priorities for adaptation. Second, donor portfolios are analyzed to examine the proportion of donor activities affected by climate risks. A desk analysis of donor strategies and project documents as well as national plans is conducted to assess the degree of attention to climate change concerns in development planning and assistance. Third, an in-depth analysis is conducted for Fiji's coastal mangroves which help reduce coastal inundation and storm surge damages, but are also themselves vulnerable to climate change.

Analysis of recent climatic trends reveals a warming trend in recent decades with country averaged mean temperature increases of 0.9°C and 1.5°C projected by 2050 and 2100. In addition, sea–level is projected to increase, with midrange scenarios yielding predictions of 10.5 cm by 2025 and 50 cm by 2100. The Fijian economy is already quite vulnerable to extreme climatic events such as cyclones, floods, and droughts, with the costs of storm surge impacts for individual events at times as high as a few percent of the annual GDP. A subjective ranking of key climate change impacts and vulnerabilities for Fiji identifies coastal resources as being of the highest priority in terms of certainty, urgency, and severity of impact, as well as the importance of the resource being affected.

Fiji receives around 30 million dollars of Official Development Assistance (ODA) annually. Analysis of donor portfolios in Fiji using the OECD-World Bank Creditor Reporting System (CRS) database reveals that between 23-36% of development assistance (by aid amount) or 19-23% of donor projects (by number) are in sectors potentially affected by climate change risks. These numbers are only indicative, and the reader is referred to the main report for a more nuanced interpretation. Several donors have been actively involved in efforts to assess the vulnerability of Fiji to climate change risks. However, aside from climate specific projects, donors and the government have generally not explicitly recognized the need to mainstream climate risks in their development work. There have however recently been a series of high level consultations between Pacific Island governments (including Fiji) and donors, and the need to mainstream climate responses in development activity is receiving increased attention.

The in-depth analysis on coastal mangroves in this report however highlights the critical challenges that face the implementation or mainstreaming of no-regrets adaptation measures in Fiji. Mangroves protect against coastal erosion and storm surge damages, but are themselves vulnerable to sea level rise. Mangrove conservation is a no-regrets adaptation given the wide range of other ecosystem services they provide to local communities. There is however a trend for continued loss of mangrove cover in Fiji. One key reason is the significant undervaluation of mangroves which facilitates their conversion for development activity. Successful mainstreaming of even no-regrets adaptation responses in Fiji might therefore require greater policy coherence between climate change and development policies – appropriate valuation of mangrove services is one such example. There is also a need for a coastal management plan that prioritizes mangrove conservation, requiring adequate setbacks of development from the high water line to facilitate mangrove migration, and engaging local communities in these processes.

LIST OF ACRONYMS

ADB	Asian Development Bank
AusAID	The Australian's Government overseas aid program
BSAP	Biodiversity Strategy Action Plan
CHARM	Comprehensive Hazard and Risk Management
CIDA	The Canadian International Development Agency
CRS	Creditor Reporting System
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAC	Development Assistance Committee
DHF	Dengue Hemorrhagic Fever
DFID	Department for International Development
ENSO	El Nino/Southern Oscillation
EU	European Union
FLMMA	Fiji Locally Managed Marine Areas Network
FSP	Foundations of the Peoples of the South Pacific
GCM	General Circulation Model
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gases
GNI	Gross National Income
GTZ	Gesellschaft für Technische Zusammenarbeit
IGCI	International Global Change Institute
IMA	International Marine Alliance
IPCC	Intergovernmental Panel on Climate Change
JICA	Japan International Cooperation Agency
NGO	Non-Governmental Organization
NLTB	Native Land Trust Board
OA	Official Aid
ODA	Official Development Assistance
OECC	Overseas Environmental Cooperation Center
OECD	Organisation for Economic Co-operation and Development
OISCA	Organization for Industrial, Spiritual and Cultural Advancement
PICCAP	The Pacific Islands Climate Change Assistance Program
PRSP	Poverty Reduction Strategy Papers
SOPAC	South Pacific Applied Geoscience Commission
SPCZ	South Pacific Convergence Zone
SPREP	South Pacific Regional Environmental Programme
START	SysTem for Analysis Research and Training
UN	United Nations
UNCBD	United Nations Convention on Biodiversity
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
UNITAR	United Nations Institute for Training and Research
USP	University of the South Pacific
WWF	World Wide Fund for Nature

1. Introduction

This report presents the integrated case study for Fiji for the OECD Development and Climate Change Project, an activity jointly overseen by the Working Party on Global and Structural Policies and the Network on Environment and Development Co-operation. The overall objective of the project is to provide guidance on how to mainstream responses to climate change within economic development planning and assistance policies, with natural resource management as an overarching theme. The Fiji case study was conducted in parallel with five other country case studies in Asia, Latin America, and Africa[1].

Each case study is based upon a three-tiered framework for analysis (Agrawala and Berg 2002):

1. Review of climate trends and scenarios at the country level based upon an examination of results from seventeen recent general circulation models, as well as empirical observations and results published as part of national communications, country studies, and scientific literature. These projections are then used in conjunction with knowledge of socio-economic and sectoral variables to rank key sectoral and regional impacts on the basis of a number of parameters. The goal of this tier is to present a framework to establish priorities for adaptation.

2. Review of economic, environmental, and social plans and projects of both the government and international donors that bear upon the sectors and regions identified as being particularly vulnerable to climate change. The purpose of this analysis is to assess the degree of exposure of current development activities and projects to climate risks, as well as the degree of current attention by the government and donors to incorporating such risks in their planning.

3. In-depth analyses at a thematic, sectoral, regional or project level on how to incorporate climate responses within economic development plans and projects, again with a particular focus on natural resource management.

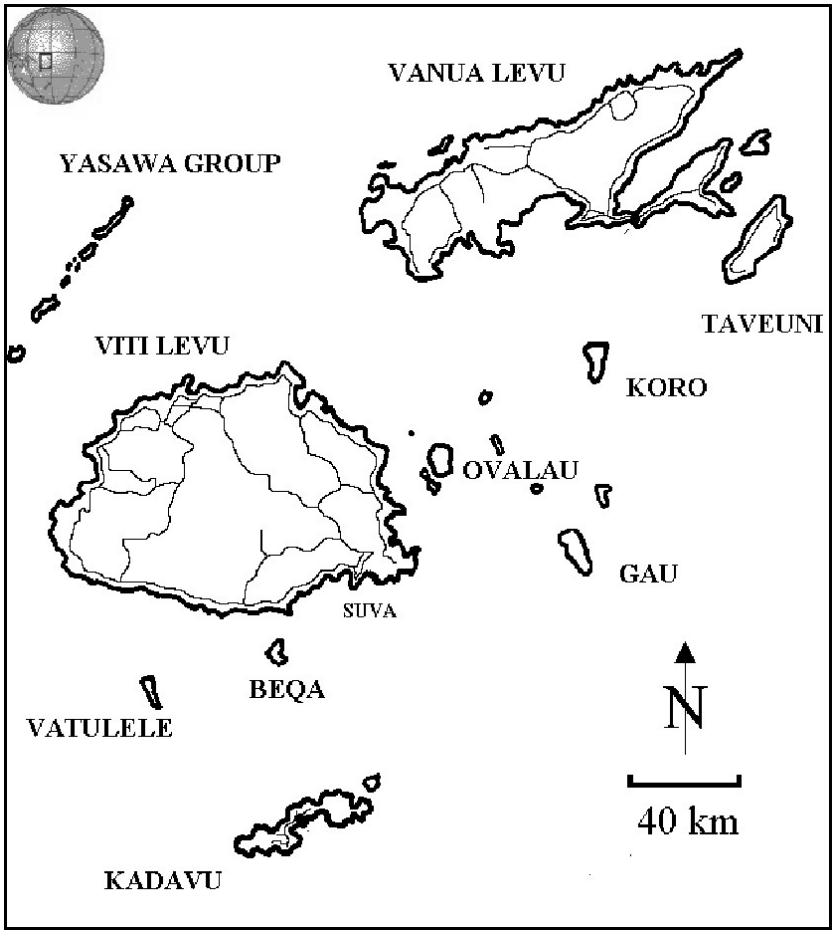
In the case of Fiji the focus of the in-depth analysis is on conservation of coastal mangroves which are both vulnerable to the climate change and, at the same time, serve as an effective adaptation to ameliorate impacts on other coastal systems. The extent and resilience of coastal mangroves in Fiji also intersects closely with development priorities and policies, and was therefore a good candidate for analysis of issues with regard to mainstreaming of climate responses. This analysis on mangroves was conducted by a case study consultant and involved a field visit and consultation with experts at the University of South Pacific (USP), and representatives from the government, international donors, and NGOs. In addition, two USP experts made a separate contribution to the case study.

2. Country background

Fiji is located at 18°S 175°E in the South Pacific (Figure 1). It comprises over three hundred islands encompassing an area of about 18,000 sq km. The largest island is Viti Levu, which accounts for about 70% of Fiji's total population of around 800,000. Fiji was first settled, by the Lapita people, about 3,500 years ago. The first thousand years of settlement were concentrated along the coasts. About 2,500 years ago a shift towards more intensive agriculture, expansion of population, and settlement of upland areas took place (Jones and Pinheiro, 2000). Encounters with Europeans began in the 17th century and intensified in the 19th century. Fiji was pronounced a British colony in 1874 and became independent again in 1970. The legal system is based on the British system. Fiji is party to a number of international environmental agreements including the United Nations Convention on Biodiversity and the Kyoto Protocol.

[1] Bangladesh, Egypt, Nepal, Tanzania, and Uruguay.

Figure 1. Location of Fiji [2]



Fiji is a "high island" setting, consisting of mainly steep, volcanic-origin uplands. The uplands slope steeply down to rolling flatland areas suitable for agricultural and other activities, and ultimately to coastal areas defined by sand beaches and coral reefs. Viti Levu, the largest island (10,389 km^2), is home to 75% of the population. It is the political and economic center of the country, containing the capital (Suva), the tourism center (Nadi), and much of the land used for sugarcane farming in the country (JICA, 1998). According to the 1996 census, the population of Fiji is 775,077, with an annual growth rate of 0.8% (Fiji Island Statistics Bureau, 2002). Although Fiji has become increasingly urbanized in recent years, over 60% of the population still lives in rural areas (Feresi et al., 1999). While gross national income per capita of US$1,820 exceeds the average of that for lower-middle income countries (US$1,130), 25.5% of Fiji's population lives below the poverty line (World Bank, 2002). The Gini Index for Fiji stood at 0.46 in 1991, suggesting a somewhat unequal distribution of income (ILO, 2003)[3].

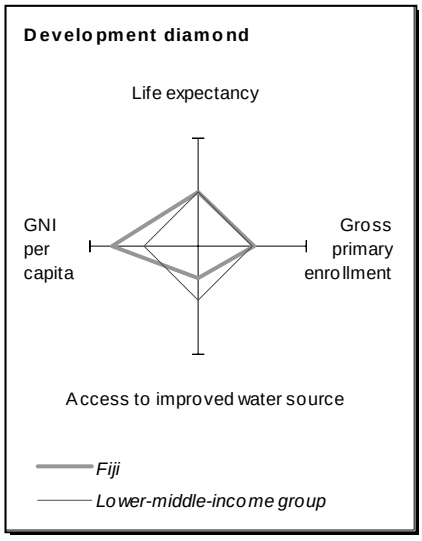
2 Map from Bygrave (1998).

3 The Gini coefficient is a number between zero and one that measures the degree of inequality in the distribution of income in a given society. The coefficient would register zero inequality for a society in which each member received exactly the same income and it would register a coefficient of one (maximum inequality) if one member got all the income and the rest got nothing.

Fiji is a small open economy dependent primarily on tourism and sugar production. Real economic growth averaged 2.7% between 1993 and 1996, although it only grew by 1.6% in 1993 because of Tropical Cyclone Kina, highlighting Fiji's economic sensitivity to natural disasters (Feresi et al., 1999). Fiji essentially pursued inward looking import-substitution policies until the mid-1980s when it made a radical shift towards an export oriented growth strategy. The structure of the Fijian economy however has not changed significantly despite efforts by the government over the past decade and a half. Fiji's relatively undiversified economy also makes it vulnerable to internal (natural disasters, political instability) as well as external (fluctuating world market prices) shocks. In 1998, GDP was F$3.13 billion (US$1.6 billion), with an exchange rate of F$1.96 to the US$. The GDP is partitioned among services (60%), industry (25%) and agriculture (15%). The major sources of foreign exchange are from sugar production and the tourist industry. There is also a large subsistence sector in the economy. Principal exports are sugar, clothing, and natural resources. Exports go principally to Australia (34%) and the UK (18%). Primary imports are machinery, petroleum products, food, and chemicals, principally from Australia (45%) and New Zealand (15%). Electricity production is primarily from hydroelectricity (80%) with fossil sources making up the balance.

Several key statistics give some insight as to the state of its physical infrastructure and social and human capital, which might condition its potential to adapt to climate change. In 1999, it was estimated that 49.2% of Fiji's 3,440 km road network was paved, a figure that exceeds the averages both for countries within Fiji's income group and for countries in the East Asia and Pacific region (World Bank, 2002). Another possible proxy of infrastructure quality, propensity to adopt new technology, and adaptive capacity in general could be prevalence of personal computers within the population, which in Fiji in 2000 stood at 55 per 1,000 people, compared to only 21 per 1,000 in lower-middle income countries (World Bank, 2002). In 1990, the World Bank estimated that some 48.5% of Fiji's 8.4% gross tertiary enrolment was in sciences and engineering. These are numbers that are comparable to those of other lower-middle income countries, as does Fiji's gross secondary enrolment of 63% in 1999. Figure 2 provides an indication of how Fiji compares to other lower-middle income countries in terms of four key indices of development.

Figure 2. Development diamond for Fiji



Source: World Bank, 2002.

3. Climate: baseline, scenarios, and key vulnerabilities

Fiji has an oceanic tropical climate, with seasonal and inter-annual climate variations. Temperatures range from 23°C to 25°C during the dry season (May to October) and from 26°C to 27°C during the rainy season (November to April). Rainfall distribution is strongly influenced by the terrain of the islands, because leeward sides of mountainous islands tend to be drier and windward sides tend to be wetter. On Viti Levu, for example, rainfall ranges from 3,000 mm to 5,000 mm on the windward side, and from 2,000 mm to 3,000 mm on the leeward side.

Fiji is subject to extreme climate events. Cyclones are a major weather concern: the highest concentration of cyclones in the South Pacific occurs in Fiji's waters. Cyclones can have a major economic and public safety impact, for example, causing up to 25 deaths and F$170 million (~US $85 million) in one event (Feresi et al., 1999). Periodic droughts are another concern. El Niño events generally position the South Pacific Convergence Zone northeast of the island and result in hotter, drier conditions from December to February and cooler, drier conditions from June to August. The 1997-98 El Niño resulted in one of the most severe droughts in Fiji's history. Within the past decade, Fiji has experienced a range of adverse climate-related events. These climate events have included several tropical cyclones, with associated flooding and other adverse consequences. Fiji also recently suffered its most severe drought on record (1997-1998). There have also been health issues associated with climatic conditions, including dengue fever outbreaks.

3.1 Climate projections

Key elements of anticipated climate change as reported in Climate Change Vulnerability and Adaptation Assessment for Fiji (Feresi et al., 1999) are described below. The following were some key conclusions from this assessment for climate change over the 100 year period from 2001 to 2100:

- *Temperature changes using midrange emissions scenarios are estimated to increase by 0.5°C by 2025, and increasing to 1.6°C by 2100*. Applying a higher emissions scenario, these projected temperature increases grow to 0.6°C in 2025 and 3.3°C by 2100.

- *Sea level is projected to increase, with midrange scenarios yielding predictions of 10.5 cm by 2025 and 49.9 cm by 2100*, although scenarios based on higher greenhouse gas emissions projections indicated a rise twice as high, that is, over 20cm by 2025 and 1 m by 2100 (Feresi et al., 1999).

