



PACIFIC ADAPTATION TO CLIMATE CHANGE

TUVALU

REPORT OF IN-COUNTRY CONSULTATIONS

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I. INTRODUCTION

1.1 The need for adaptation to climate change

1. Small island developing States (SIDS) are highly vulnerable to climate change and sea level rise owing partly to their small land masses surrounded by ocean, and their location in regions prone to natural disasters. SIDS are often characterized by having relatively large populations for the area they occupy with high growth rates and densities; poorly developed infrastructure and limited natural, human and economic resources, and their high dependence on marine resources for their livelihood needs. Most of their economies are reliant on a limited resource base and are vulnerable to external forces, such as changing terms of trade, trade liberalization, and migration flows. Adaptive capacity to climate change is generally low.

2. In the Pacific region where the Tuvalu (see figure 1) is situated, the climates are influenced by a number of factors such as trade wind regimes, the paired Hadley cells and Walker circulation, seasonally varying convergence zones such as the South Pacific Convergence Zone (SPCZ), semi-permanent subtropical high-pressure belts, and zonal westerlies to the south, with the El Niño Southern Oscillation (ENSO) as the dominant mode of year to year variability (Fitzharris, 2001; Folland *et al.*, 2002; Griffiths *et al.*, 2003). The Madden-Julian Oscillation (MJO) also is a major mode of variability of the tropical atmosphere-ocean system of the Pacific on times scales of 30 to 70 days (Revell, 2004), while the leading mode with decadal time-scale is the Interdecadal Pacific Oscillation (IPO) (Salinger *et al.*, 2001). A number of studies suggest the influence of global warming could be a major factor in accentuating the current climate regimes and the changes from normal that come with ENSO events (Hay *et al.*, 2003; Folland *et al.*, 2003).

3. Recent studies in the southern Pacific region show that the annual and seasonal ocean surface and island air temperatures have increased by 0.6 to 1.0°C since 1910 throughout a large part of the South Pacific, southwest of the South Pacific Convergence Zone (SPCZ) where as decadal increases of 0.3 to 0.5°C in annual temperatures are only widely seen since the 1970, preceded by some cooling after the 1940, which is the beginning of the record, to the northeast of the SPCZ (Salinger, 2001; Folland *et al.*, 2003).

4. Analyses of trends in extreme daily rainfall and temperature across the South Pacific for the period 1961 to 2003 show significant increases in the annual number of hot days and warm nights, with significant decreases in the annual number of cool days and cold nights, particularly in years after the onset of El Nino, with extreme rainfall trends generally less spatially coherent than were those of extreme temperature (Manton *et al.*, 2001; Griffiths *et al.*, 2003). Variations in tropical cyclones, hurricanes, typhoons in all small islands' regions are dominated by ENSO and decadal variability which result in a redistribution of tropical storms and their tracks, so that increases in one basin are often compensated by decreases in other basins. For instance, during an El Niño event, the incidence of tropical storms typically decreases in the far western Pacific and the Australian regions, but increases in the central and eastern Pacific while during La Nina the trend reverses. The numbers and proportion of hurricanes reaching category 4 and 5 globally have increased since 1970, while total number of cyclones and cyclone days decreased slightly in most basins which is consistent with the trends observed in the Pacific islands region. Additionally, in the tropical South Pacific, the distribution of tropical storms and their tracks are dominated by ENSO and decadal variability, with small islands to the east of the dateline

highly likely to receive a higher number of tropical storms during an El Nino event compared to a La Niña event and vice versa (Brazdil *et al.*, 2002).

5. Given the urgency for adaptation in small island states there has been an increase in *ad-hoc* stand alone projects, rather than a programmed or strategic approach to the funding of adaptation options and measures. It can be argued that successful adaptation in small islands will depend on supportive institutions, finance, information and technological support. Thus an adaptation strategy for the Pacific islands and indeed for Tuvalu should include a strategy for precautionary adaptation since it is difficult to predict far in advance how climate change will affect a particular site, sector or community. Thus adopting a “no regrets” adaptation measures would be justified even in the absence of climate change, as this would more than likely lead to better management of natural resources and sustainable development.

1.2 Objective of Pacific Adaptation to Climate Change (PACC)

6. Given the foregoing urgency for the need for adaptation to climate change in the Pacific island countries, a Pacific Adaptation to Climate Change (PACC) has been developed to assist with the implementation of adaptation measures in 11 countries of the region. Tuvalu, as one of the countries will participate in the PACC to implement adaptation measures to enhance its resilience to the adverse impacts of climate change in the longer term.

7. The principal objective of the PACC is to facilitate the implementation of long-term adaptation measures to increase the resilience of a number of key development sectors in the Pacific island countries to the adverse impacts of climate change. A framework for PACC (PACC framework) will be developed through a consultative process involving all relevant stakeholders (including national governments and their respective agencies, institutions, departments and ministries, and non-government organizations, where appropriate, CROP agencies, donor partners, private sector, where appropriate, and others deemed necessary). The PACC framework will guide the implementation of the PACC at the national (including community and/or village) and regional levels.

1.3 Scope of the Report

8. As one the of the key outcomes of the in-country consultations is to determine detailed adaptation activities and baselines in each country, this report provides the outcomes of Tuvalu in-country consultations on PACC which were held from October 09 to 12, 2006. The report is divided into five sections: section I outlined the urgency for adaptation to climate change in SIDS, building on the IPCC third assessment report; section 2 provides a general overview of the climate change and development situation (situation analysis) in Tuvalu covering issues relating to assessment of impacts of climate change on the biophysical and human systems and stakeholder analysis; section 3 covers sectoral analysis with regard to a methodology and/or a criteria used to select a priority sector for adaptation intervention, institutional and development baselines within the priority sector as well as the analysis of the impacts of climate change within the priority sector; section 4 provides information of the delivery mechanism for full-sized project implementation of the PACC-TUVALU component and section 5 covers the project goals, outcomes, outputs and activities. The letter of endorsement for co-financing and list of individuals/experts and their respective institutions consulted during the in-country consultation are appended as annexes in section 6.

II. GENERAL OVERVIEW

2.1 Situation Analysis

9. Tuvalu is a small island developing State consisting of five true atolls and four raised limestone reef islands, with a total land area of approximately 26 km². Land levels are very low, with maximum heights above mean sea level typically ranging from 3.0 to 4.0 m.. The mean air temperature is 28 °C, with a mean maximum of 31 °C and a mean minimum of 25 °C. The mean rainfall ranges from 2,300 to 3,700mm annually. Climate variability and extremes, in particular ENSO and tropical cyclones, are important features of the Tuvaluan climate. The climate of Tuvalu is tropical and marine.

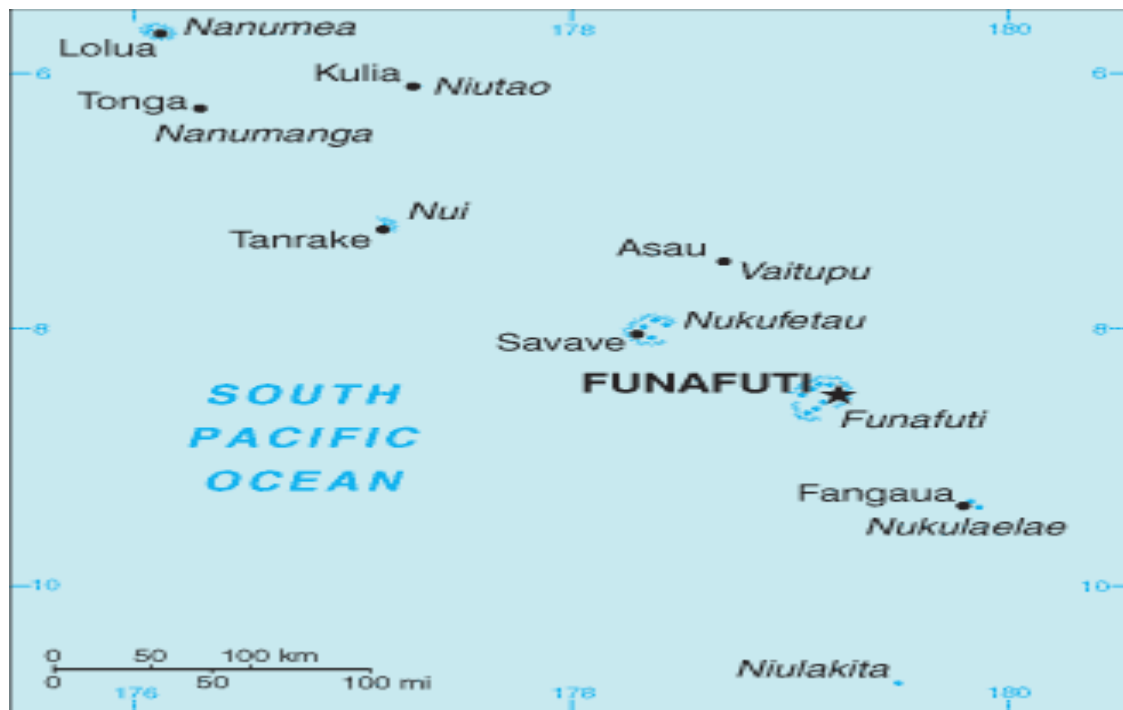


Figure 1. Location of Tuvalu

10. A number of issues are of particular concern to Tuvalu in the context of future changes in climate change and sea- level rise. These include the following:

- a) Coastal erosion and infrastructure development - increase in population and the growth in demand for permanent housing and infrastructure in Funafuti has resulted in an increased demand for sand and gravel for building and construction purposes. The sourcing of aggregate from coastal environments, may increase the risk of coastal erosion, flooding and environmental damage in the future. Thus selection and sourcing of aggregate removal will become a concern.
- b) Housing, land availability and population growth – land limitation has become a problem due to a rapid increase in population in Funafuti.
- c) Food and health - The overall population have shifted their food diet from traditional food to imported food. The capital, Funafuti is depending more on imported food due to population

pressure and limitation of land for subsistence farming. This has led to an increase in the so-called lifestyle diseases.

- d) Growth of cash economy - The development of a cash economy in Tuvalu is increasing the material expectations and aspirations of the people. Although, subsistence activities and sharing and reciprocity with extended family and the community are the common features of the Tuvaluan traditional life, people are increasingly participating in the cash economy.
- e) Pollution from solid and liquid waste - Poorly controlled waste disposal is still commonplace throughout Tuvalu. Inadequate disposal management methods associated with land-use is common on Funafuti. These practices are contributing to increased health risks and environmental degradation.
- f) Marine resources - The exploitation of marine resources is increasing due to population pressure. This is mostly happening in the capital, Funafuti. The establishment of the Funafuti conservation area has been a response to this growing pressure on marine resources.
- g) Water supply - Water supply is fairly adequate except during dry spells. Coupled to that is the population pressure which is becoming a problem on Funafuti. The well-being of the people in Tuvalu depends on a healthy and productive environment. Tuvaluans are presently well adapted to the limited land resources and variable climate of their atoll environments. The remainder of this report identifies how they may be affected by, and adapt to, the effects of future changes in climate and sea level.