- *Precipitation changes of appreciable magnitude are anticipated, but the direction of the change is highly uncertain:* This is because Fiji's climate is strongly influenced by the position of the South Pacific Convergence Zone (SPCZ). Depending on how climate change influences the position of the SPCZ, Fiji may experience a significant increase or a significant decrease in rainfall in the future (Feresi et al., 1999, Risbey et al. 2002). Most general circulation models[4] (GCMs) project increased rainfall, with the estimates derived here being a 3.3% change by 2025 (3.7% with higher emissions of GHG) and 9.7% by 2100 (20.3% with high emissions). Decreases in precipitation (but of the same percentage magnitude as the increased precipitation forecast) are an alternative scenario[5].

[4] Four out of five GCMs evaluated

[5] Derived from one of the five GCMs used by the International Global Change Institute (IGCI) to support Feresi et al. (1999).

Although uncertainty exists, in some ways the impacts are unaffected by the sign. There is some evidence to suggest that Fiji may experience more oscillations between El Niño and La Niña type conditions in the coming decades[6]. This would imply that the future climate in the region will have swings between years that are wetter than currently experienced, followed by years that are drier than experienced on average today. The potential increase in such oscillations between periods of higher and lower precipitation would likely pose a challenge for devising and implementing adaptation strategies.

- *Increased climatic variability was also anticipated*, meaning that extreme events such as cyclones, floods, and droughts would be more likely to be more severe and, perhaps, more frequent. Based on research performed at CSIRO, Fiji may be subject to increasing variability between El Niño and La-Niña-like conditions. While increasingly severe events are of obvious concern, of particular importance may be the cumulative effect of any increasingly frequent events, such as evidenced in recent years. Under these cumulative events, natural systems may have inadequate opportunity to recover from the adverse effects (for example, cyclones in series, droughts recurring in succeeding years, or cyclones followed by drought periods).

The present study follows a somewhat different approach from Feresi et al. (1999) whose findings are summarized above. Specifically changes in area averaged temperature and precipitation over Fiji are estimated based upon over a dozen recent GCMs using a new version of MAGICC/SCENGEN[7]. MAGICC/SCENGEN is briefly described in Box 1. First results for Fiji for 17 GCMs developed since 1995 were examined. Next, 11 of 17 models which best simulate current climate over Fiji were selected. The models were run with the IPCC B2 SRES scenario (Nakicenovic and Swart 2000)[8]. The spread in temperature and precipitation projections of these 11 GCMs for various years in the future provides an estimate of the degree of agreement across various models for particular projections. More consistent projections across various models will tend to have lower scores for the standard deviation, relative to the value of the mean.

Box 1. A brief description of MAGICC/SCENGEN

MAGICC/SCENGEN is a coupled gas-cycle/climate model (MAGICC) that drives a spatial climate-change scenario generator (SCENGEN). MAGICC is a Simple Climate Model that computes the mean global surface air temperature and sea-level rise for particular emissions scenarios for greenhouse gases and sulphur dioxide (Raper et al., 1996). MAGICC has been the primary model used by IPCC to produce projections of future global-mean temperature and sea level rise (see Houghton et al., 2001). SCENGEN is a database that contains the results of a large number of GCM experiments. SCENGEN constructs a range of geographically-explicit climate change scenarios for the world by exploiting the results from MAGICC and a set of GCM experiments, and combining these with observed global and regional climate data sets. SCENGEN uses the scaling method of Santer et al. (1990) to produce spatial pattern of change from an extensive data base of atmosphere ocean GCM – AOGCM (atmosphere ocean general circulation models) data. Spatial patterns are "normalized" and expressed as changes per 1°C change in global-mean temperature. The greenhouse-gas and aerosol components are appropriately weighted, added, and scaled up to the actual global-mean temperature. The user can select from a number of different AOGCMs for the greenhouse-gas component. For the aerosol component there is currently only a single set of model results. This approach assumes that regional patterns of climate change will be consistent at varying levels of atmospheric greenhouse gas concentrations. The MAGICC component employs IPCC Third Assessment Report (TAR) science (Houghton et al., 2001). The SCENGEN component allows users to investigate only changes in the mean climate state in response to external forcing. It relies mainly on climate models run in the latter half of the 1990s.

Source: National Communications Support Program Workbook

6 G. Kenny (IGCI) personal communication, March 2000, based on research reported from the Commonwealth Scientific and Industrial Research Organization (CSIRO)

7 An alternate approach would be to use Regional Climate Models (RCM) such as PRECIS, which provide higher spatial resolution. A model comparison across RCM results was beyond the scope of the study.

8 The IPCC SRES B2 scenario assumes a world of moderate population growth and intermediate level of economic development and technological change. SCENGEN estimates a global mean temperature increase of 0.8 °C by 2030, 1.2 °C by 2050, and 2 °C by 2100 for the B2 scenario.

The results of the MAGICC/SCENGEN analysis for Fiji are shown in Table 1. The climate models all estimate a steady increase in temperatures for Fiji with little inter-model variance.[9] The temperature increases are uniform across seasons and on average somewhat lower than projections for the global mean average temperature under the same IPCC SRES B2 scenario. With regard to precipitation, on average the models project an increase in precipitation for all seasons and years. However, the standard deviation in projections across the various models is consistently higher than the model averaged mean, implying that the estimated change is not significant. Therefore the magnitude and direction of changes in precipitation are highly uncertain. It must also be noted that the models are only capturing trends in seasonal mean conditions, and not any changes in climate variability. In particular, any changes induced in the ENSO cycle may induce a stronger intra-seasonal influence on precipitation than might be captured in the MAGICC/SCENGEN analysis.

Table 1. GCM estimates of temperature and precipitation changes for Fiji

	Temperature change (°C) mean (standard deviation)			Precipitation change (%) mean (standard deviation)		
Year	**Annual**	**DJF[10]**	**JJA[11]**	**Annual**	**DJF**	**JJA**
2030	0.6 (0.1)	0.6 (0.1)	0.6 (0.1)	+3% (6)	+6% (9)	+0.5% (6)
2050	0.9 (0.1)	0.9 (0.1)	0.9 (0.2)	+4% (9)	+9% (13)	+0.7% (9)
2100	1.5 (0.2)	1.5 (0.2)	1.6 (0.3)	+7% (16)	+16%(23)	+1.2%(15)

The above results are broadly consistent with the Climate Change vulnerability and adaptation Assessment for Fiji (Feresi et al. 1999) discussed earlier. The magnitude of the temperature increase is similar for the various time periods, and low standard deviations indicate good agreement among the selected models. With regard to precipitation, MAGICC/SCENGEN results indicate increased precipitation, both for the summer and winter, and for the year as a whole. This conflicts somewhat with Feresi et al. (1999) that indicate the possibility of an increase or decrease in precipitation. However, the standard deviations are relatively high, indicating low confidence in such mean values. Therefore, the MAGICC/SCENGEN findings support the more general conclusion by Feresi et al. that while precipitation changes might be expected, confidence in such projections remains very low.

3.2 Priority ranking of impacts and vulnerabilities

The necessity of suitable responses to climate change not only relies on the degree of certainty associated with projections of various climate parameters (discussed in the previous section), but also on the significance of any resulting impacts from these changes on natural and social systems. Further, development planners often need a ranking of impacts, as opposed to a catalogue that is typical in many climate assessments, in order to make decisions with regard to how much they should invest in planning or mainstreaming particular response measures. Towards this goal, this section provides a subjective but reasonably transparent ranking of climate change impacts and vulnerabilities for particular sectors in Fiji.

9 Note that each GCM is scaled (i.e., regional changes are expressed relative to each model's estimate of mean global temperature change). Since the GCMs have different estimates of change in global mean temperature, this overstates intermodel agreement.

10 December, January, and February – the summer months in Fiji

11 June, July, and August – the winter months in Fiji

Vulnerability is a subjective concept that includes three dimensions: exposure, sensitivity, and adaptive capacity of the affected system (Smit et al. 2001). There are no universally accepted, objective means for "measuring" vulnerability. This section instead subjectively ranks vulnerability based on the following dimensions[12]:

- *Certainty of impact*. Temperatures and sea levels are highly likely to rise and some impacts can be projected based on these projections. Changes in regional precipitation are less certain. This analysis uses MAGICC/SCENGEN outputs to address relative certainty about changes in direction of mean precipitation. Changes in climate variability are uncertain. The Intergovernmental Panel on Climate Change (Houghton et al., 2001) concluded that higher maximum and minimum temperatures are very likely, that more intense precipitation is very likely over most areas, and that more intense droughts, increased cyclone wind speeds and precipitation are likely over some areas.

- *Timing*. When are impacts in a particular sector likely to become severe or critical? This factor subjectively ranks impacts in terms of whether they are likely to manifest themselves in the first or second half of this century.

- *Severity of impact*. How large could climate change impacts be? Essentially this factor considers the sensitivity of a sector to climate change – adaptive capacity could not be explicitly considered as this was a desk review and primary data gathering on socio-economic variables was beyond the scope of this work.

- *Importance of the sector*. Is the sector particularly critical in terms of its size of economy, cultural or other importance, or its potential to affect other sectors? This factor considers exposure of the sector to climate change, that is, how many people, property, or other valuable assets could be affected by climate change.

A score of high, medium, or low for each factor is then assigned for each assessed sector. In ranking the risks from climate change, the scoring for all four factors was considered, but the most weight was placed on the certainty of impact. Impacts that are most certain, most severe, and most likely to become severe in the first half of the 21st century are ranked the highest. Table 2 presents a subjective evaluation of the risks of climate change to the most sensitive sectors of Fiji[13].

12 A comprehensive vulnerability assessment would have necessitated collection/aggregation of a range of socio-economic variables at a sub-national scale, and was beyond the scope of this desk analysis.

13 This ranking is focussed primarily on biophysical risks and does not explicitly include a detailed analysis of socioeconomic and demographic factors that might mediate vulnerability, which was beyond the scope of this study.

Table 2. Priority ranking of climate change impacts for Fiji

Resource/ranking	Certainty of impact	Timing of impact	Importance of resource	Severity of impact
Coastal resources	High	Medium	High	High
Agriculture	Medium-low	Medium-low	High	Medium-high
Human health	Medium-low	Medium-low	High	Medium-high
Water resources	Low	Low	High	Medium-high

Coastal resources are ranked as the greatest concern in Table 2. For an island nation, coastal resources are highly important. In addition, impacts are expected to be significant and there is a relatively high level of confidence of them occurring. However, significant impacts on coastal resources are unlikely to be immediate and therefore their timing is ranked as medium. Risks to the other sectors appear to be significantly lower and are "clustered" to separate them from the risks to coastal resources. Even though Fiji is a high island setting, it does have significant human settlements and ecosystems in vulnerable coastal areas. Coastal mangroves are particularly threatened, and would be the focus of an in-depth analysis in later sections of this report.

Agriculture is listed next because it is also important and is highly sensitive to climate change. While impacts on many crops are uncertain because precipitation changes are uncertain, the main export crop, sugar cane, is sensitive to increased temperature as well as changes in precipitation. The certainty is medium-low, and it appears that impacts could become significant approximately in the middle or last half of the century.

Human health has the same ranking as agriculture. Certainty of impact is relatively low. Like agriculture, it does not appear that climate change effects would be realized in the first half of this century. However, the sector is very important and severity could be high, although not as high as the effect on coastal resources.

Water resources is ranked last among priority concerns because changes in precipitation are quite uncertain and it does not appear that significant effects would be realized in the near term. The sector however is highly important and severity of the stress could also be high, especially in the case of drought.

4. Attention to climate concerns in national planning

Fiji has a three-tier governance structure with central, provincial and local governments, although most decision-making authority rests with the central government through its 16 ministries. The two principal urban areas are governed by a local government (with limited authority), and there is also a provincial administration that falls under the Ministry of Fijian Affairs (UNESCAP 2002). A number of ministries oversee activities with implications for the environment, including the Ministry of Agriculture, Fisheries, and Forestry, Ministry of Urban Development, Housing and Environment, and Ministry of Lands, Mining and Energy. These as well as other Ministries also oversee critical development priorities that may influence vulnerability to climate change. Several current development patterns, for instance the continued destruction of mangroves and coral reefs, result in ever-increasing vulnerability to climate risks. Good opportunities therefore exist to integrate adaptation priorities (in the context of current disaster risks, climate change and sea level rise) into development planning.

4.1 Strategic Development Plan

Fiji's Strategic Development Plan recognizes that "Fiji's generally benign climate is […] interposed by climatic extremes in the form of hurricanes, cyclones, floods, and drought. These extremes have serious economic, social, and environmental consequences that require prudent macro economic management, proper land use planning, and water and watershed management". Natural disasters are listed among the key risks to the Fijian economy. The plan notes that environmental vulnerability is not caused just by natural factors, but also by the ineffectiveness with which the country handles serious issues like land degradation, climate change, increasing flood risk, unsustainable exploitation of marine resources, waste management, air and water pollution, and environmental impacts of urbanization.

While the plan pays no explicit attention to adaptation to climate change, it addresses many of the environmental vulnerabilities related to current and future climatic risks. In this area, performance indicators range from the submission of the first National Communication to the United Nations Framework Convention on Climate Change (UNFCCC) to a review of the Mangrove Management Plan and controls on coral harvesting.

Outside of natural resources management, the Plan also pays ample attention to disaster risk reduction. The approach is to fully integrate disaster management into national development planning[14]. Concrete plans range from risk assessments for urban centers and a database of infrastructure disaster mitigation priorities, to the reduction of land degradation and fires and the promotion of traditional cropping systems to enhance the resilience of small communities in the face of disasters. While climate change is not mentioned in this context, the overall approach is an excellent example of fully integrated adaptation planning.

Several other sectors also contain examples of appropriate adaptation strategies, including (in agriculture) the promotion of the production of non-sugar crops and commodities that will enhance food security, (in forestry) the switch to sustainable management strategies, and (in fisheries) a moratorium on reef mining and a review of the Mangrove Management Plan (since depletion of mangroves is already hurting coastal fisheries). Some other sections on possibly vulnerable sectors however, including infrastructure and water resources, pay no attention to climate-related risks.

4.2 Reports to global environmental conventions

Fiji is a signatory to the three Rio Conventions on Climate Change, Biodiversity and Desertification, and has also ratified the Kyoto Protocol. These commitments require Fiji to submit periodic national communications.

4.2.1 UN Framework Convention on Climate Change (UNFCCC)

Fiji's first National Communication to the UNFCCC has not yet been submitted (it is planned for 2003).

4.2.2 UN Convention on Biodiversity (UNCBD) - Fiji Report to the Convention, 1997

Fiji's ecosystems, particularly at the coast, are at considerable risk due to climate change, and may also be important for protection against its impacts. Nevertheless, Fiji's report to the CBD does not even mention climate change. The report does discuss other threats to coastal ecosystems. For instance, it

[14] According to the Comprehensive Hazard and Risk Management (CHARM) framework, supported by the regional organization SOPAC.

notes that coral reefs are at risk from salinity changes and sedimentation due to flooding and cyclones, but also from the negative impacts of coastal development, including seawalls, land reclamation, dredging, and ports, and sedimentation due to clearing of land for agriculture. Similarly, extensive destruction of mangroves is taking place for tourism, farming, and urban development, and remaining mangroves suffer from solid waste pollution and industrial dumping. Aside from the establishment and better management of protected areas, no concrete measures are proposed to protect those resources. A more recent and briefer Second National Report to the CBD (2001) provides no further analysis, and does not even mention mangroves as an issue of concern.

4.2.3 UN Convention to Combat Desertification (UNCCD) - National Report (2002)

This report notes that while Fiji has yet to prepare its National Action Plan under the CCD, yet has already implemented several desertification control activities, such as soil surveys, a soil and crop evaluation project, the formulation (with the help of the German aid agency GTZ) of a coherent set of national rural land use policies, and (also with German help) promotion of sustainable agro-forestry. The government also recently initiated a program towards integrated coastal resources management. With respect to extreme events, the report notes the El Niño-related droughts (but offers few mitigation measures), the formulation of a Watershed Management Master plan (aided by JICA), and the adoption of a National Plan for Natural Disaster Management. Here, climate change is considered a substantial risk. The main activity that is mentioned in this area is the impact modelling work using the FIJICLIM/PACCLIM model (under the World Bank study for the Regional Economic Report 2000). The report finds that more modelling work is required to be able to plan for specific measures to reduce vulnerability to climate change. Climate change is one of the issues to be included in future technical work in preparation for Fiji's national action plan under the CCD.