11. The following sensitive sectors and exposure units that are likely to be particularly sensitive to future climate change and sea-level rise have been identified during the preparation of initial national communication:

- a) Coastal and marine systems
- b) Subsistence agriculture
- c) Water supply and quality
- d) Human health and well-being
- e) Housing

12. Global climate model results indicate that a temperature increase ranging from 0.5 to 2.2 °C in 2050 to 0.9 to 4.5 °C in 2100 is highly likely. These outputs are based on the IPCC IS92a (best guess) and IS92e (high) emission scenarios, for the years 2025, 2050 and 2100, in combination with results from four GCMs. In respect of rainfall, the one scenario shows moderate to very high decreases in rainfall (the UKHI GCM gives a 95% rainfall decrease by 2100, for the IS92e (high) emission scenario), while the other scenario (Scenario 2) shows moderate to high increases in rainfall. Thus Scenario 1 gives warmer and drier conditions, and Scenario 2 gives warmer and wetter conditions.

13. Apart from the consideration of changes in mean climate conditions it is important to consider climate variability and extremes. Climate models are not yet able to state with any certainty what changes in variability and extremes may occur. In the absence of such certainty, historical events are used to provide analogues for considering effects of variability and extremes, in association with mean changes in climate:

- a) Tropical cyclones appear to have increased in frequency in Tuvalu. The most recent severe event was cyclone Bebe (in 1972), which had significant effects in Tuvalu;
- b) ENSO events have been experienced with greater frequency over the last two decades. In Tuvalu, El Nino events bring warmer, drier conditions, whereas La Nina conditions are cooler and wetter.

14. Global climate models are not yet able to project changes in sea level at a regional scale of direct relevance to Tuvalu. However, scenarios of global sea-level change for the years 2025, 2050 and 2100 have been derived from the IPCC emission scenarios, IS92a and IS92e. An estimate of the present long-term relative sea level change at Funafuti, which uses all the data, is a rate of rise of 0.8 – 1.9 mm/year relative to the land. This indicates that there is about a 68% probability of the rate of rise being between -1.1 and 2.7 mm/year. A less cautious estimate, based on the rejection of data affected by El Niño-Southern Oscillation (ENSO) events, is a rate of rise of 1.2 – 0.8 mm/year relative to the land. This indicates that there is about a 68% probability of the rate of rise being between 0.4 and 2.0 mm/year.

15. Tuvalu's economy is dominated by subsistence farming and fishing activities. Government revenues largely come from the sale of stamps and coins and remittances from seamen on merchant ships abroad and substantial income is received annually from an international trust fund established in 1987 by Australia, NZ, and the UK and supported also by Japan and South Korea. In an effort to reduce its dependence on foreign aid, the government is pursuing public sector reforms, including privatization of some government functions and personnel cuts of up to 7%. With merchandise exports only a fraction of merchandise imports, continued reliance is placed on fishing and telecommunications license fees, remittances from overseas workers, official transfers, and income from overseas investments.

Ratification of the UNFCCC

16. Tuvalu ratified the UN Framework Convention on Climate Change (UNFCCC) on October 26 1993 and has submitted its Initial National Communication (INC) to the UNFCCC on 30 October 1999. Tuvalu has also ratified the Kyoto Protocol of the UNFCCC on 16 November 1998. Following the preparation of its INC and Phase II enabling activities, the country has initiated efforts to create an institutional set-up that seeks to mainstream climate change issues into the national legal frameworks. Moreover, its INC provides compelling evidence that, by global standards, Tuvalu is one of the countries most vulnerable to climate change and sea-level rise.

17. Ratification of the UNFCCC is one step forward in terms of commitment to addressing climate change and related issues. Tuvalu is also a Party to many other UN conventions, such as those, among others: Convention on Biological Diversity, the Cartagena Protocol for Biosafety, the Stockholm Convention for Persistent Organic Pollutants, and Convention to Combating Desertification.

18. At the national level, the proposed project will have strong linkages to a number of on-going UNDP-GEF enabling activities such as Tuvalu's National Capacity Self-Assessment (NCSA) activities, National Biodiversity and Action Plan (NBSAP), National Sustainable Land Management Project (SLM) as well as with other UNDP-funded activities in the area of sustainable energy including the proposed Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP).

19. Since the completion and submission of the INC, Tuvalu has embarked on the implementation of sustainable development programmes which have strong linkages to its reporting commitments under other multilateral environmental agreements. These reports include its contribution to World Summit on Sustainable Development (WSSD) and Johannesburg Plan of Implementation (JPOI), Barbados Programme of Action for Small Island Developing States (BPoA) and the International Meeting on the Review of the Barbados Programme of Action (IM), National Strategy and Action Plan (NBSAP) under the Convention on Biological Diversity (CBD).

SUSTAINABLE DEVELOPMENT STRATEGY

20. Sustainable Development Strategy is framed in Te Kakeega II: National Sustainable Development Strategy 2005-2015. The strategy is centered on the Millennium Development Goals (MDGs) including the challenges Tuvalu is facing at present and those that the nation will face in the decades to come. The national commitment to achieve the MDGs is embodied in the *Malefatuga* Declaration. Four policy objectives are of particular relevance to climate change adaptation interventions in Tuvalu:

- a) Improving the quality of life for every Tuvaluan;
- b) Providing enabling environment for employment and private sector development;
- c) Strengthening human capacity; and
- d) Ensuring sustainable management and conservation of Tuvalu's natural resources and protection of the environment.

2.2 Stakeholder Analysis

Process and approach used

21. The consultations on Pacific Adaptation to Climate Change (PACC) were conducted by the PDFB team¹ and involved eight stakeholder consultations and workshops and several focus group meetings. Three approaches were used to solicit and collect information from various ministries, agencies, institutions of government and non-government organizations:

- a) Gathering of information (including policy documents) relating to the activities, programmes and projects from various government ministries, departments and agencies,
- b) Meetings/consultations and workshop held with representatives of relevant ministries, agencies institutions of government and non-government organizations,
- c) A national consultation workshop on PACC priorities.

22. The consultations were focused on the activities relating to adaptation and other related issues such as institutional arrangements, and opportunities for promoting synergy between the various activities and organizations, priorities for PACC activities, consistent with the UNDP and GEF guidelines/criteria for adaptation activities. Specific issues covered in the meetings and consultations included all elements of project implementation including policy/regulatory framework to integrate adaptation within the design and implementation of development activities; institutional framework; information and knowledge; stakeholder involvement and co-financing possibilities.

Institutions and individuals involved/consulted

23. A total of four ministries, agencies and institutions of government and non-government organizations involving 10 experts were consulted during the in-country consultations and workshop. These consultation workshops provided the opportunity for all individuals and organizations to be informed about PACC objectives, priorities and activities and also to consider some of the common elements or priority activities for adaptation implementation. The consultation meetings were usually carried out over 1-2 hour sessions. Thus, in total 8 hours of consultations were held spread over four days.

¹ Chief Technical Adviser, UNDP Programme Officer and GEF Expert Consultant

Department of Environment

24. The PACC Consultation Team paid courtesy visits to the Director of Environment and staff of the Climate Change section. Briefing from the PACC Consultation Team (PCT) emphasized the need for Tuvalu to firm up the priority thematic area for PACC that Tuvalu would like to focus on so that consultations would be more focused. The PACC project focuses on three thematic areas: water resource management, coastal management and infrastructure and food production and food security, however, Tuvalu was encouraged to develop adaptation activities in any one of these sectors due to inadequate funding to cover all three sectors.

25. Following some discussion on the thematic areas it was suggested that given the information and other sustainable development projects that are currently being implemented in Tuvalu PACC should focus on water resources management. This recommendation was based on the following considerations:

- a) In the area of coastal zone management , several donors have already provided support in that area. However, it was found that not many activities are being carried out in the coastal zone management sector except for some monitoring and coastal protection work.
- b) In the case of the food production and food security programme of government, the Technical Corporation Programme (TCP) of FAO and SPC's DSAP project, and ROC Technical Cooperation on food production are currently being implemented to address, among others, food security issues.
- c) Water resources is a serious concern for communities/villages in Funafuti, where it often experiences water shortages caused by drought and low rainfall as it relies almost entirely on rainfall catchments.
- d) Prior assessment work has been carried out by the Public Works Department on the quantity (supply) of water including infrastructure and the vulnerabilities that the people are facing; and,
- e) Co-financing of PACC activities for water resources management can easily be obtained from the government and other donors working on water resources management.

26. Additional meetings were held In addition to the meeting with the Project Coordinators of the National Adaptation Programme of Action (NAPA) and the International Waters Programme (IWP) to ascertain the kind of activities being undertaken, programme priorities being selected, and whether or not these could be aligned and /or integrated with the proposed thematic area for PACC-TUVALU. NAPA process, based on community consultations to identify urgent and immediate needs for adaptation, showed that coastal protection is of highest priority while food security is the second highest priority. However, at present there is no funding available either from the government or donors to implement coastal protection work thus making it difficult to raise co-financing for PACC activities. With respect to the International Waters Programme, PCT was informed that an integrated water resources management plan has been drafted which would enable multi-stakeholder involvement and participation in water resources management.

Department of Lands and Surveys

27. A meeting was held with the Department of Lands and Surveys on PACC project. At the outset the PCT informed the department that the meeting with Department of Environment already identified water resources management (WRM) as a thematic area for adaptation intervention in Tuvalu under PACC. In

response the Secretary of Department of Lands and Surveys endorsed the proposed thematic area of WRM. He further noted that WRM issues are critical for the Funafuti island where most of the population of Tuvalu is concentrated. He also outlined the activities that are being carried out by the department particularly on coastal changes and beach profiling and a pilot study to investigate dredging of the Funafuti lagoon for aggregates. He further stressed that at present there is no coherent land use planning policy and that most land is leased to the government for infrastructure development.

Public Works Department

28. The meeting with the Public Works Department reaffirmed that water resources management on Funafuti Island is of particular concern. It was pointed out that while there is adequate water supply on the island, the biggest problem has been the lack of adequate water storage facilities. This lack of storage capacity renders Tuvalu highly vulnerable to extreme events such as droughts and tropical cyclones and associated storm surge, wave over-topping. Thus adaptation activities relating to water resources management on Funafuti island would be essential over the long term.

Department of Agriculture

29. Consultation meeting with the Director of Agriculture indicated that many projects that are currently being implement and/or planned for Tuvalu are supported and financed by donor organizations including, through FAO/Technical Cooperation programme on rat control, the DSAP programme on farming systems, and the Republic of China's programme on home gardening of vegetables. Agriculture is considered a high priority sector but funds allocated to it are not commensurate with such priority. The PCT outlined the purpose and objectives of the PACC project and indicated that the proposed thematic area for adaptation activities in Tuvalu will be water resources management given its sensitivity to climate change and sea-level rise.

Wrap up meeting with Stakeholders

30. The PCT presented their findings at a luncheon meeting with the stakeholders and the National Climate Change Committee. The agenda focused mainly on the proposed focus for Tuvalu as well as the proposed institutional arrangements. Issues that have been raised and agreed upon included:

- a) The endorsement of Water Resources Management thematic area for PACC in Tuvalu (PACC-TUVALU) as well as the proposed pilot location of Funafuti Island.
- b) The expected size for PACC-TUVALU pilot is around USD500,000.
- c) The expected ratio for co-financing to be applied in this pilot project is 1:4 (i.e. for every dollar of the GEF resources there should be four dollars from other sources).
- d) On institutional arrangements, the meeting agreed that the project management unit be set up directly under the Department of Environment, with the NCCC as the advisory body on technical and management issues. The terms of reference (TOR) for the PMU and management arrangements will be developed and will include a provision for the PMU to be accountable to the NCCC, UNDP and SPREP for the project.