5. Attention to climate concerns in donor activities

Fiji receives moderate amounts of donor aid, of the order of US$ 30 million per year, or about 2% of GNI. The largest donors, in terms of overall investments, are Japan, Australia, and New Zealand. Figure 3 displays the distribution of this aid by development sector and by donor.

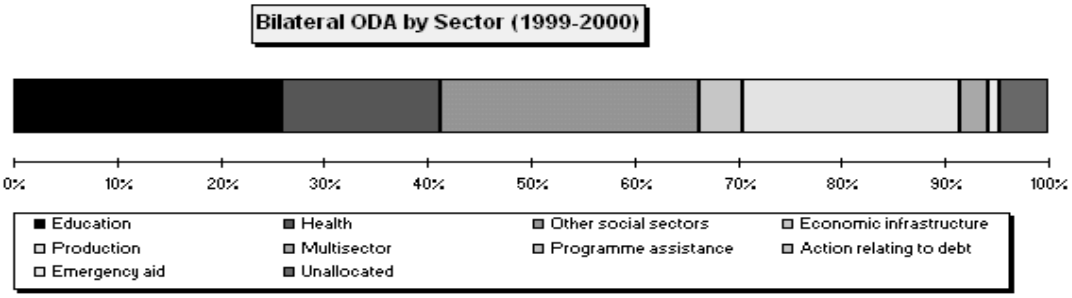
Figure 3. Development aid to Fiji (1998-2000).

Fiji

Receipts	1998	1999	2000
Net ODA (USD million)	37	35	29
Bilateral share (gross ODA)	88%	85%	88%
Net ODA / GNI	2.4%	2.1%	2.0%
Net Private flows (USD million)	- 2	28	- 20

For reference	1998	1999	2000
Population (million)	0.8	0.8	0.8
GNI per capita (Atlas USD)	2 230	2 190	1 830

Top Ten Donors of gross ODA (1999-2000 average)	(USD m)
1 JAPAN	18.0
2 AUSTRALIA	10.9
3 NEW ZEALAND	3.5
4 EC	1.8
5 UNTA	1.8
6 UNICEF	1.2
7 FRANCE	0.9
8 UNDP	0.3
9 GERMANY	0.2
10 UNFPA	0.1



Source: OECD, World Bank

The following sections highlight the possible extent of climate risks to development investments in Fiji, and examine to what extent current and future climate risks are factored in to development strategies and plans.[15] Given the large quantity of strategies and projects, this analysis is limited to a selection. This selection was made in three ways (i) a direct request to all OECD DAC members to submit documentation of relevant national and sectoral strategies, as well as individual projects (ii) a direct search for some of the most important documents (including for instance national development plans, submissions to the various UN conventions, country and sector strategies from multilateral donors like UNDP, the World Bank and the ADB, and some of the larger projects in climate-sensitive sectors), and (iii) a pragmatic search (by availability) for further documentation that would be of interest to this analysis (mainly in development databases and on donors' external websites). Hence, the analysis is not comprehensive, and its conclusions are not necessarily valid for a wider array of development strategies and activities. Nevertheless, there is reasonable confidence that this limited set allows an identification of some common patterns and questions that might be relevant for broader development planning. Analysis of selected donor project and planning documents is provided in Section 5.

[15] The phrase "climate risk" or "climate-related risk" is used here for all risks that are related to climatic circumstances, including weather phenomena and climate variability on various timescales. In the case of Fiji, these risks include the effects of seasonal climate anomalies, extreme weather events, floods and droughts, as well as trends therein due to climate change, and risks due to sea level rise. "Current climate risks" refer to climate risks under current climatic conditions, and "future climate risks" to climate risks under future climatic conditions, including climate change and sea level rise.

5.1 Donor activities affected by climate risks

The extent to which climate risks affect development activities in Fiji can be gauged by examining the sectoral composition of the total aid portfolio. Development activities in sectors such as agriculture, infectious diseases, or water resources could clearly be affected by current climate variability and weather extremes, and consequently also by changing climatic conditions. At the other end of the spectrum, development activities relating to education, gender equality, and governance reform will be much less directly affected by climatic circumstances.

In principle, the sectoral selection should include all development activities that might be designed differently, depending on whether or not climate risks are taken into account. In that sense, the label "affected by climate risks" has two dimensions. It includes projects that are at risk themselves, such as investments that could be destroyed by flooding. But it also includes projects that affect the vulnerability of other natural or human systems. For instance, new roads might be fully weatherproof from an engineering standpoint (even for climatic conditions in the far future), but they might also trigger new settlements in high-risk areas, or they might have negative effects on the resilience of the natural environment, thus exposing the area to increased climate risks. These considerations should also be taken into account in project design and implementation. Hence, these projects are also "affected by climate risks". A comprehensive evaluation of the extent to which development activities are affected by climate change would require detailed assessments of all relevant development projects as well as analysis of site specific climate change impacts, which was beyond the scope of this analysis. This study instead assesses activities affected by climate risks on the basis of CRS purpose codes (see Appendix B, which identifies "the specific area of the recipient's economic or social structure which the transfer is intended to foster")[16, 17].

Clearly, any classification that is based solely on sectors suffers from oversimplification. In reality, there is a wide spectrum of exposure to climate risks even within particular sectors. For instance, rain-fed agriculture projects might be much more vulnerable than projects in areas with reliable irrigation. At the same time, the irrigation systems themselves may also be at risk, further complicating the picture. Similarly, most education projects would hardly be affected by climatic circumstances, but school buildings in flood-prone areas might well be at risk. Without an in-depth examination of risks to individual projects, it is impossible to capture such differences. Hence, the sectoral classification only provides a rough first sense about the share of development activities that might be affected by climate risks.

To capture some of the uncertainty inherent in the sectoral classification, the share of development activities affected by climate change was calculated in two ways, a rather broad selection, and a more restrictive one. The first selection (high estimate) includes projects dealing with infectious diseases, water supply and sanitation, transport infrastructure, agriculture, forestry and fisheries, renewable energy and hydropower[18], tourism, urban and rural development, environmental protection, food security, and

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16 Each activity can be assigned only one such code; projects spanning several sectors are listed under a multi-sector code, or in the sector corresponding to the largest component.

17 The OECD study "Aid Activities Targeting the Objectives of the Rio Conventions, 1998-2000" provides a similar, but much more extensive database analysis. It aimed to identify the commitments of ODA that targeted to objectives of the Rio Conventions. For this purpose, a selection was made of those projects in the CRS database that targeted the Conventions as either their "principal objective", or "significant objective".

18 Traditional power plants are not included. Despite their long lifetime, these facilities are so localized (contrary to, e.g., roads and other transport infrastructure) that climate risks will generally be more limited. Due to the generally large investments involved in such plants, they could have a relatively large influence on the sample, not in proportion with the level of risk involved.

emergency assistance. The second selection (low estimate) is more restricted. First, it excludes projects related to transport and storage. In many countries, these projects make up a relatively large share of the development portfolio, simply due to the large size of individual investments (contrary to investments in softer sectors such as environment, education and health). At the same time, infrastructure projects are usually designed on the basis of detailed engineering studies, which should include attention at least to current climate risks to the project.[19] Moreover, the second selection excludes food aid and emergency assistance projects. Except for disaster mitigation components (generally a very minor portion of emergency aid), these activities are generally responsive and planned at short notice. The treatment of risks is thus very different from well-planned projects intended to have long-term development benefits. Together, the first and the second selection give an indication of the range of the share of climate-affected development activities.

In addition, the share of emergency-related activities was calculated. This category includes emergency response and disaster mitigation projects, as well as flood control. The size of this selection gives an indication of the development efforts that are spent on dealing with natural hazards, including, often prominently, climate and weather related disasters. If an activity falls in the "*climate-affected*" basket, which does not mean that it would always need to be redesigned in the light of climate change or even that one would be able to quantify the extent of current and future climate risks. The only implication is that climate risks could well be a factor to consider among many other factors to be taken into account in the design of development activities. In some cases, this factor could be marginal. In others, it may well be substantial. In any case, these activities would benefit from a consideration of these risks in their design phase. Hence, one would expect to see some attention being paid to them in project documents, and related sector strategies or parts of development plans. Figures 4 and 5 show the results of these selections, for 1998, 1999, and 2000 using the OECD Creditor Reporting System (CRS) database (Box 2)[20].

19 Note however, that they often lack attention to trends in climate records, and do not take into account indirect risks of infrastructure projects on the vulnerability of natural and human systems.

20 The three-year sample is intended to even out year-to-year variability in donor commitments. At the time of writing, 2000 was the most recent year for which final CRS data were available. Note that coverage of the CRS is not yet complete. In particular, it should be noted that one of the major donors to Fiji, New Zealand, does not yet report its activities to the CRS. As an indication, New Zealand's direct bilateral commitments to Fiji amount to about US$ 2.2 million in 2003, with additional support for several regional programs. Overall coverage ratios were 83% in 1998, 90% in 1999, and 95% in 2000. Coverage ratios of less than 100% mean that not all ODA/OA activities have been reported in the CRS. For example, data on technical co-operation are missing for Germany and Portugal (except since 1999), and partly missing for France and Japan. Some aid extending agencies of the United States prior to 1999 do not report their activities to the CRS. Greece, Luxembourg and New Zealand do not report to the CRS. Ireland has started to report in 2000. Data are complete on loans by the World Bank, the regional banks (the Inter-American Development Bank, the Asian Development Bank, and the African Development Bank) and the International Fund for Agricultural Development. For the Commission of the European Communities, the data cover grant commitments by the European Development Fund, but are missing for grants financed from the Commission budget and loans by the European Investment Bank (EIB). For the United Nations, the data cover the United Nations Children's Fund (UNICEF) since 2000, and a significant proportion of aid activities of the United Nations Development Programme (UNDP) for 1999. No data are yet available on aid extended through other United Nations agencies. Note also that total aid commitments in the CRS are not directly comparable to the total ODA figures in Figure 3, which exclude most loans.

Box 2. Creditor Reporting System (CRS) database

The Creditor Reporting System (CRS) comprises of data on individual aid activities on Official Development Assistance (ODA) and official aid (OA). The system has been in existence since 1967 and is sponsored and operated jointly by the OECD and the World Bank. A subset of the CRS consists of individual grant and loan commitments (from 6000 to 35000 transactions a year) submitted by DAC donors (23 members) on a regular basis. Reporters are asked to supply (in their national currency), detailed financial information on the commitment to the developing country such as: terms of repayment (for loans), tying status and sector allocation. The OECD Secretariat converts the amounts of the projects into US dollars, using the annual average exchange rates.

Figure 4. Aid amounts committed to activities affected by climate risk (1998-2000)

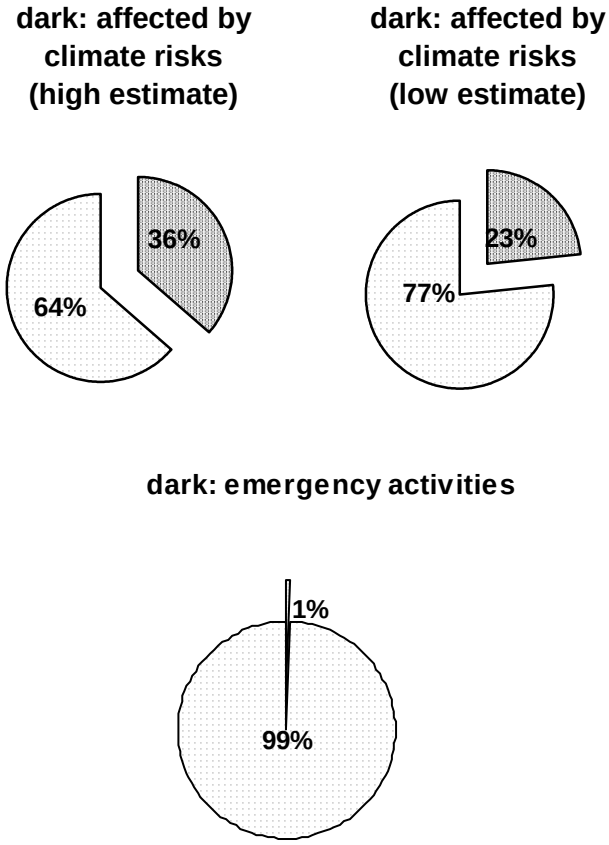

Figure 5. Share (by number) committed to activities affected by climate risk (1998-2000).

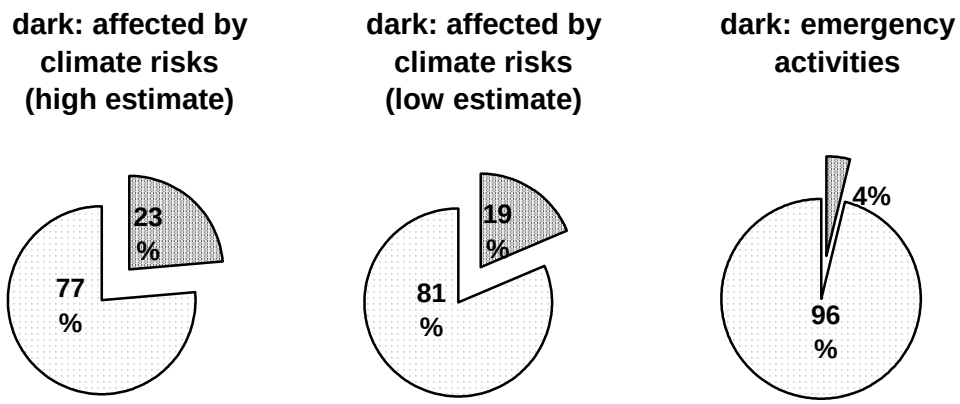

Table 3. Relative shares (by amount) of CRS activities for top-five donors in Fiji (1998-2000).

Amounts of activities (millions US$)			**Activities affected by climate risks (high estimate)**			**Activities affected by climate risks (low estimate)**			**Emergency activities**		
Donor	Amount	%	Donor	Amount	%	Donor	Amount	%	Donor	Amount	%
Total	86	100%	Total	31	100%	Total	20	100%	Total	0.5	100%
Australia	33	39%	Japan	18	56%	Japan	17	87%	Australia	0.2	62%
Japan	33	39%	EC	12	38%	Australia	1	5%	UK	0.1	18%
EC	14	16%	Australia	1	4%	EC	1	5%	Finland	0.04	10%
UK	2	3%	UK	0.4	1%	UK	0.3	2%	Japan	0.04	10%
France	2	2%	France	0.1	0%	France	0.1	0%			

Table 4. Relative shares (by number) of CRS activities for the top five donors in Fiji (1998-2000)

Numbers of activities			**Activities affected by climate risks (high estimate)**			**Activities affected by climate risks (low estimate)**			**Emergency activities**		
Donor	Number	%	Donor	Number	%	Donor	Number	%	Donor	Number	%
Total	183	100%	Total	43	100%	Total	34	100%	Total	7	100%
Australia	80	44%	Australia	19	44%	Australia	17	50%	Australia	3	43%
France	42	23%	France	7	16%	France	7	21%	UK	2	29%
Netherl.	13	7%	EC	6	14%	Netherl.	4	12%	Finland	1	14%
Japan	11	6%	Netherl.	4	9%	EC	3	9%	Japan	1	14%
EC	9	5%	Japan	3	7%	Japan	2	6%			

In monetary terms, therefore, between one-fifth and two-fifths of all development activities in Fiji could be affected by climate change. By number of projects, the shares are closer to one-fifth.[21]

[21] The number of activities gives a less straightforward indication than the dollar amounts. First of all, activities are listed in the CRS in each year when a transfer of aid has occurred. Hence, when a donor

Emergency projects make up 1% of the monetary amount, and 4% of the number of projects. In addition to providing insight in the sensitivity of development activities in Fiji as a whole, this classification also gives a sense of the relative exposure of various donors. Tables 3 and 4 list the results for Fiji, again in the years 1998, 1999, and 2000[22] .

Given the high share of development activities in Fiji that could be affected by climate risks, one would assume that these risks are reflected in development plans and a large share of development projects. The following sections will examine to which extent this is the case.

5.2 Attention to climate risks in donor strategies

Donors are supporting a large number of activities that contribute to a reduction in Fiji's vulnerability. Most of these activities are not labelled as climate change adaptation, or even targeted at current extreme events, but there may still be opportunities to increase their benefits by explicitly incorporating these aspects. Overall however, many donors have yet to recognize the need to mainstream climate risk management into their regular work in Fiji, as exemplified by the complete lack of attention to these risks in the donor strategy documents that were reviewed.

For instance, attention to climate risks is lacking in several of AusAid's regional and Fiji-specific planning documents. A report on "practical sustainability" discusses risk management and sustainability of projects, but again, natural hazard related risks are entirely neglected. At the same time, several of AusAid's own activities, and some other strategic reports, recognize the grave risks posed by, e.g., current cyclones and future sea level rise. In other cases, such as the UNDP/UNPF Multi-Country Programmes Outline, climate change is only mentioned as an environmental issue (albeit one with significant social and economic consequences). However, managing climate change will require a more comprehensive view on climate change: adaptation needs to take place in many different sectors. Similarly, DFID's regional strategy paper acknowledges the risks of current climate hazards; climate change and sea level rise, and supports regional organizations to deal with them. But again, mainstreaming in DFID's own work is not discussed.

In other donor strategies however, attention to climate-related risks is missing altogether. For instance, strategies by the ADB and the EU pay no attention to natural hazards of any kind. In the ADB's case, a clear example of why this neglect is dangerous is provided in the description of Fiji's economic performance: "The Fiji Islands economy experienced negative growth for the second year in succession in 1998 at -3.2 percent. This was largely due to the effects of a drought on sugar production [and reduced gold production]." While a recent ADB technical assistance project to prepare a new economic analysis for Fiji still largely neglects climate risk management, their new CLIMAP program is intended to develop methodologies to fill that gap, both at the country and project level in all ADB operations in the Pacific.

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disburses a particular project in three tranches, that project counts three times in this three-year sample. If the financing for a similar three-year project is transferred entirely in the first year, it only counts once. Secondly, the CRS contains a lot of non-activities, including items like "administrative costs of donors". Moreover, some bilateral donors list individual consultant assignments as separate development activities. In most cases, such transactions will fall outside of the "climate-affected" category. Hence, the share of climate-affected activities relative to the total number of activities (which is diluted by these non-items) is lower. On the other hand, the shares by total amount tend to be dominated by structural investments (which tend to be more costly than projects in sectors such as health, education, or environmental management).

22 Note that New Zealand does not submit its aid activities to the CRS; hence it is not included in the tables, nor in the totals, listed here. In addition, there are no ADB activities for Fiji in the CRS, while the ADB is also quite a large donor (of both loans and technical assistance) in the country.

5.3 Climate risk in selected development programs and projects

Fiji's vulnerability to climate change and sea level rise is reflected in the large number of projects dealing specifically with climate risks. Since the early nineties, several programs such as AusAid's climate change and sea level rise monitoring program and a coastal zone management project by the Environment Agency of Japan and SPREP, have focused mostly on studies and monitoring. The Pacific Islands Climate Change Assistance Program (PICCAP) was also quite successful in terms of mapping climate change impacts and identification of possible adaptation options, but achieved few results in terms of implementation and mainstreaming.

However, a transition towards the implementation of risk reduction policies and measures is now taking place. AusAid's monitoring program is moving into its third phase, which will include planning of response/adaptation measures. In addition, AusAid has established a regional adaptation fund that can finance pilot adaptation projects. CIDA has started a regional climate change project, with a component in Fiji with community level and national mainstreaming components. The World Bank is also highlighting the need to mainstream adaptation concerns into economic planning (in the entire region), and the ADB has established the CLIMAP program, which aims to incorporate adaptation in regular ADB programs and projects, as well as in the ADB's development dialogue with several countries. Another indication of the rising profile of risk management issues is the implementation of the South Pacific Applied Geoscience Commission's (SOPAC) Comprehensive Hazard and Risk Management (CHARM) program, which works from the highest levels of government.

The two infrastructure development projects that were reviewed give a mixed picture. A recent port development project does not explicitly consider climate change, sea level rise, or current climate risks. However, a 1997 road development project did address current climate risks in engineering and environmental assessments, apparently as a matter of routine. In fact, it even considered sea level rise, but concluded that over the 20-year lifespan of the project, the additional 20 mm would be of little consequence relative to current inundation levels.

5.3.1 Development of integrated coastal zone management plan (Environment Agency of Japan/SPREP)

As early as 1992, the Environment Agency of Japan initiated a study program to assess vulnerability and adaptation options in the light of climate change and sea level rise, in Fiji and Samoa. The program was later extended to Tuvalu. The studies were a collaboration of SPREP and the Overseas Environmental Cooperation Center (OECC). Its results were prepared along the lines of the IPCC technical guidelines for assessing climate change impacts and adaptation.

5.3.2 PICCAP

The Pacific Islands Climate Change Assistance Program (PICCAP, started in 1997) was funded by the Global Environment Facility (GEF), through UNDP. The regional South Pacific Regional Environment Programme (SPREP) coordinated the efforts of country teams in the 10 participating countries. CC:TRAIN, a UNITAR capacity building project in the Pacific, was integrated into PICCAP. The objectives of PICCAP were (i) assistance to the countries in reporting to the UNFCCC, and (ii) capacity building. Activities included GHG inventories, identification and evaluation of mitigation options, (iii) vulnerability and adaptation assessments (iv) submission of national communications to the UNFCCC, and (v) development of national strategies for mitigation and adaptation. While PICCAP has been successful in many respects, many challenges also remain, including further identification and prioritization of adaptation options, and mainstreaming of adaptation in government planning.

5.3.3 World Bank Pacific Adaptation Program

Ever since the 2000 Regional Economic Report, the World Bank has been an active player in climate change adaptation in the region (Box 3). In particular, it has promoted the need to see climate change as an economic and social issue, rather than only as an environmental problem. These efforts culmimated in the High Level Consultation: Investing in Adaptation in Nadi, Fiji, in May 2002, attended by ministers and permanent secretaries of finance from most countries in the region. In addition, the World Bank has started a pilot project in Kiribati, which aims to fully integrate adaptation into development, by linking consultations with local communities to the national development planning process in the ministry of finance and the sectoral ministries.

Box 3. World Bank regional economic report

The World Bank currently has no investment projects in Fiji. However, its Regional Economic Report (RER) is more than a basis for project development in the region (which is generally limited, mainly due to the countries' small sizes). Instead, it also aims to supply knowledge and provide policy advice with in-depth analyses of fundamental socio-economic challenges. The 2000 RER contained a full volume on climate change, which analyzes economic implications of climate risks (and adaptation options) in Viti Levu (Fiji) and Tarawa (Kiribati). Economic costs of climate change in Viti Levu, around 2050, without adaptation, are estimated at between 23 and 52 million US dollars, or 2-4 percent of Fiji's GDP.

5.3.4 CIDA Capacity Building for the Development of Adaptation Measures in Pacific Island Countries (CBDAMPIC) project

The CBDAMPIC project focuses on four Pacific Island countries (Fiji, Cook Islands, Samoa, and Vanuatu). It aims to build capacity to reduce climate-related risks at the national and community level. Its two main objectives are (i) mainstreaming of climate change adaptation into national and sectoral planning and budgeting processes, and (ii) enhancing communities' adaptive capacity. The former should be achieved through awareness raising among decision makers and resource managers, the latter through community pilot projects to assess their climate related vulnerabilities and potential solutions. The idea is that bottom-up participatory efforts will feed into national level decision-making processes. In Fiji, the national level component will include the formulation of a climate change adaptation policy, and the incorporation of climate change concerns into the EIA process (to be finalized once a national coordinator has been recruited).

5.3.5 AusAid climate change and sea level rise monitoring program

This program has been operational since 1990, and is now in its third phase. It features monitoring stations in most countries in the Pacific region. While initial efforts focused solely on monitoring, the third phase may also include work on adaptation/response measures.

5.3.6 AusAid vulnerability and adaptation initiative

This initiative, with a budget of A$ 4 million over seven years (and seeking opportunities to co-finance with other donors and inter-governmental agencies) will support regional cooperation to deal with the impacts of climate change, climate variability and sea level rise. So far, it has, among others, provided support for a regional High Level Seminar on adaptation (May 2002), and for a feasibility study for a regional adaptation financing facility. It could also fund capacity building, training, institutional strengthening and awareness raising, as well as pilot activities.

5.3.7 ADB/CIDA Climate Change Adaptation in the Pacific (CLIMAP) Program

This program, based on a technical assistance grant of US$ 800,000 over 15 months, provided by CIDA) is to mainstream climate adaptation, through risk reduction into development planning and management, primarily in the ADB's own operations in the Pacific. The initial phase mainly focuses on pilots in the Cook Islands and the Federated States of Micronesia. Eventually however, the program should cover all ADB operations in the Pacific, including those in Fiji.

In the ADB's own programs, CLIMAP will mainstream adaptation into Country Strategies and Programming, through the preparation of Country Adaptation Mainstreaming Profiles (CAMP), based upon country vulnerability analysis and pipeline screening. At the project level, Project Adaptation Briefs (PABs) will provide project vulnerability and risk ratings; possibly leading to adjustments of Project Preparation Technical Assistance and expansion of Environmental Impact Assessments. At the same time, CLIMAP is intended to raise awareness of ADB staff about adaptation and develop guidelines for ADB Pacific on adaptation mainstreaming.

5.3.8 SOPAC CHARM program

The South Pacific Applied Geoscience Commission (SOPAC) is implementing its Comprehensive Hazard and Risk Management (CHARM) program in several countries in the Pacific region (with assistance from Australia, in particular the Queensland government). CHARM is based upon internationally agreed risk management standards, and takes a cyclical approach to evaluating and managing risks, integrated in regular policy making. It contains training for officials from a wide variety of sectoral ministries, technical assistance, and institutional strengthening of the national disaster management capacity. In addition, a high-level sensitization component aims to ensure political support for the changes throughout various ministries. In Fiji, the government has adopted the CHARM approach to risk management, and the high-level sensitization workshops have already taken place. Climate change is fully integrated in CHARM's risk management framework, which looks at risk across all time- and spatial scales[23].

5.4 Other development programs and projects

Fiji's vulnerability to climate related risks are taken into account by many other development programs and projects. The following is a selection of projects which pay special attention to climate-related risks.

5.4.1 ADB Third Road Upgrading Project

Report and recommendation of the President (1997)

The project aims to improve the efficiency of the road sector through road upgrading and rehabilitation, and improvement of the management of road assets and sector resources. The project report shows that climate-related risks were taken into account as part of routine engineering design and environmental screening, and even sea-level rise was considered (as early as 1997).

[23] In Kiribati, the other Pacific Island country where a CHARM program is being implemented, the CHARM approach has been fully integrated with the World Bank Kiribati Adaptation Project, which aims to mainstream adaptation to climate change, climate variability and sea level rise into Kiribati's national development planning.

The "project risks" section mentions the cost overruns and construction delays that occurred in the Second Road Upgrading Project, partly due to poor weather conditions and cyclones. These risks are addressed in the sense that "cost estimates of the subprojects … have been prepared using maximal physical contingencies allowing for changes in construction conditions." In addition, the ADB will be consulted in the selection of engineers and consultants, and has to approve all engineering and designs for road sections to be upgraded or rehabilitated. Longer-term weather and cyclone risks to the road system itself (rather than project implementation schedules and costs) are not discussed explicitly in the main sections.

However, the more detailed design sections for the subcomponents show that at least frequent current risks are routinely taken into account. The frequent cyclones and storm surges are mentioned prominently in the general description of the environment. Hence, the section on drainage and culverts contains provisions for flooding from minor streams in several areas, as well as for exceptional storm surges in a stretch of road close to sea level. Similarly, the environmental examination addresses drainage problems and the risk of increased sedimentation in sensitive coastal areas and rugged and mountainous areas. In the context of the frequent inundations in low-lying areas during high tide, sea level rise was considered, but deemed to be of minor importance*: "During the 20 years of economic life of the road a sea-level rise of only 20 mm is predicted"*. The current inundations are addressed by raising road designs by about 1 meter.

5.4.2 ADB Ports Development Project

Report and Recommendation of the President (2002)

This project aims to improve the competitiveness of Fiji's economy by enhancing the port sector facilities and operations of ports in Suva and Lautoka, including an upgrade of wharfs. One of the aims of the upgrade is to ensure compliance with current seismic standards, but risks related to sea level rise and climate change are not mentioned. The occurrence of cyclones is listed in the section on environmental conditions, but is not explicitly addressed.

The "physical resources" sections mention that both ports are protected from ocean swells by the outer barrier reefs. The value of Fiji's mangroves is also recognized. Suva's port development is not expected to affect the mangroves in that area. The Lautoka port section mentions that "*Several mangrove trees can be seen from the substrate, but appear to be covered in mud, and may not survive… The small area of mangroves at the northeastern corner of the area to be reclaimed comprises 20-30 trees. Because the area is small and trees are fairly short, fauna is not abundant or diverse."* According to the environmental impacts and mitigation table, mangrove destruction in the reclamation area will be compensated by re-plantation elsewhere. Changes in flows will be avoided through proper wharf design.

6. Overview of adaptation responses for Fiji

Section 3.2 of this report developed a priority ranking of impacts and vulnerabilities for Fiji which concluded that coastal resources were the most important, followed by agriculture, human health and water resources. Each of these sectors involves a range of activities, and in many cases these activities will be exposed to multiple stresses stemming from climate change (such as enhanced temperatures and sea-levels, and altered precipitation and extreme event regimes).

There are a range of adaptation strategies available to Fiji to cope with at least some of these anticipated impacts. Some of these are not specifically for adaptation to climate change, and are already in varying stages of implementation within the context of ongoing development activity. The following paragraphs draw on the World Bank Regional Economic Report (2000) that identifies the following

adaptation responses for each of the four critical sectors. This summary is followed in Section 7 with an in-depth case study of mainstreaming mangrove management as an adaptation response to several key impacts faced by Fiji.

6.1 Coastal resources

The adaptation strategies for coastal resources have three major objectives: protection of crucial ecosystem, protection of towns and properties, and land use policies and control of erosion. For the protection of crucial ecosystems, the World Bank report lists five strategies: increase public awareness; prohibit extraction of reef and sand; prevent mangrove removal; control pollution; and control overfishing. In implementing these strategies, involvement of local communities is essential, since in Fiji, the villages are more active in the political system and have more autonomy than in other countries.

For the protection of towns and properties, three measures are identified: engineered structures; setback development from shoreline; and raise structures. Although construction of seawalls is likely to be a major choice in densely populated coastal areas, the construction of seawalls is not a fundamental solution for controlling erosion. Moreover, seawalls can cause inundation at downstream locations. In Qoma, Fiji, the downstream community has reported frequent inundation after the construction of seawalls. Engineered structures like seawalls should be used for the protection of valuable properties which cannot be relocated. Use of setbacks is recommended for new infrastructure. Finally, for land use policies and control of erosion, four measures are considered; coastal hazard mapping; mangrove replantation; engineering works in passages; and groynes. Replantation of mangrove and engineering works in passages are recommended for low islands or atolls, where it is essential to retain overwash sediments. The World Bank assessment concludes that groynes should be used only in key locations, as they cause downstream erosion and require continuing maintenance.

6.2 Agriculture

The World Bank assessment identifies several key adaptation responses for agriculture: traditional weather-resistant practices; agro-forestry, water conservation; flexible farming systems; mapping of suitable cropping areas; and avoidance of cultivation on marginal lands. In Fiji, mangrove land is being reclaimed for conversion to agriculture, principally sugarcane. The loss of mangrove regions increases the vulnerability of coastal areas to climate change. Mapping of soil and climate zones will improve the matching of crops and land use practices, which is highly recommended in high islands like Viti Levu. Agro-forestry is also a suitable strategy in high islands like Viti Levu.