2.3 Climate Change Programmes, Project and Activities

31. A number of climate change programmes, projects and activities have been carried out in Tuvalu since the entry into force of the UNFCCC. Tuvalu implemented an enabling activity project on the preparation of its initial national communication under the UNFCCC and completed a Phase II enabling activity project (top-up). Tuvalu submitted its initial national communication to the UNFCCC on November 30 1999. The country is currently carrying out its national capacity self-assessment to identify capacity needs for the implementation of the UNFCCC and has initiated a process for the preparation of its second national communication under the UNFCCC. It also participated in the regional mitigation project known as Pacific Islands Renewable Energy Project (PIREP) funded by the GEF. The project was completed in 2005 with the development and entry into the pipeline of a full-size project on Pacific Islands Greenhouse Gas Abatement and Renewable Energy Project.

32. Tuvalu is currently completing its national adaptation programme of action with support for the GEF. A total of 16 adaptation projects have been identified in the areas of coastal zones and resources, water resources, human health, fisheries, agriculture and natural disasters.

VULNERABILITY AND ADAPTATION

33. Within the context of Tuvalu's initial national communication a vulnerability and adaptation assessment was conducted to determine what is known about the possible effects of climate and sea-level change, possible adaptation to these effects and the resultant vulnerabilities; identify gaps in knowledge in determining climate and sea-level change effects, adaptation options and vulnerability; and identify national needs and priorities to prepare for climate and sea-level change.

34. The results of the vulnerability and adaptation assessment indicate that key development sectors will likely be affected by climate change and sea-level rise. These sectors include water resources, agriculture, coastal areas and resources, fisheries and human health.

ADAPTATION

35. Management of water catchments so as to maintain water quality and supply will minimize climate change impacts on water resources while providing immediate human benefits in areas that already suffer seasonal shortages and helping to maintain environmental quality. Improved management and maintenance of water supply networks to reduce wastage will lead to a reduction in water supply. Extension initiatives that promote water conservation and moderate usage, while raising awareness of the importance of water resource management, will also help to maintain long-term water supplies. Expansion of rainwater storage capacity, frequently through the installation of water tanks will reduce the vulnerability of communities in times of water shortage.

III. SECTORAL ANALYSIS

36. The principal objective of Pacific Adaptation to Climate Change (PACC) is to facilitate the implementation of long-term adaptation measures to increase the resilience of a number of key development sectors in the Pacific island countries to the adverse impacts of climate change. The development sectors are food production and food security, water resources management and coastal zone management and its associated infrastructure. Given limited financial resources the countries have been encouraged to focus only one of the three development sectors where adaptation intervention would be essential. The in-country consultations in Tuvalu would also determine detailed adaptation activities and baselines in each country.

3.1 Methodology/criteria for the selection of priority sector

37. Given that PACC would only support adaptation activities in one of the three main development sectors of food production and food security, water resources management and coastal zone management and associated infrastructure it was necessary to select one of these priority areas for adaptation intervention. In order to facilitate the selection of the priority area the following criteria was used for PACC priority sector. That the selected adaptation project or activities should have:

- a) A strong fit/alignment with the Tuvalu Government's existing programmes
- b) All necessary baseline assessments have been carried out, and additional activities are ready for implementation, and,
- c) Ability to co-finance and ability to deliver.

Thematic Area for Adaptation

38. Based on these three criteria and on the stakeholder consultations (see section 2.2) water resources management was selected as a priority sector for adaptation intervention in Tuvalu under the PACC project. Under this theme, an adaptation project entitled "*Piloting climate change adaptation in water resources management in Funafuti Island, Tuvalu*" was proposed. This project would focus on enhancing, and where necessary, developing water infrastructure for the whole island of Funafuti. The basic tenet is that the current water infrastructure design and management is not able to cope with changes in rainfall regimes including its storage, distribution and sustainable use thereby affecting potable water for consumption, agricultural production and industry as well as having adverse effects on livelihood of villages. Funafuti island (>5,000 popn) depends entirely on rainwater and therefore is highly vulnerable to changes in rainfall regimes and sea-level change (associated with extreme events) which affect the quality and quantity of potable water.

39. At present there is limited integration of climate change adaptation into sectoral development planning and budgeting processes relating water resources management and it is hoped that a project such as this will sensitize decision-making that will integrate climate change concerns into planning and budgetary processes over the long term.

3.2 Assessment of priority sector for adaptation activities

40. A number of adaptation options have been identified by a vulnerability and adaptation assessment conducted during the preparation of the initial national communication. These options deal with water issues in the country and linked to economic efficiency and environmental benefits, cultural and social suitability and practicability considerations. Because the water management and distribution is affected by extreme events (droughts, tropical cyclones) it would be necessary to include redesigning water infrastructure as part of ongoing activity of the water management system. In order to be able to effectively manage water loss education and awareness about water resource issues would also become a critical component.

41. Community education and awareness would not only prevent further water loss from leakage but also enhance and promote water conservation in communities. It has been widely recognized that only with the support and participation of the community at large, especially women and children, will the

small islands be able to reduce wastage and move towards sustainable development of their freshwater resources. Thus, an appropriate community information and education in this regard are most important and can be provided through public meetings, school presentations and radio broadcasts. It is essential that governments and water agencies recognize the need for community participation in water resources conservation, planning and management in order to preserve freshwater resources for future generations on small islands.

42. Demand management of water resources are generally more cost effective than alternative source development. Thus by reducing the demand for water or by ensuring more effective use of existing sources, there will be less pressure on limited water resources. In areas where water is supplied to the consumer, a pricing policy and water metering should be developed as an effective way of managing demand. This would lead to water conservation because people will only use water when they need it.