6.3 Human health

Adaptation strategies for human health need to be incorporated into existing public health initiatives. Development initiatives to reduce the vulnerability of the population such as poverty reduction programs, improved sanitation and water supply, waste management, protection of groundwater, and squatter settlement management, are considered to be effective in reducing the enhanced vulnerability that might be experienced from climate change. In addition to these strategies, community-based vector control, improved preparedness (monitoring), and prevention of exposure are necessary for the control dengue fever.

6.4 Water resources

As discussed earlier in Section 3, the impact of climate change on precipitation is highly uncertain. From this regard, adaptation measures should be flexible and take the likelihood of both drought and flood into account. For water source management, the World Bank assessment identifies four measures; leakage control; pricing policies (fee, levies, surcharges); conservation plumbing; and stricter

penalties to prevent waste. Leakage control is important as the current rate of water leakage is 29 % in Western Viti Levu. Giving incentives for water conservation is also very important. From this perspective the introduction of water fees and metered consumption will be effective. For catchment management, reforestation, soil conservation and establishment of water authority are considered. Watershed management, for instance reforestation and soil conservation, should be combined with land management in high islands like Viti Levu. For alternative water supply, there are four basic measures; expansion of rain water collection; alternative groundwater use; desalination; and importation. Developing alternative water supply is especially important for arid islands, particularly for atolls. For flood control, diversion of channels, land use control and flood proof housing are effective. Viti Levu is an island with extensive rivers where flood control has special importance. Flood control measures might include widening and diverting channels, retarding basins, and building weirs (JICA 1998).

When choosing adaptation strategies, it is advisable to avoid those which could fail or have unanticipated social or economic consequences if climate change impacts turn out to be different than anticipated (IPCC 1998). From this point of view, strategies which make good use of nature or preserve ecosystem are more favorable than those which construct engineered structures.

Table 5 provides an overview of specific adaptation responses, as well as some information on a range of other parameters including their net benefits, timing, and cultural acceptability.

Table 5. Selected examples of adaptation measures for Fiji (Source: World Bank 2000)

Goal	Adaptation measure	No regrets?	Level of implementation	Bottom up or top down	Negative Environmental impacts?	Culturally acceptable?	Timing	Cost-benefit
Moderate impacts on coastal areas	Increase public awareness		Generic	Both	No	Yes	Immediate	Positive
Protection of critical ecosystems	Prohibit extraction of reef and sand	Yes	Sector specific	Both	No	May increase building costs	Immediate	Positive
	Prevent mangrove removal	Yes	Sector specific	Both	No	Unknown	Immediate	Positive
	Control pollution	Yes	Generic	Top down	No	Unknown	Immediate	Unknown
	Control overfishing	Yes	Sector specific	Both	No	Loss of food	Immediate	Positive
	Engineered structures (such as seawalls)	No	Site specific	Top down	Probably	Unknown	Unknown	Unknown
Protection of towns and property	Set back development from shoreline	No	Site specific	Both	Unknown	Land tenure?	Can wait	Unknown
	Raised structures	No	Site specific	Both	Unknown	Unknown	Can wait	Unknown
	Coastal hazard mapping	Yes	Site specific	Top down	No	Yes	Immediate	Unknown'
Land use policies	Mangrove replantation	Yes	Sector specific?	Both	No	Yes	Immediate	Positive
Control of erosion	Engineering works in passages	No	Site specific	Top down	Probably	Unknown	Can wait	Unknown
	Groynes	No	Site specific	Top down	Probably	Unknown	Immediate	Positive(?)
Moderate impacts on water resources								
Water resource management	Leakage control	Yes	Sector specific	Both	No	Yes	Immediate	Positive
	Pricing policies (fees, levies, surcharges)	Yes (?)	Sector specific	Top down	No	Problematic	Immediate	Positive
	Conservation plumbing	Yes	Sector specific	Both	No	Unknown	Immediate	Positive
Catchment management	Stricter penalties to prevent waste	Yes (?)	Generic	Top down	No	Resistance?	Immediate	Positive
	Reforestation, soil conservation	Yes	Generic and site	Both	No	Yes	Immediate	Positive
	Establishment of a Water Authority	Yes	specific	Top down	No	Unknown	Immediate	Positive
Alternative water supply	Expansion of rainwater collection	Yes	Sector specific	Both	Unknown	Maybe	Immediate	Unknown
	Alternative groundwater use	Yes	Sector and site	Top down	Unknown	Land tenure?	Can wait	Unknown
	Desalination	No (?)	specific	Top down	Unknown	High costs	Can wait	Unknown
Flood control	Importation	No (?)	Sector and site specific	Top down	No	High costs	Can wait	Negative
	Diversion channels, weirs, etc.	No	Sector and site specific	Top down	Probably	Unknown	Immediate	Unknown
	Land use controls, flood proof housing	No (?)	Sector specific Site specific Site specific	Both	No	Land tenure?	Immediate	Unknown

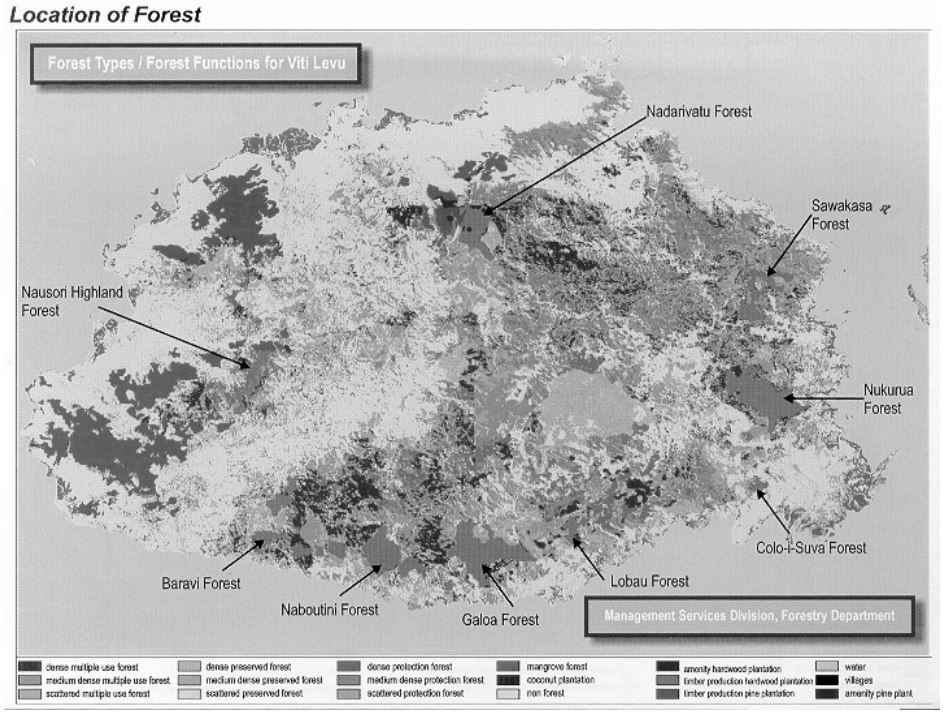
Moderate impacts on agriculture								
Community sustainability programs	Traditional weather-resistant practices	Yes	Sector specific	Bottom up	No	Yes	Immediate	Positive
		Yes	Sector specific	Both	No	Unknown	Immediate	Positive
Sustainability production systems	Agroforestry, water conservation	Yes	Sector specific	Top down	No	Unknown	Immediate	Positive (?)
Research	Flexible farming systems	Yes	Generic	Top down	No	Unknown	Immediate	Positive
Land use policies	Mapping of suitable cropping areas Avoid cultivation on marginal lands	Yes	Site specific	Top down	No	Disruptive	?	Positive
Moderate impacts on public health								
Integrated adaptation strategies and control of diarrheal disease	Poverty reduction programs	Yes	Generic & site specific	Top down	Unknown	Yes	Immediate	Positive?
	Improved sanitation and water supply	Yes	Sector and site specific Sector and site specific	Both	No	Yes	Immediate	Positive
	Waste management	Yes	Sector and site specific	Both	No	Unknown	Immediate	Positive
	Protection of ground water	Yes	Site specific	Both	No	Unknown	Immediate	Positive
	Squatter settlement management	Yes	Site specific	Both	Unknown	Yes?	Immediate	Positive
	Community-based vector control	Yes	Sector and site specific	Bottom up	No	Unknown	Immediate	Positive
Control of dengue fever	Improved preparedness (monitoring)	Yes	Sector specific	Top down	No	Yes	Immediate	Positive
	Prevention of exposure	Yes	Sector specific	Bottom up	Unknown	Difficult?	Unknown	Unknown
Control of ciguatera poisoning	Reduce destructive practices to coral reefs	Yes	Sector specific	Both	No	Food,incom?	Immediate	Positive
	Monitoring and public awareness	Yes	Sector specific	Both	No	Yes	Immediate	Positive
Moderate impacts on tuna fisheries	Multilateral agreements	Yes	Sector specific	Top down	Unknown	Distrust?	Immediate	Positive
Stronger regional collaboration	Better ENSO forecasting	Yes	Generic	Top down	No	Yes	Immediate	Positive
	Improved tuna management	Yes	Sector specific	Top down	No	Yes	Immediate	Positive
Research	Diversification of domestic fleets	No	Sector and site specific	Top down	Unknown	Problematic	Can wait	Positive
Fleet management								

7. Mangroves and climate change

In assessing the range of adaptation measures to sea level rise recommended for Fiji a common theme that emerges is preservation of coral reef and mangrove systems to act as buffers against rising seas and storm surges (Nunn et al. 1993; Knight et al. 1997; Moberg and Folke 1999; World Bank 2000). This option is often cast as a "no-regret" adaptation in that it provides economic and environmental benefits that extend well beyond the function served in reducing impacts from climate change. This section discusses in-depth the particular role of mangrove regions in the coastal ecosystem, their vulnerability to climate change, and the opportunities and challenges facing the mainstreaming of mangrove conservation as an adaptation to climate change in Fiji.

Mangroves appear to have evolved during the cretaceous region around the fringes of Australia and New Guinea (Pernetta, 1993). The extent of mangroves in Fiji around the time of human habitation some several thousand years ago is not known, but they presumably fringed much of Viti Levu. Traditional or subsistence Fijian agriculture and fisheries probably led to some decline in mangrove extent. These declines intensified with the onset of commercial agriculture (principally sugarcane) and settlements in the past century. Conversion for agriculture accounts for by far the greatest loss of Fiji's mangroves. Watling (1986a) estimated that about 6% of Fijis mangroves had been removed for agricultural use by 1986. Since then, development of towns and resorts has increased their share of consumption of mangrove land relative to agriculture. It is not clear what current losses are, with some estimates as high as 30%. Currently, the mangroves on Vitu Levu are said to cover about 23,000ha, which is around 60% of the total land area in Fiji (Smith, 2003), although estimates vary by source. Figure 6 shows a pictorial representation of the current mangrove extent on Viti Levu estimated by the Department of Forestry.

Figure 6. Land use map of Fiji (Viti Levu)



7.1 Mangrove structure and function

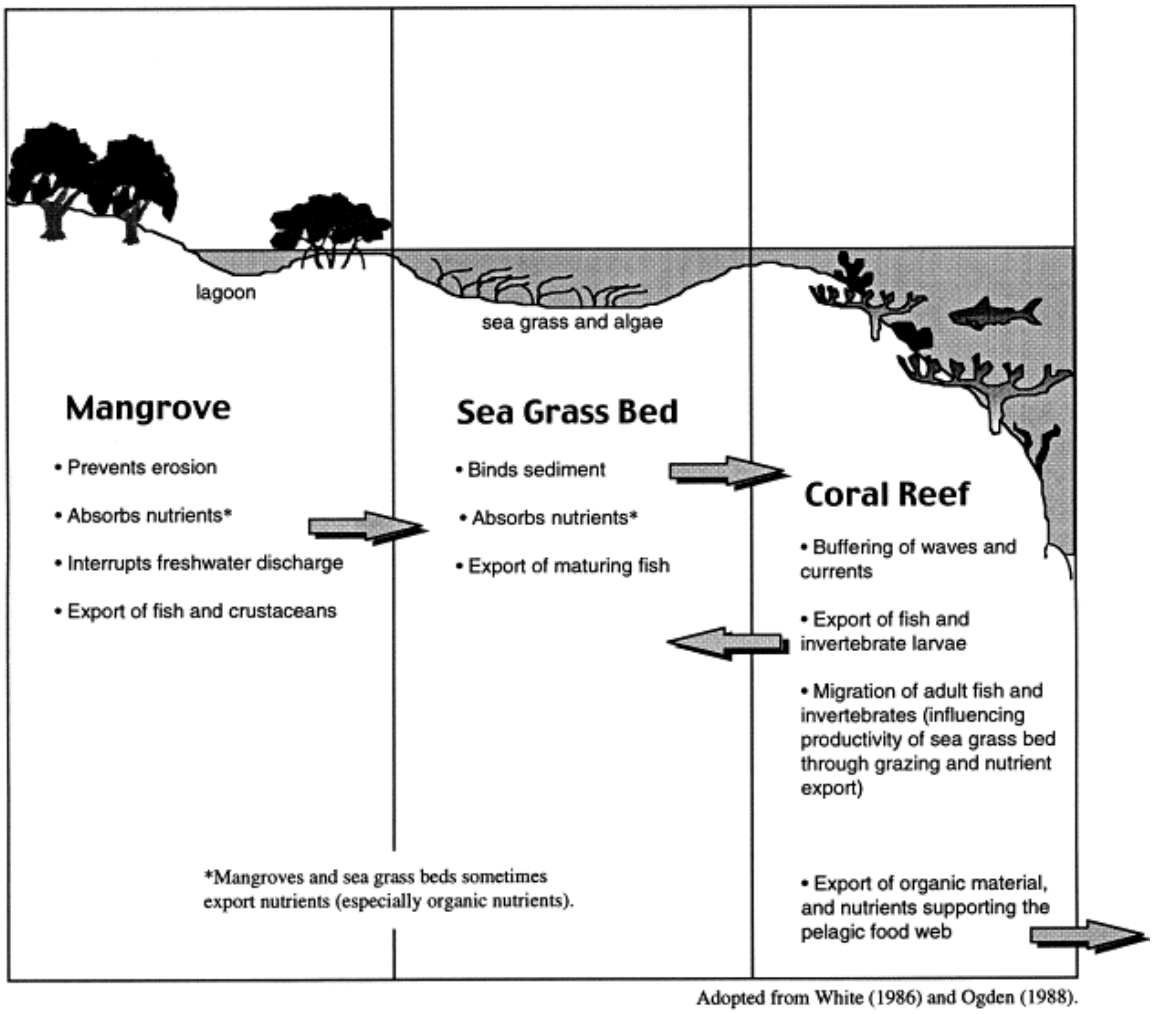
Following Blasco et al., 1996, "mangrove" is an ecological term referring to a taxonomically diverse assemblage of trees and shrubs that form the dominant plant communities in tidal, saline wetlands along sheltered tropical and subtropical coasts. A mangrove community in Fiji is shown in Figure 7. Plants comprising mangrove communities belong to many different genera and families, but they have in common a variety of morphological, physiological, and reproductive adaptations that enable them to grow in harsh salty environments. Extensive mangrove communities occur mostly in areas where the water temperature of the warmest month exceeds 24°C. Within these areas they are found where the water is shallow enough and calm enough to allow growth (Nunn et al, 1993). Mangroves also require some fresh water inputs, which is part of the reason they are vulnerable to rising sea levels.

Figure 7. Mangrove extent in Fiji (Viti Levu)

Mangroves frequently occur in conjunction with coral reefs and sea grass beds. Indeed there are strong interactions between them, and also with surrounding terrestrial and open ocean areas. The ecosystem of the coastal zone comprising these elements has been termed a seascape (Moberg and Folke, 1999). This seascape is depicted schematically in Figure 8. Mangroves and sea grass beds filter fresh water discharges from land, promoting the growth of coral reefs offshore. High sediment loads from coastal erosion would be detrimental to coral reefs if not intercepted by mangrove communities before reaching reefs. In turn, coral reefs serve as physical buffers for oceanic currents and waves, creating, over geologic time, a suitable environment for sea grass beds and mangroves (Moberg and Folke, 1999). The detritus from mangroves provides nutrients for the marine environment and supports a wide variety of sea life. Mangroves provide refuge and nursery grounds for juvenile fish, crabs, shrimps, and mollusks, and host a wide variety of bird species (Quarto, 2002).

The broad array of mangrove functions means that they provide a host of services for local communities as well as maintaining the seascape. These services include providing habitat for fish/fisheries, maintaining the integrity of the coastal region and protection from storms, maintaining coral reef communities (which are also very important to local fisheries), sources of wood products, sources of food and honey, sources of medicinal plants, wildlife resources, retainers of carbon, nutrients, sediment, and pollutants, and provide tourism opportunities. Though it is difficult to put a price on these many services, economists have estimated that coastal wetlands provide vast value in services annually. In many parts of the world mangrove forests provide dependable livelihoods and sustain traditional cultures of indigenous peoples (Quarto, 2002). Section 7.5 provides more detail on the implicit or explicit costs ascribed to the range of mangrove services in Fiji.

Figure 8. Coastal ecosystem structure



Source: Moberg and Folke, 1999

7.2 Current threats

Mangrove forests are among the most threatened habitats in the world (Quarto, 2002). They are being impacted by pollutants, prolonged flooding from levees, over-harvesting for timber, reclaimed land for agriculture, tourism and coastal development, and the shrimp aquaculture industry. Shrimp farming is responsible for precipitous mangrove declines in some parts of the world (see, for example, the Bangladesh case study of this project), although this is not currently a major factor in Fiji.

In Fiji, mangroves are mostly threatened by excessive exploitation for firewood and building materials, by reclamation of mangrove forest land for other uses (Smith, 2003), by increased sediment loads from upland logging and agricultural operations, and by local pollution. Mangrove land is being reclaimed for construction for urban development and expansion of settlements, and for conversion to agriculture (principally sugarcane). In the upland regions, sugarcane and other developments remove forests from the slopes and tend to clog the rivers with sediment. This changes the hydrological regime of the mangroves, with more frequent flooding and less reliable supply of fresh water. The higher sediment loads place additional stress on mangroves and reefs and the fisheries they support.

The loss of mangrove regions increases the vulnerability of coastal areas to sea level rise and storms. Indeed, there has been accelerated coastal erosion in regions denuded of mangroves (Koshy and Philip, 2002). Nunn et al., 1993 note that in countries such as Indonesia and Malaysia, coastal management plans call for mangrove buffers 50-100m wide, whereas in Fiji, current practice is to maintain a belt only 5-30m wide. The following section considers the likely response of mangroves to climate change.

7.3 Response to climate change

Section 3 outlined climate change scenarios for Fiji that envisage a potential sea level rise of up to a meter over this century; temperature increases of a few degrees; and possible increases in intense tropical storms. These changes, or something approaching them, will constitute a significant impact on the coastal areas of Fiji. It seems clear that in regions of the coast where extensive mangrove forests exist, they will help ameliorate the impacts of the climate change. But the question still remains as to how the mangroves themselves will withstand such changes and whether they would be able to cope with rising sea levels, increased temperatures, and stormier conditions.

The likely response of mangroves to rising sea levels depends on a variety of factors. The relative rates of sea level rise and sedimentation will determine the local change in water depth. Thus, for example, if sedimentation rates exceeded sea level rise rates, then the mangrove region may even expand seaward. In the longer run however, it is more likely that sea level rise rates will dominate, in which case mangroves would have to retreat shoreward. Whether they actually do retreat shoreward would then depend on how fast the rate of rise is, and whether there is available appropriate land to retreat to. Some evidence from mangroves in India and Bangladesh suggests that when the rate of sea level rise is not too dramatic (*mm/yr*) mangroves are able to adapt to the changes and colonize suitable shoreward areas (Blasco et al., 1996).

The ability of mangroves to colonize shoreward regions is likely to vary from place to place depending on several factors. From studies across mangrove forests in different regions, it appears that each species of mangrove lives in ecological conditions that approach the limit of tolerance with regard to the salinity of the water and soil, and the inundation regime (Blasco et al., 1996). Inundation from sea level rise would result in increased salinity. Some mangrove stands may readjust to new conditions, and some may not. Both responses have been observed, with massive mortalities in some cases occurring as a result of only small changes in hydrological regime. Mangroves may also be threatened by increased sediment from storm surges and by coastal erosion. Further, it is still an open question whether mangrove survival or migration will occur with ample success to preserve their ecosystem functions.

Mangroves are an integral part of the coastal seascape comprising coral reefs, sea grasses, mangroves, and shore. The health of mangrove forests will also depend on how other components of the seascape respond to climate change. In this regard, the prime threat seems to be to coral reef systems (Hoegh-Guldenberg et al., 2000). Rising sea surface temperatures have lead to coral bleaching events and mass mortality of coral reefs in some places. Some coral bleaching has already occurred in Fiji (World Bank, 2000). If this trend continues with climate change and Fiji's coral reefs were to die off, this would have profound impacts on the seascape. Coral reefs help create sheltered regions in which mangrove communities can establish themselves. Without this protection, mangroves will be further threatened by increased exposure and could follow coral reefs into extinction. Rising sea level and rising temperature could therefore have a compounding adverse impact on the viability of mangroves in Fiji.

Thus, mangroves are both part of the solution to climate change in Fiji (by stabilizing and protecting coastal regions and providing economic, social, and environmental resources) and potentially threatened by climate change (through inundation, over-sedimentation, ecosystem breakdown, and loss of reef cover). Mangroves function as an integral part of the economic fabric of Fiji via fisheries and timber

and they are already under threat from overexploitation for timber and from coastal development. The next section reviews the priorities and plans that are in place to manage coastal regions and development in Fiji.

7.4 Review of plans bearing on mangrove regions in Fiji

By being entwined in such a vast and heavily used coastal ecosystem that supports a variety of cultural and commercial enterprises in Fiji, there are a range of programs and agencies that have a bearing on mangrove regions. These programs span the range from international agreements, to governmental agency programs, to local and community initiatives. This section provides a summary of these programs and plans as they relate to mangrove regions.

7.4.1 International agreements

The international initiative pertaining most directly to mangrove regions is the Ramsar convention. Mangroves are classified under wetlands in the Ramsar convention, which is the main international body set up to manage them. The Convention on Wetlands, signed in Ramsar, Iran, in 1971, provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 135 Contracting Parties to the Convention. Fiji is not a member of the Ramsar Convention; however efforts to join are currently underway in Fiji. Priority sites for Fiji's entry into the convention are being identified, and there is every expectation that Fiji's application will be successful. This will provide additional focus and protection on the priority sites, though it does not necessarily guarantee any broader protection for Fiji's mangrove regions.

The UN Framework Convention on Climate Change and related programs provide a range of initiatives that may have a bearing on Fiji's ability to manage its mangrove regions. The Global Environmental Facility (GEF) is a potential source of project funding. The global change SysTem for Analysis Research and Training (START) initiative provides opportunities for capacity building and training. The Pacific branch of START is based at the University of the South Pacific (USP) in Suva and is well placed to fulfill this kind of role. Monitoring, management, and replanting of mangroves require a range of expertise ranging from working with village communities to writing project proposals. Projects such as START are aimed at enhancing capacity in this regard.

7.4.2 National planning

National plans and jurisdiction on activities related to Fiji's mangroves are held in a number of governmental departments. These include Environment, Fisheries and Forests, Town and Country Planning, the Lands Department, and Fijian Affairs. All land in Fiji above the mean high water mark belongs either to the Crown (9%), Fijians as Native Land (83%), or private owners as freehold land (8%) (Waltling, 1986a). The land encompassing Fijian villages is owned by the villagers (part of the 83%). Village communities span much of the coast of Viti Levu and are an integral part of mangrove planning. All land below the mean high water mark is Crown land, though native rights to resources on this land are recognized. All decisions made entailing development of mangrove land in Fiji are made by the Lands Department. Where this land abuts village land, village interests would be considered in oversight from boards within Fijian Affairs.

7.4.2.1 Lands Department

The Lands Department can issue a foreshore development lease under the State Lands Act when the Minister of Lands deems that such development would not create substantial infringement of public rights. The process of developing a mangrove region for other uses currently entails:

- A developer submits a proposal to the Lands Department
- Lands then invites comment from other government ministries and departments
- An arbitration process is commenced to assess a recompense sum for loss of the mangrove and services
- Public comments are sought
- A final determination is made and a foreshore development lease may be granted.

The decision process does not recognize any specific formal laws related to mangrove management, though there is a Mangrove Management Plan for Fiji (Watling, 1986a; Watling, 1986b), which arose from the recommendations of a Mangrove workshop held in Suva, February, 1983. Following this workshop the Cabinet of the Fiji Government endorsed the formation of a Mangrove Management Committee and directed that at Mangrove Management Plan be drawn up. The Mangrove Management Plan introduced a philosophy of classifying mangroves in terms of their uses and importance. It also prescribes more specific management guidelines for specific river deltas and town locales, which have generally not been implemented.

7.4.2.2 Department of Fisheries and Forests

The resources of the mangroves fall within the jurisdictions of several groups. Village communities may use the mangrove trees, plants, and fisheries for their own purposes. The Department of Fisheries and Forests controls all non-village use of mangrove fisheries and forests. From 1933 mangroves were designated as forest reserves and were managed by Forestry, but that designation was revoked in 1974 and control was handed over to Lands (Watling, 1986a).

7.4.2.3 Department of Environment

The Department of Environment has promoted two bills relevant to management of mangrove regions: the Fiji Biodiversity Strategy Action Plan (BSAP) and a sustainability bill. The Fiji Biodiversity Strategy Action Plan was passed in parliament in 2003. The BSAP arose in part because Fiji is party to the Convention on Biodiversity, wherein it is obligated to take measures to protect its biodiversity through the formulation of a strategy and action plan. The plan commits Fiji to the protection and conservation of a variety of life forms, plants, animals, micro-organisms, genes they contain, and the ecosystems they form. The BSAP contains provisions to try to ensure the participation of landowners and traditional fishing right owners in documenting traditional knowledge of biodiversity and its uses and the development of their own local management strategies. The BSAP contains a section on mangroves and is likely to raise their profile and importance in the political system. The BSAP also provides estimates for the value of mangrove services, which are discussed in section 7.5.1. The preparation of the BSAP was funded by the Global Environmental Facility, and it will be implemented by the Department of Environment.

Another proposed legislation that is relevant to mangrove management is the Sustainability Bill which has been pending for some years and has still not yet been passed in Parliament. The Bill may provide some support to mangrove management if passed, although it does not contain specific mangrove provisions. The bill was constructed largely at governmental level with apparently little input from the village level. It is currently being examined by the Fijian Affairs board.

7.4.2.4 Fijian Affairs

The Ministry of Fijian Affairs, Culture, and Heritage oversees a range of issues and legislation related to native Fijians. The Ministry encompasses a set of organizations who oversee the development of Fijian affairs. These include the Native Lands and Fisheries Commission, the Fijian Education Unit, the Institute of Fijian Language and Culture, and the Centre for Appropriate Technology and Development. The statutory authorities within the Ministry are the Fijian Affairs Board and the Native Lands Trust Board. Both of these authorities are relevant to mangrove management.

The Native Land Trust Board (NLTB) provides custodianship for the 83% of land held by Fijians and is responsible to ensure that land and natural resources are used and managed in a wise and sustainable manner and that unique and important features of the Fijians natural and cultural heritage are set aside and protected for the benefit of the current and future generations. Given the integral role of mangrove regions in village life, subsistence, and affairs, there is a clear mandate to protect them under the aegis of the NLTB. Most mangroves are associated with reserve land, which has been specifically put aside for the use, maintenance or support of the indigenous landowner. Non-reserve land is native land outside of villages which is often under lease or license, typically for agricultural uses. Despite its apparent mandate to conserve the resources of reserve lands, the NLTB has not been notable in preventing the ongoing decline in mangrove extent. The Fijian Affairs Board oversees legislation for consistency with the objectives of the Fijian Affairs Act. Similarly, conservation of mangrove resources has not been a manifest objective of that oversight.

7.4.3 Non State Actors

While decisions on large scale management of mangroves and conversion of mangrove land to other uses are made primarily at the national (governmental) level, the day to day use and management of mangroves takes place primarily on a local level, principally in village communities. A range of organizations also work in partnership with the village communities.

7.4.3.1 Villages

Village communities in Fiji have considerable autonomy over use and management of their land and resources. The villages have managed the mangrove resources in a sustainable manner for several thousand years. That has not changed, though the broader social, cultural, and economic contexts in which the villages are embedded in Fiji has changed radically since colonization. The subsistence economy of the villages continues (rooted substantially in mangroves for many coastal villages), but interacts with, and is impacted by, commercial activities and relationships. That has consequences for the ability of the village communities to continue to manage mangroves in the same way. Further, the environmental context has also changed radically since colonization, with degradation of upland regions, pollution, and outright loss of mangroves (see section 2.3.3). Thus, the relationships of the villagers to the mangroves are changing. This requires new initiatives for conserving, protecting, and in some cases, replanting of village mangroves. It may also require adaptation to irreversible loss of mangroves and their services when replanting of mangroves is not possible.

The participation of village communities is likely to be critical to the success and sustainability of efforts to manage and preserve mangrove ecosystems. The villages manage their own environs and also work in consultation with the broader Council of Chiefs in managing their affairs. The villages however are hampered by chronic lack of resources, which are alleviated in some cases by partnerships with outside NGOs, which are reviewed in the next sub-section.

7.4.3.2 NGOs

As one of the main commercial centers of Pacific Island nations, Fiji is home to a number of international Non-Governmental Organizations (NGOs). Some of these have interests and programs on climate change and/or mangrove management. These include the World Wide Fund for Nature (WWF), Greenpeace, and the Organization for Industrial, Spiritual and Cultural Advancement (OISCA). WWF and OISCA in particular have programs in partnership at the village level.

OISCA is based in Sigatoka on Viti Levu and runs training programs on agro-forestry. One element of this entails replanting mangroves with villages in the Sigatoka region (see Figure 9). Significantly, these replanting efforts have proved successful, where some others have not. Part of this success was attributed to the close partnership with villagers in designing and operating the programs, attending village meetings and engaging in traditional decision-making and reconciliation processes in the villages. Success was also partly attributed to the development of expertise on how to carry out the replanting. For example, this entails cultivating young mangrove plants in nurseries to the point where they have a better chance of establishing themselves in the tidal zone.

Figure 9. OISCA mangrove replanting area, Sigatoka

WWF is based in Suva and is engaged in a number of community based programs on wetlands and marine areas. One of their wetlands projects is being carried out in partnership with Fijian women in Navakosobu and Korovuli (Box 4). This project aims to restore wetlands supporting the Kuta plant, which is used in weaving. WWF is working with other organizations [USP, Foundations of the Peoples of the South Pacific (FSP), and International Marine Alliance (IMA)], the ministry of Fisheries and Forests, and village communities to conserve marine areas through the Fiji Locally Managed Marine Areas Network (FLMMA). The FLMMA has nine project sites in Fiji, of which five are on Viti Levu. Each site works to develop a community-based marine resource management plan. Limits on harvesting marine resources are set, and this is followed by monitoring, evaluation, and learning programs. The projects are driven by the local communities on the one hand, but provide opportunities for them to assess their efforts, identify gaps, and access information and resources in other communities and outside organizations in the FLMMA.

Box 4. Kuta wetlands project

The Kuta wetlands project being carried out by village women in conjunction with WWF, USP, and the Fijian Government is illustrative of the type of project that can be of considerable benefit to mangrove wetlands as well. The project is run by village women to restore threatened wetland habitat that supports the kuta plant. The kuta plant is used in weaving by the women and is a source of local income. The freshwater wetland habitat of the kuta plant has been increasingly threatened by deforestation, weed infestation, and agricultural run-off. Like mangrove wetlands, kuta wetlands are an important resource to village communities that are under threat. Where efforts to save and restore kuta wetlands have been successful, there may be lessons for mangrove wetlands.