43. In the short, medium and long term, there are a number of adaptation options aimed at the development of additional or supplementary freshwater resources, or maximising the use of currently available resources. These options include:

- a) Expansion of rainwater collection schemes - These measures obviously add additional construction costs but as a long-term strategy they provide a means of 'climate proofing' to cater for future droughts especially on Funafuti Island which relies heavily on rainwater as a major source of water supply.
- b) Land use planning and water reserves - Effective land use planning and management is important for the protection of water storage facilities from contamination. Water reservoirs or 'engineered groundwater protection/storage zones' should be established and land use regulated. This will require negotiation between government and private landowners and agreement on appropriate administrative, legal and financial conditions.
- c) Dry sanitation systems - Dry sanitation systems can be used which does not use water for flushing, transport or treatment, which saves considerable quantities of water. Dry sanitation also avoids the considerable water loss through leaking toilet cisterns
- d) Coastal management and protection - Measures to protect coastal areas on small islands are an important component in the long-term sustainable management of islands, including the water resources. If island margins are eroded the area available for freshwater reservoirs may be limited.
- e) Desalination - Desalination is a relatively expensive and complex method of obtaining freshwater for small islands. The cost of producing desalinated water is almost invariably higher than 'conventional' options (e.g. pumping of groundwater) due to the high-energy costs and other operating costs. In Funafuti Island, two desalination plants were installed with support from the Government of Japan, to meet the water demand during the drought. However, the two desalination plants have already been providing water to communities/villages on the island. The cost of the operation per month is estimated to be AUD30,000, which is considered very expensive and is not sustainable in the long term.
- f) Importation of water - Importation of water from other country is one of the last options mainly due to very high cost involving therefore it is not recommended to the outer islands.

3.3 Current institutional and development baseline within priority sector

44. Tuvalu consists of nine low-lying, tropical coral islands, with limited land areas. Some islands lie within the cyclone belt and heavy storms experienced by its southern islands have produced islands composed of very coarse coral gravels and sands which cannot sustain substantial fresh groundwater lenses.

So, in Funafuti Island the principal source is from stored household and communal rainwater. The estimated demand for freshwater in its population centre on Funafuti is close to or exceeds the estimated sustainable rainwater yield making it vulnerable to variations in climate.

45. Estimates of mean annual rainfall in Tuvalu's nine islands are all greater than 2,700 mm. Thus, domestic rain tanks are the principal source of freshwater for both the urban centres on Funafuti and in the outer islands. Because of its location the variability of rainfall (expressed as the coefficient of variation, CV) is also lower than in neighbouring countries. Because of this, Tuvalu is one of the most advanced PIC in roof catchment development. There are very few dug wells in the country and their groundwater quality is generally thought to be poor particularly on Funafuti where contamination is a major concern. Despite large mean annual rainfalls and their low CV, droughts do occur, with an average frequency of once every 11 years. In these periods, rain tank systems fail. During drought period the estimated rainwater storage required is 34 m³/household. For Funafuti, the recommended storage is at least 18 m³ of rainwater using a minimum of two tanks for each household.

46. Community rainwater cisterns, which harvest rain from public buildings, are used during dry times to supplement household water supplies. When household storages run low, water is drawn from government or community owned cisterns, by either individuals or through water delivered by the Public Works Department's (PWD) 10,000 L tanker in Funafuti. PWD uses a two-tiered charging system for households or businesses, with no apparent penalties for excessive use of government deliveries. In Funafuti, demand for delivered water starts after one week of no rain. Indicating either low available storage or a lack of household water management skills and the need to improve demand management. The available rainwater storage throughout the islands, with the exception of Funafuti, is largely unknown. This makes it difficult for the PWD to assess the water situation during dry spells. There are concerns about the use of valuable rainwater by water-flushed toilets as well as leakage from septic tanks and pit latrines

47. Groundwater from dug communal wells is mostly used for stock or gardens. In outer islands, it is used for drinking when rainwater stocks are low. Poor quality groundwater could substitute water for rainwater use in toilet flushing or as a feedstock for desalination plants during emergencies. Infiltration galleries would decrease salinity in thin lenses. Useable brackish groundwater may exist in Funafuti atoll (Falkland, 1999). Potentially about 1.0 million m³ of groundwater of variable quality is available for extraction, however, little of this is in population centres on Funafuti. Reverse osmosis desalination plants have also been introduced into Tuvalu during droughts and following emergency declarations. Like elsewhere in the Pacific, these were only used in the short term as they were too expensive to run and too difficult to maintain and water importation from other islands or countries during droughts is expensive and problematic.

48. It appears that water resources management is carried out by many institutions and agencies of government and their roles and responsibilities are driven by their own mandates. Under the Kakeega II: National Sustainable Development Strategy 2005-2015, the government will provide through its Public Works Department "water supply services efficiently and economically" with a focus on urban areas. However there is no coherent national policy on water resources management which may be a reflection of the problems of water supply being dependent on rainwater catchments. Water supply, storage and infrastructure in the outer island of Tuvalu is the responsibility of the Department of Rural Development, Falekaupule and Kaupule.

3.4 Impacts of climate change on the priority sector

49. Previous work on vulnerability and adaptation assessment provides pertinent information on the impacts of climate change and sea-level rise in Tuvalu. Water resources are continuously affected by

droughts, and seawater intrusion. The GCM outputs indicate that that Tuvalu will be experiencing an increase in atmospheric temperature ranging from 0.5 to 2.2 degrees C in 2050 to 0.9 to 4.5 degrees C in 2100 (scenario 1) with 95% change in rainfall by 2100. Under scenario 1, there will be a great increase of about 95% in rainfall by the year 2100. Based on historical events, following analogues for considering 'effects of variability and extremes in combination with mean changes in climate are used. Tropical cyclones have continued to hit Tuvalu at a rate of 1-2 every 50 years. The most recent severe one was Cyclone BEBE in 1972.