The kuta plant grows in ponds surrounding village communities. It is harvested from the ponds, dried in the sun, flattened, and then woven into fine mats. Where kuta has come into short supply due to destruction of its habitat, some villages have substituted coconut palm leaves. However, they are not as supple or appropriate for weaving as the kuta.

WWF began working with the women of Navakosobu and Korovuli in Vanua Levu to help record traditional knowledge of the kuta plant. In the project areas, WWF calculates that about half the forest cover has been lost since 1978, principally to sugar cane and roads. Large ponds that once surrounded the project villages have been greatly reduced in size, silted, and weed choked. As the wetland habitat has changed, introduced species such as the pink water lily have out-competed kuta and other native wetland species. The water lily is better able to grow in the disturbed habitat that has fewer native species and a greater input of nutrients from erosion and agricultural runoff.

The communities in Navakosobu and Korovuli have been working to restore their ponds, clearing the natural waterways of silt and debris, uprooting water lily from the ponds, and replanting kuta plants. To prevent further silting of the ponds, the villagers are planting native tree species (logologo and lauci) around the edges of the ponds.

While these efforts have been successful so far, Ghazanfar, 2001 argues that the Kuta project has restored the kuta species, but not yet the habitat that supports it. Ghazanfar, 2001 notes that the ponds need constant weeding and management because the broader degradation of the wetland ecosystem has not been addressed. Thus conditions still favor the water lily and the threat to kuta has not been removed. Ghazanfar, 2001 proposes that a more effective approach is to ``first recover the functional values and self-sustaining characteristics of the original habitat''. This would entail more broad-scale reintroductions of native species into the kuta wetlands, and reductions in soil erosion and agricultural runoff into the wetland. That would then create a more conducive and sustainable environment for a weeding and replanting program. The clear parallel to mangrove conservation here is that mangrove ecosystems are also threatened by upland erosion, silting, and agricultural runoff. If the broader ecosystem is not considered, then efforts to reintroduce mangroves into the inter-tidal zone may face similar issues of ongoing maintenance and decline.

Community response to the Kuta project has been enthusiastic and there has been an upsurge in interest in the kuta and its habitat. Communities are realizing that the resource is being lost, and the Kuta project represents an achievable response that can start to turn that around on a village-by-village basis. WWF and the Ministry of Agriculture have held training exercises for agricultural officers to better understand the importance of the kuta plant and to raise awareness of its precarious state. Thus, the importance of maintaining kuta habitat is now signaled at governmental levels, no doubt in part due to the success of the kuta projects. However, the word of caution from this project seems to be that long term sustainable management of the resource (kuta or mangrove) may require a more systematic view of ecosystem restoration than is encapsulated on a project-by-project basis.

Though not strictly an NGO, the University of the South Pacific (USP) plays some of the same roles as NGOs in working with local communities. The University draws together researchers and students from across the South Pacific and beyond and is key in developing a capacity for research, monitoring, and training in a range of areas, mangroves included. USP and its staff are engaged in many of the current efforts to manage mangroves sustainability in Fiji. This includes obtaining membership in the Ramsar convention for Fiji, developing a database on mangrove resources, training members of the community, coordinating research, and focusing international efforts appropriately.

7.4.3.3 Donor organizations

Among the main donor organizations in Fiji are those associated with the governments of Japan [Japan International Cooperation Agency (JICA)] and Australia (AusAID). JICA supports a range of projects in Fiji and has identified environmental protection as one of the priority areas for its work in Fiji. While JICA has set its own general priorities, its project funding tends to follow requests on more specific priorities from the Fiji government. Thus, if mangrove management and conservation is not identified specifically by the government as a priority, then it is less likely to attract support from JICA.

The AusAID program for Fiji aims to reduce poverty through the promotion of stability and more equitable distribution of resources and government services to the people of Fiji. The 20022003 budget is $AUD 19.7 million. The programs stated goals do not foreground climate change, though the stated environmental objectives include measures to mitigate the impact of economic activity and population growth on land and marine environments. This provides scope for mangrove support. As for JICA and other donor programs, AusAID indicate that they attempt to align their support to objectives and programs identified by the Fiji government.

This raises the question as to whether climate change, sea level rise, and management of mangrove regions is specifically identified by the Fiji Government as a priority. There is no simple answer to this question. It is difficult to say how much attention is too little, and how much is too much when climate impacts are balanced along with a raft of development issues. Regardless, anecdotal evidence based on consultation with stakeholders during a field visit by a case study consultant suggests that sea level rise and mangrove conservation are not central to the government agenda. Other indications seem to confirm this. For example, the Fijian Government Ministry of Finance and National Planning recently produced a 216 page report 20 year development plan (2001-2020) for the enhancement of participation of indigenous Fijians and Rotumans in the socio-economic development of Fiji (Fiji Government, 2002). There is no mention of mangroves or sea level rise in this report. To be sure, the report is not about those issues, though one could well imagine sea level rise impacts and mangrove resources playing a role in the socio-economic development of Fijians over this period.

7.4.4 Sea level rise planning

Current policy with regard to sea level is to maintain a 30m setback of any development from the high water mark. This appears to be a guideline only though, and has not been enacted. Indeed the main road along the coral coast runs much closer to the high water mark than 30m in places (see for example Figure 10). There is concern to formalize the 30m setback, and it is expected to be included in the sustainability bill.

Figure 10. Stretch of road near Suva close to the high water mark

Regardless of the state of policy on sea level rise, sea level has risen in Fiji about a centimeter per decade over the last century. Coupled with a loss of mangrove protection, this has lead to significant coastline erosion in parts of Viti Levu. Coastal villages, towns, and tourist resorts have sought to protect themselves against these losses. Towns and tourist resorts have often responded by building sea walls. Similarly, roads and other infrastructure have been protected by sea walls when threatened by shoreline recession (Figure 11). Villages have also responded to shoreline losses by building sea walls, in part encouraged by government support for sea wall construction in the past. The attitude of both government and villages toward sea walls has changed however. Building of sea walls is now recognized as having clear costs. The walls may breach in storms and need reconstruction. They need ongoing maintenance. More troubling though is the fact that the beaches are lost when the walls are constructed. Further, the areas of coast around the sea walls seem to be more subject to erosion as a result of the walls. This observation has been reported by villages neighboring tourist resorts that have constructed sea walls, and is a source of some tension also. With the loss of beach and a physical barrier in place, the environment is not conducive to mangroves, and fisheries are also likely to suffer.

Figure 11. Seawall along the coral coast

Some village communities now favor the use of mangroves for protection rather than construction of sea walls. While government policy is no longer geared toward construction of sea walls, village communities who choose to build walls may do so themselves. Construction in villages is governed by the Fijian Affairs Act, not by the national development plan, and so the 30m setback guideline does not apply. With the shift in consciousness at village level toward mangrove conservation, this indicates considerably more flexibility and potential in managing sea level rise than is indicated by the apparent paucity of explicit governmental policy on sea level rise.

One of the key issues for maintaining mangrove regions in response to sea level rise is whether the mangroves are able to migrate shoreward into appropriate habitat as the intertidal zone moves further in. Where sea walls and other developments and obstructions have been put in place, mangroves will be precluded from migrating and will be lost. Retention of wetland regions such as mangroves is likely to require a set of strategies to manage development in the coastal zone and shore regions. This issue is taken up in the next section.

7.5 Incorporating climate responses into development plans

Some climate change is projected to occur over the coming decades regardless of global mitigation efforts. In Section 3 it was noted that projected changes include rising sea levels, warming, possible damage to coral reefs, more intense storms, and storm surge damages to the coast of Fiji. Fiji will have to adapt to some of these impacts. Adaptation to sea level rise and coastal impacts can take two main forms: holding back the sea or allowing the shoreline to retreat. The former entails construction of physical barriers such as walls or raising the land. The latter can entail use of mangrove wetlands to provide a buffer against storm damages. Physical barriers eventually eliminate the beach, wetlands, and other inter-tidal zones (Titus, 2000). A detailed cost-benefit analysis of all the options has not yet been carried out for Fiji. Where these kinds of analyses have been carried out for other countries/regions, the general sense is that wetland protection and allowing wetland migration with a retreating shoreline is a more cost-effective strategy than building sea barriers or rebuilding the land (Marine State Planning Office, 1995).

In Fiji there are currently two competing trends in this regard. At various levels of government and in local communities there is a preference emerging for managing sea level rise via conservation of mangrove communities. Countering that, the actual trend in Fiji in recent decades (and through the last century) is toward destruction of mangrove regions and a diminishing of mangrove coverage. The reasons for that are complex, but in short, mangroves are losing out to development pressures on land from agriculture, resorts, and towns.

The benefits from mangrove conservation tend to accrue either to small communities with not much voice in government, or else to future generations with no present voice. The benefits from mangrove destruction tend to accrue to developers, companies, or towns with more direct access to government and who can demonstrate more tangible and immediate rewards by reclaiming mangrove land. On the one hand, mangrove conservation is a no-regrets adaptation to climate change in that it makes sense to do in providing services and protection irrespective of whether climate changes or not. On the other hand, there are distributive consequences to mangrove destruction and conservation (those who gain from destruction are not the same as those who pay the ultimate costs). Thus, there are political barriers to conservation even for an apparent no-regrets adaptation. Another factor working against conservation of mangroves is that they can be removed very rapidly, whereas it takes many years to re-grow mangrove communities. These features of the problem are similar for deforestation in most parts of the world. The devaluation of mangrove services is illustrated in cost/benefit studies of these services in Fiji.

7.5.1 Valuation of mangrove services

Mangroves provide a range of goods and services to local communities. Not all of these can be costed, but some efforts have been made to attribute value to many of these services. Smith (2003) the following values (in F$) for mangroves/ha/year for Viti Levu in each of the designated categories: subsistence fisheries (400-700), commercial fisheries (150-300), recreation (600), medicinal plants (400-700), habitat functions (150-300), and raw materials (150-500). This yields a value from these services of about F$2000-3000/ha/year (or roughly US$1000-1500/ha/year). This valuation does not include a number of mangrove services which could not be costed, including: ornamental fish, biodiversity (other than medicinal plants) non-use (existence and bequest) values, fuel wood, non-wood products, importance to marine ecosystems, importance to marine recreation, and importance to inland groundwater. While Smith (2003) does not determine a value for coastal protection, the article cites parallel studies for other regions which imply a value of about F$3000/ha/year. This may be an overestimate for Fiji however, as the assessment of potential land lost to erosion on Viti Levu by sea level rise in World Bank (2000) corresponds to about F$1000/ha/year. Taken together, these figures seem to imply a rough estimate of mangrove services for Viti Levu of from F$2000-5000/ha/year (US$ 1000-2,500/ha/year).

The Fiji Biodiversity Strategy Action Plan (BSAP) meanwhile ascribes values of F$2400/ha/year for food, nutrient, and habitat services, and F$2500/ha/year for disturbance regulation (coastal protection) from mangroves, yielding a figure in the vicinity of F$5000/ha/year which is broadly consistent with Smith (2003). While neither estimate captures all possible values from mangrove services, but they each do include the more salient mangrove services associated with fisheries, habitat, and coastal protection.

The above estimates differ from the valuation used by the Departments of Lands which took over operational control of the mangroves in 1974. The transfer of authority to Lands also included a provision that Lands provide for re-compensation for loss of fishing rights. Thus Lands levies a compensation to be paid to villages when mangrove land is taken. In typical cases this seems to amount to a one-time negotiated payment – not explicitly based on any valuation of mangrove services - in the vicinity of F$300,000-400,000 for an area of about 70ha of mangrove lost. That is, about F$5,000/ha. To be clear, that is a one-time only payment, not F$5,000/ha/yr as in the above valuations. To convert the Lands implicit valuation of mangrove services to a value /ha/yr, assumptions need to be made with regard to the

time frame for provision of mangrove services. About the most generous assumption one could make for Lands is that the mangrove could in theory be replanted and replaced in a couple of decades, leading to a value of F$250/ha/year (US $ 125/ha/year) or 1/20th of the values ascribed above. In practice of course the mangroves are not replanted and one might reasonably assume a much longer time scale for the loss of mangrove services. The longer the time scale viewed, the lower the valuation of Lands relative to the BSAP.

Conversely, if a village were compensated for 100 years of loss of mangroves at the BSAP rate, the amount of compensation would be in the vicinity of F$30,000,000 not F$300,000. The former value would be lowered by discounting, but that does not change the basic point that the value used by Lands might be a significant undercompensation in considering tradeoffs between mangrove services and other development uses of mangrove land. This in effect represents a subsidy for conversion of mangrove land to development use.

7.5.2 Issues in mainstreaming mangrove management

7.5.2.1 Capacity enhancement

There is no single reason why mangroves services are undervalued and mangrove extent has declined. One might argue that there is a lack of capacity in place to provide effective management and conservation. In Fiji, however, there is already considerable capacity in place, and the issue is more capacity enhancement than development (Koshy and Philip, 2002). For example, Fiji has data and knowledge collection programs for mangroves in place via the National Trust and initiatives at USP. There are a series of active partnerships in place between villages and a sizeable NGO community directed at mangrove conservation. There is interest from donors and capacity within government. The coastal villages possess a wealth of traditional knowledge on mangroves, and USP provides ongoing research. Each of these groups needs more resources of course, but the basic capacity framework is already in place.

7.5.2.2 Governmental actions

Since the government is the primary organizational institution of the state, the main access point for mainstreaming approaches to mangrove management is via government agencies. As noted in sections 3 and 4.1, government has not prioritized mangrove conservation and management. The two pieces of current legislation that may help in this regard are the biodiversity plan (BSAP), which was passed, and the sustainability bill, which is yet to be passed. Since the BSAP contains provisions which value mangrove services at levels significantly over the valuation currently used by the Lands department, it will be interesting to see whether Lands alters its valuations in accordance with the BSAP. If this is done, it would provide a signal that mangrove conservation and coastal impacts are a priority. Conversely, if it is not followed it will also send a fairly clear signal that priorities have not changed.

The mangrove management plan that informally adopted for Fiji (Walting 1986a; Walting 1986b) has not been effectively implemented thus far. While there might a need for a new plan that targets the role of mangrove management in forestalling and protecting against sea level rise impacts, such a plan would only be useful if it were accompanied with effective implementation measures. Since mangrove conservation runs headlong into other coastal development projects related to settlement, agriculture, and tourism, it would be appropriate to situate mangrove management inside a framework for broader coastal management. Such a framework would need to recognize the need to fortify the coast in areas vital to protect and to allow it to recede in other areas (as did Walting 1986a; Walting 1986b). Over the long run, attempts to fortify the coast are likely to prove more expensive than allowing it to recede, so there is clearly a tradeoff. There is also a tradeoff in finding the right level of development use and conservation

use. Too little conservation of mangroves will lead to faster loss of coastal land and bigger impacts from storm surges.

Part of the solution, and hence the planning vision, must include a view of mangroves as integral components of development projects. The difficulty however is that mangroves will need to be able to migrate shoreward as sea level rises. If mangroves face shoreward barriers such as settlements, roads, or walls, then migration is precluded. Protection from mangroves and their services will then be lost as rising sea level strands them. In order to provide mangroves with the ability to migrate, some setback needs to be declared that prohibits long-lived development structures within the likely migration zones of wetlands. The exact amount of setback required would depend on how much sea level rise is planned for. The current policy of a 30m setback seems inadequate for the kinds of sea level rises outlined previously.

7.5.2.3 Community and Non-governmental actions

Since much of the coastal land of Fiji is part of village communities, part of the balance in finding tradeoffs between mangrove conservation and conversion to other uses lies with the village communities. As such, these communities should be an integral part of the coastal planning process. In the case of mangroves in Fiji there are additional factors at play that may allow for more favorable outcomes than in a typical case of forest conservation. One is that mangrove conservation has clear and well recognized benefits to the village communities in the present context (fisheries, timber, shoreline stabilization, reef protection, etc.). Though perhaps less well recognized, mangrove conservation is likely to be of immense value in managing sea level rise impacts in future contexts. The very direct link with climate change and the expected value from shoreline protection are features of mangrove forests that are not as clear cut for land-based forest communities. Further, much of the mangrove land is integrated within the subsistence economies of village communities. In many parts of the world, subsistence-based communities have had relatively little formal power to confront outside interventions. In Fiji, the villages are better recognized, more active in the political system, and have more autonomy than in other countries. Taken together, these factors provide opportunities for mangrove management in Fiji that follows more sustainable pathways.

The fact that the Fiji Locally Managed Marine Areas Network (FLMMA) was recognized for its achievements by the UN last year, may reflect in part the relatively advanced capacity of Fiji for community-based management. One strategy then is to increase support for community management of marine (mangrove) resources throughout Viti Levu. Prominent NGOs in Fiji have, by and large, adopted the approach of working with and through local communities and these partnerships are well established. This approach ensures the relevance of the projects undertaken. As the number of communities engaged and projects expands, so too does the capacity of Fiji to conserve mangrove regions.

It might therefore be imperative to accelerate this process before many more mangroves are lost. Some of the principal donors however have a preference for supporting activities that are in line with the priorities of the Fijian government. The government in turn is not likely to prioritize mangrove conservation unless there is an overwhelming case demonstrated by successful projects that this is both important and feasible. One way to begin to make this happen is for those donor organizations who are less constrained in their funding priorities to support these kinds of initiatives. In addition efforts must also be to try to raise the priority of mangrove conservation within government through the promotion of existing projects and helping to raise awareness.

8. Concluding remarks

This integrated analysis reveals the need for mainstreaming climate change responses in development planning and assistance in Fiji. Given that Fiji has a high island setting; it is therefore a priori relatively less vulnerable to climate change impacts than low lying atoll countries such as Tuvalu. Nevertheless, a considerable portion of ecosystems, built infrastructure, and economic activity in Fiji is concentrated in low-lying coastal regions, thereby making them vulnerable to climate change.

8.1. Climate trends, scenarios and impacts

Impacts of climate change on Fiji will include rising temperature and sea levels, possibly more intense storms, and damaging storm surge events. There might also be significant shifts in precipitation for Fiji, but a comparative analysis of climate model projections in this report reveals that the magnitude and direction of such shifts is highly uncertain. The Fijian economy is already quite vulnerable to extreme climatic events such as cyclones, floods, and droughts, with the costs of storm surge impacts for individual events at times as high as a few percent of the annual GDP. A subjective ranking of key climate change impacts and vulnerabilities for Fiji identifies coastal resources as being of the highest priority in terms of certainty, urgency, and severity of impact, as well as the importance of the resource being affected.

8.2 Attention to climate change concerns in national planning and donor portfolios

There is a general awareness of the risks posed by climate change, both in Fiji and, more generally, among Pacific Island Country (PIC) governments. The Fijian government is aware of the environmental vulnerabilities related to current and future climatic risks. For instance, the Strategic Development Plan recognizes Fiji's vulnerabilities to climatic extremes and pays ample attention to disaster risk reduction. Although there is no specific plan yet that focuses explicitly on adaptation to climate change, there are several plans which include appropriate adaptation strategies to cope with climatic risks. Such plans however remain works in progress and will require effective implementation, as well as greater coherence between climate change and national economic development priorities.

Several bilateral and multilateral donors have been actively involved, some for over a decade, in efforts to assess the vulnerability of Fiji and other PICs to climate change risks. However, aside from projects that are specific to climate change or sea level rise, donors have generally not explicitly recognized the need to mainstream climate risks in their regular development work in Fiji. An analysis of donor projects - Fiji receives around US$ 30 million in development assistance annually - using the OECD/World Bank Creditor Reporting System (CRS) database reveals roughly 23-36% (in terms of investment dollars) and 19-23% (in terms of number of projects) of donor portfolios in Fiji that are potentially vulnerable to climate change impacts. Often, not only the attention to climate change but also to climate risks or to natural hazards more generally is not discussed in the donor strategies. Considering that climate risks in Fiji extend to economic, social and environmental contexts, there is a need for the donor side to mainstream the climatic risks in donor development strategies.

8.3 Towards no regrets adaptation and mainstreaming of climate responses

Fiji is currently part of an emerging trend in certain PICs where there is a shift in emphasis from assessment of climate change impacts towards implementation of adaptation measures. There has simultaneously also been growing recognition of the need to "mainstream" such adaptation responses within national and donor development priorities. These trends were spurred in part by the World Bank Regional Economic Report (RER) of 2000 which contained a full volume on climate change and implications of climate risks in Viti Levu (Fiji) and Tarawa (Kiribati). The World Bank RER concluded that the current "do nothing" approach was inadequate, while adaptation planning through expensive

investments for the worst case scenario might be impractical and unaffordable, particularly given the uncertainties in climate change and sea level rise projections. The report therefore recommended "no regrets" adaptation – measures which make good sense for other reasons and might contribute to reduced vulnerability to climate change impacts. Water conservation and leakage prevention in particular were cited as high priority no-regrets adaptation options for Viti Levu. "Mainstreaming" of climate responses within development planning and assistance was also viewed from the prism of no-regrets adaptation.

There have been a series of high level consultations in the PIC region since the publication of this report, and both no-regrets adaptation and mainstreaming have received political endorsement at very high levels. A Pacific Island High Level Consultation on Investing in Adaptation was held in Nadi, Fiji, in May 2002 with senior representation not only from Environment, but also from Finance and Planning ministries. The Nadi communiqué "highlighted the importance of an integrated and participatory approach to climate change, climate variability and sea-level rise […] within national development plans, budgets and national planning and decision-making machineries of governments". Subsequently, at the World Summit on Sustainable Development (WSSD) in September 2002, the Prime Minister of Fiji chaired a side event in which fourteen Type II initiatives were launched for PICs, including adaptation to climate change.

8.4 Coastal mangroves and climate change

The high level endorsement for mainstreaming climate responses notwithstanding, an in-depth analysis of mangrove conservation in Fiji in the latter half of the present report highlights the critical challenges for actual implementation or mainstreaming of even so-called no-regrets adaptation measures in Fiji. Coastal mangroves act to reduce coastal erosion and storm surge damages, but are themselves vulnerable to climate change and would need to migrate shoreward with the rising inter-tidal zone as sea level rises. Successful migration of mangroves requires that upland areas be managed to allow migration to take place. Conservation of mangroves is viewed as a no-regrets climate change adaptation in that mangroves provide existing services to local communities irrespective of their buffering of rising sea level. This includes their role in fisheries, reef protection, stabilization of coastlines, timber supply, medicinal uses, and so on.

Conservation of mangroves is not without distributive costs however, as existing mangrove land is converted to uses for agriculture, tourism, and settlements. Those who benefit from mangrove destruction and conservation are typically different groups. The current and long term trend in Fiji is for a loss of mangrove coverage. A key reason for this continued loss is the mismatch between the mangrove ecosystem and the property rights regime. In Fiji, a traditional clan, or mataqali, has communal claim over the physical resources and the environment, including mangroves. However, the government has declared these rights as being *usus fructus* only, thereby affecting the amount of compensation paid for a loss of mangroves for reclamation purposes (Lal 1990; 2002). The economic analyses reviewed in this report indicate that the mangrove valuation typically used by the Department of Lands is only a fraction (as low as $1/20^{th}$) of the values assessed by other groups through economic valuation studies that take into account various mangrove services, including by the World Bank and Fiji's own Biodiversity Strategy Action Plan (BSAP). The mismatch might be even greater if the role of mangroves as a coastal defence against climate change and sea-level rise was also to be explicitly factored. Successful mainstreaming of even no-regrets adaptation responses therefore might require greater policy coherence between climate change and development policies – appropriate valuation of mangrove regions is one such example.

Finally, there is also a need for a coastal management plan that prioritizes mangrove conservation, requiring adequate setbacks of development from the high water line to facilitate mangrove migration, and engaging local communities in these processes. At the local level, Fijian villages dominate the coastal environment. Some of these communities are working with one another and with NGOs based in Fiji to conserve marine and coastal resources. Though only a relatively small number of projects of this

kind exist at this point, they have been widely viewed as successful. There are however concerns that some of these efforts may have been too narrowly focused on restoration of mangrove species, and not necessarily of the habitat that supports them. If the broader ecosystem is not considered, then local efforts at mangrove conservation might be hindered by non-local stresses such as upland erosion, silting, and agricultural run-off that deteriorate the habitat. Such concerns however are being recognized and opportunities exist to promote more initiatives in this regard as a way to broaden the area of mangroves under local management and protection, and as a way to raise the profile of mangrove conservation with the government of Fiji.

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Titus, J. (2000). Does the U.S. government realize that the sea is rising? how to restructure federal programs so that wetland and beaches survive. *Golden Gate University Law Review*, 30(4):717-778.

Watling, R. (1986a). A mangrove management plan for Fiji. Phase 1: Zonation requirements and a plan for the mangroves of the Ba, Labasa, and Rewa Deltas. Technical report, The Mangrove Management Committee, Fiji. A joint project of the Fiji Government and the South Pacific Commission. 67pp.

Watling, R. (1986b). A mangrove management plan for Fiji. Phase 2: A plan for the mangroves of the Nadi Bay and Suva-Navua locales. Technical report, The Mangrove Management Committee, Fiji. A joint project of the Fiji Government and the South Pacific Commission. 31pp.

WorldBank (2000). Cities, sea, and storms: Managing change in Pacific island economies. volume IV Adapting to climate change. Technical report, The World Bank. 72pp.

APPENDIX A: GCM PREDICTIVE ERRORS FOR EACH SCENGEN MODEL FOR FIJI

These tables show the predictive error for annual precipitation levels for each SCENGEN model for each country. Each model is ranked by its error score, which was computed using the formula 100*[(MODEL MEAN BASELINE / OBSERVED) - 1.0]. Error scores closest to zero are optimal. For Fiji, the first eleven models had significantly lower error scores than the remaining six; therefore, the latter six were dropped from the analysis.

Table A.4. Predictive errors for each SCENGEN model for Fiji

	Average error[24]	Minimum error	Maximum error
Models to be kept for estimation			
CCC1TR99	8%	2%	16%
GISSTR95	9%	3%	17%
CSI2TR96	9%	1%	19%
PCM_TR00	10%	1%	21%
BMRCTR98	15%	3%	22%
GFDLTR90	15%	4%	25%
HAD3TR00	16%	2%	30%
ECH3TR95	17%	2%	27%
ECH4TR98	18%	3%	31%
CSM_TR98	19%	7%	36%
MRI_TR96	21%	18%	25%
Models to be dropped from estimation			
CERFTR98	24%	21%	29%
W&M_TR95	27%	1%	62%
IAP_TR97	30%	12%	47%
LMD_TR98	31%	13%	44%
HAD2TR95	31%	4%	66%
CCSRTR96	50%	41%	56%

[24] SCENGEN outputs data for 5×5 degree grids. To estimate for an entire country, a 10×10 degree area was used and the data output from the resulting four 5×5 grids were averaged. The maximum and minimum of these four 5×5 grids are also reported.

APPENDIX B: LIST OF PURPOSE CODES INCLUDED IN THE SELECTION OF CLIMATE-AFFECTED PROJECTS, ORGANIZED BY THE DAC SECTOR CODE.

DAC code	General sector name	**Purpose codes that are included in the selection**
110	Education	-
120	Health	12250 (infectious disease control)
130	Population	-
140	Water supply and Sanitation	14000 14010 14015 14020 (water supply and sanitation – large systems) 14030 (water supply and sanitation – small systems) 14040 (river development) 14050 (waste management/disposal) 14081 (education/training: water supply and sanitation)
150	Government & civil society	15010 (economic & development policy/planning)
160	Other social infrastructure and services	16330 (settlement) and 16340 (reconstruction relief)
210*	Transport and storage	All purpose codes
220	Communications	-
230	Energy	23030 (renewable energy) 23065 (hydro-electric power plants) [23067 (solar energy)] 23068 (wind power) 23069 (ocean power)
240	Banking and financial services	-
250	Business and other services	-
310	Agriculture, forestry, fishing	All purpose codes
320	Industry, mining, construction	-
330	Trade and tourism	33200 (tourism, general) 33210 (tourism policy and admin. management)
410	General environment protection	41000 (general environmental protection) 41010 (environmental policy and management) 41020 (biosphere protection) 41030 (biodiversity) 41040 (site preservation) 41050 (flood prevention/control)# 41081 (environmental education/training) 41082 (environmental research)
420	Women in development	-

430	Other multisector	43030 (urban development) 43040 (rural development)
510	Structural adjustment	-
520*	Food aid excluding relief aid	52000 (dev. food aid/food security assist.) 52010 (food security programmes/food aid)
530	Other general programme and commodity assistance	-
600	Action relating to debt	-
700*	Emergency relief	70000 (emergency assistance, general) #
710*	Relief food aid	71000 (emergency food aid, general) # 71010 (emergency food aid) #
720*	Non-food emergency and distress relief	72000 (other emergency and distress relief) # 72010 (emergency/distress relief) #
910	Administrative costs of donors	-
920	Support to NGOs	-
930	Unallocated/unspecified	-
* sector codes that are excluded in the second selection (low estimate). # purpose codes that are included in the emergency selection		

APPENDIX C: SOURCES FOR DOCUMENTATION

Documentation

Statistics
CRS database, OECD/World Bank http://www.oecd.org/htm/M00005000/M00005347.htm

Government documents

Fiji Government www.fiji.gov.fj
- Strategic Development Plan 2003-2005 (2002)
-

UN Conventions

UN Convention on Climate Change (UNFCCC) www.unfccc.int

UN Convention to Combat Desertification (UNCCD) www.unccd.int
- National Report (2002)

UN Convention on Biodiversity (UNCBD) www.biodiv.org
- *National Report (1997)*
- *Second National Report (2001)*

World Summit on Sustainable Development

Donor agencies

ADB www.adb.org
- *Country Assistance Plan (2000-2002)*
- Country Strategy and Program Update (2003-2005)
- Third Road Upgrading Project, Report and Recommendation of the President (1997)
- Climate Change Adaptation Program for the Pacific (CLIMAP)
    - Past Adaptation Assistance – a Review (2003)
    - Technical Assistance Report OTH 36069 (2002)
- Ports Development Project, Report and Recommendation of the President (2002)
- Supporting Economic Management and Development Policies Technical assistance Project, Technical Assistance Report (2002)

AusAid www.ausaid.gov.au
- Regional Strategy (1998)
- Country Brief
- Submission to Parliament (2002)

- Rural strategy (undated)
- Pacific Profiles (2000, 2001)
- Promoting Practical Sustainability (undated)
- The Overseas Aid Program and the Challenge of Global Warming (1999, 2000)
- Climate Change and Sea Level Rise Monitoring Program (since 1990)
- Vulnerability and Adaptation Initiative (2002)

CIDA
- Capacity Building for the Development of Adaptation Measures in Pacific Island Countries (CBDAMPIC) project – project brief (2003)

DFID www.dfid.gov.uk
- Pacific Region Strategy Paper (1999)

EU
- National Indicative Program for Cooperation under the Second Financial Protocol of the Fourth Lome Convention (1997)

JICA www.jica.go.jp
- Annual Report (2001)

Japan Environment Agency www.env.go.jp/en
- Development of Integrated Coastal Zone Management Plan (1992)

NZAid www.nzaid.govt.nz
- Pacific Initiatives for the Environment Program (?)

SOPAC www.sopac.org.fj
- Comprehensive Hazard and Risk Management Program (program CD-ROM, 2002)

SPREP www.sprep.org.ws
- PICCAP

UNDP www.undp.org.np
- Multi-country Programmes Outline for the Pacific Island Countries (2003-2007)
-

UNEP www.unep.org

USAID www.usaid.gov

World Bank www.worldbank.org

- Regional Economic Report (2000)
- Pacific Adaptation Program (personal correspondence)