50. The effect of climate change and sea-level rise on coastal zones and resources would be significant. Thus land loss, shoreline retreat, coastal erosion and wave-overtopping would affect beach vegetation and mangrove forest which act as buffers against such extremes. Much of the infrastructure and socio-economic activities in Tuvalu are located near or on the coast which makes them highly vulnerable to effects of climate change and sea-level rise. Changes in temperature and rainfall are likely to affect human health through incidences of vector-borne and water-borne diseases. Additionally frequent and high intensity tropical cyclones could affect the economy and the livelihood of the people.

51. Tuvalu is affected by tropical cyclones and is susceptible to extreme climate events such as prolonged droughts associated with the ENSO events, coral bleaching and cause severe damage to socio-economic activities and infrastructure, agriculture and biodiversity.

3.5 Method for assessing priority sector baseline

52. Previous studies in Tuvalu, particularly following the 5 August 1999 proclamation of a State of Public Emergency for the island of Funafuti because of acute water shortages, have provided extensive lists of recommendations for water resource management in Tuvalu. Some of these have been recently re-emphasised under the International Waters Project. Six aspects of previous recommendations raise concerns. These are:

- a) The lack of a formal Draft Water Resources and Sanitation Management Bill and the Draft Tuvalu Water and Sanitation Plan.
- b) Knowledge on water resources, demand and storage is very limited, particularly in outer islands.
- c) Demand for delivered (government) water starts directly after a week of no rain.
- d) Average demand in Funafuti appears slightly higher than the estimated average yield of rainwater storages and that average per household storage is about 40% of that required for a 1 in 11 year failure rate.
- e) The very limited use of groundwater, which in some islands appears a substantial resource, and
- f) Water use by freshwater-flushed toilets and leakage from septic tanks and pit latrines.

53. These indicate that Tuvalu is extremely vulnerable to climate variability and change. Suggested priorities for water in Tuvalu following from studies carried out previously include the following:

- a) Establish a sound institutional basis for the management of water and sanitation (policy, regulations, incentives, plans, organisational reform and responsibilities).
- b) Increase capacity to manage water and sanitation and predict water related extreme events (household and community).
- c) Improve knowledge of available water resources, demand and prediction of extreme events.
- d) Improve water conservation and demand management strategies.

- e) Increase household and communal rainwater storage.
- f) Increase the use of groundwater.
- g) Improve sanitation systems.

3.6 Determination of additional adaptation activities

54. Due to the poor quality of groundwater in Funafuti Island (Capital of Tuvalu), much of the population (4,800 people) depends entirely on rainwater for consumption and other uses. Heavy reliance on rain water makes Funafuti highly vulnerable to variations in rainfall regimes. A period of 2-3 weeks of drought (i.e. period of no rainfall) on Funafuti can cause serious shortage of water as the water levels in many of the holding tanks and reservoirs reduce in volume by up to 50%. This situation is exemplified by the ENSO-forced drought of 1997/1998 which forced the government to declare a State of Emergency and also to purchase a costly desalination plant with support from the Government of Japan. The original purpose of desalination plant was to provide additional water supply in times of drought and other natural disaster emergencies. However, information of late on water sources indicates that a large population is now dependent on water supply from desalination plant which has an operational cost of AUS\$30,000 per month²

55. ENSO events have been experienced (i.e. warmer, drier conditions) with greater frequency over the last two decades. So, in Funafuti Island the principal source is from stored household and communal rainwater. The estimated demand for freshwater in its population centre on Funafuti is close to or exceeds the estimated sustainable rainwater yield making it vulnerable to variations in climate. Estimates of mean annual rainfall in Tuvalu's nine islands are all greater than 2,700 mm with domestic rain-tanks as the principal source of freshwater for both the urban centres on Funafuti and in the outer islands. Because of its location the variability of rainfall (expressed as the coefficient of variation, CV) is also lower than in neighbouring countries. Because of this, Tuvalu is one of the most advanced PIC in roof catchment development. Despite large mean annual rainfalls and their low CV, droughts do occur, with an average frequency of once every 11 years. In these periods, rain-tank systems fail. During drought period the estimated rainwater storage required is 34 m³/household. For Funafuti, the recommended storage is at least 18 m³ of rainwater using a minimum of two tanks for each household. Given the high likelihood of droughts associated with ENSO and future climate change and sea-level rise it is critical for Tuvalu to enhance the resilience and adaptive capacity through the management of climate risks in water resources. The GEF assistance will enhance adaptive capacity of villages/communities and socio-economic activities to climate change and sea-level rise by addressing climate change risks in water resources management

IV. MECHANISM FOR DELIVERY OF FSP

4.1 Institutional Arrangements

56. All climate change programmes, projects and activities are being coordinated by the Department of Environment (DoE). The DoE has two full-time staff who carry out tasks/activities relating to climate change in the country such as the preparation of climate change enabling activities (e.g. phase II enabling activity, and second national communication) and the national adaptation programme of action (NAPA). The DoE also serves as a secretariat for the National Climate Change Committee (NCCC).

² Public Works Department Report, 2005

57. Under the PACC-TUVALU project, the DoE will continue to coordinate climate change activities relating to PACC. Given that PACC is focused on implementation of adaptation activities, the implementing agency for PACC-TUVALU will be the Department of Environment (DoE) who will also serve as secretariat to the NCCC on issues relating to the implementation of PACC-TUVALU.

58. In addition to the implementation of PACC-TUVALU, DoE will host at least two full-time staff that will provide the day-to-day operation of the PACC-TUVALU. These two full-time staff will be part of the PACC Project Management Unit (PMU). The PMU will be directly responsible to the Director of Environment.

59. At the national level, PACC-TUVALU will be implemented by various stakeholders within their respective mandates while scientific, technical and policy oversight will be provided by the NCCC. The NCCC comprises representatives from various government ministries, agencies and institutions. Other partners in the project will include Department of Lands and Surveys, Tuvalu Meteorological Services, Public Works Department, Ministry of Health, Ministry of Agriculture, Ministry of Finance, Funafuti Town Council, villages/committees.

4.2 Assessment of existing and potential barriers to implementation of adaptation

60. PACC-TUVALU is underpinned by Kakeega II: National Sustainable Development Strategy 2005-2015, the government will provide through its Public Works Department “water supply services efficiently and economically” with a focus on urban areas.

61. A number of climate change enabling activities (e.g. national communication and NAPA) have also involved numerous organizations, institutions and individuals in carrying out various tasks and activities. These activities have been supported by the National Climate Change Country Team through the provision of scientific, technical and policy oversight and guidance. Thus many of the roles and responsibilities have been clarified. However some barriers still remain and will have to be overcome in order to improve delivery of the PACC-TUVALU. Some of these barriers include, competing demands on staff time, inadequate staff resources, equipment, and lack of incentives.

62. Lack of capacity (human, systemic, institutional, financial and technical) constrains the sharing of information and knowledge particularly of climate change and adaptation issues which makes the integration of climate change adaptation into sustainable development prohibitive. A project of this kind will more than likely make the integration of climate change into sectoral planning possible.

V. EXPECTED GOAL, OUTCOMES, OUTPUTS AND ACTIVITIES

63. The main goal of this project is to “increase the resilience of the water resources management sector and to enhance adaptive capacity of villages/communities and socio-economic activities to climate change and sea-level rise.” This goal will be achieved through a project “Piloting climate change adaptation in water resources management in Funafuti Island focusing on sustainable use and management of water resources. The implementation of adaptation activities in water resources management will entail the implementation of water conservation, water use efficiency, rainwater harvesting and storage. Adaptation interventions will include (soft) non-structural and structural (hard) options that compliment each other.

64. Based on the priorities outlined in paragraph 52 above, and the experiences in the Pacific, a range of adaptation actions and/or strategies have been proposed for Tuvalu Water Resources Management. The main goal of this project is *to improve the resilience of communities in Funafuti and their water supply systems and to reduce their vulnerability to climate variability and change*. This project is consistent with the Pacific Regional Action Plan of Sustainable Water Management.

Goal:

65. The main goal of this project is to enhance the capacity of Tuvalu to adapt to climate change, including variability, in selected key development sectors.

Objective:

66. The main objective of this project is to “increase the resilience of coastal zones and its associated infrastructure”. This goal will be achieved through a project “Piloting climate change adaptation in coastal zone management and airport redevelopment in Manihiki Island, Cook Islands.” This project will also focus on enhancing, and where necessary, increasing the resilience of coastal communities, socioeconomic infrastructure and activities in a small island.

Specific Outputs

Output 1.1: Relevant plans and programmes incorporate climate risks in the water sector in Tuvalu.

Output 2.1. Practical guidance to climate proof current integrated water management plan.

Output 2.2. Measures identified in 2.1 to climate proof current integrated water management plan demonstrated.

Description:

Output 1.1: Relevant plans and programmes incorporate climate risks in the water sector in Tuvalu.

This will include integrating climate change into key development sectors that are highly vulnerable to climate change which include; agriculture, water, and coastal management. At the national level, work in climate variability and change is still the ‘domain’ of Meteorology Services, Environment Departments and National Disaster Agencies but the impacts are being felt by other agencies e.g. Fisheries, Agriculture, Forestry, Physical Planning, and Public Works. To mainstream key climate change issues into development plans of government sectors, a number of critical steps would be followed, which requires collaborative analytical and policy inputs from a number of different technical experts and domestic partners. Critical components of mainstreaming include: review of the NSDS and its role in national development; the identification of the strengths, weaknesses, gaps, responses to strengthen specific sectoral management (problem tree analysis and objective/ solution identification); the review of the link between sectoral plans and NSDS and the relationship between sectoral medium term budget and the medium term national fiscal expenditure and revenue budget; and strengthening of sector level budgeting that reflects outcome focused priorities and national development goals.

Specific activities to be undertaken would include:

- Promote and support dialogue, exchange of information and coordination amongst early warning, disaster risk reduction, disaster response, development and other relevant agencies and institutions at all levels, with the aim of fostering a holistic and multi-hazard approach towards disaster risk reduction.
- Development or customizing of a mainstreaming methodology that takes into consideration climate change technical and policy frameworks and issues;
- Forming of a Mainstreaming Team to work with key government sectors to mainstream climate change issues into key sectoral plans and policies;
- Countries to form V&A Teams comprising people in various agencies and institutions who can collaborate, integrate their work and be the main contact points in the various agencies to champion adaptation approaches and initiatives. Once the teams are formed a range of capacity building initiatives to be developed in the next component can be implemented.
- Mainstream climate change risk considerations into planning procedures, especially for major infrastructure projects, including the criteria for design, approval and implementation of such projects and considerations based on social, economic and environmental impact assessments.

Output 2.1. Practical guidance to climate proof current integrated water management plan.

Output 2.2. Measures identified in 2.1 to climate proof current integrated water management plan demonstrated.

82. This output will assist the Department of Public Works and the Department of Environment to develop their capacity to climate proof current and future integrated water management plans taking into consideration current and future changes in climate. Tuvalu does not have above-ground water source and relies largely on precipitation, desalination and underground water. It is critical that Tuvalu institutes a strong water conservation programme as well as look for alternative ways of reducing fuel expenses from desalination. The choice of which combination of methods to use will depend on local conditions, but a strong program of conservation is essential. Capacity training and application of vulnerability and adaptation assessments using climate information, design and demonstration of an approach to climate proof the water supply systems, and design and demonstrate ways to improve water retention capacity as a long-term strategy and a means of ‘climate proofing’.

83. Tuvalu is an extremely small, isolated atoll island nation, aligned in a northwest-southeast orientation; dispersed within the central Pacific Ocean; and categorized as a Least Develop Country (LDC) due to its relatively low national income; weak human resources; and extreme economic vulnerability to external stresses. It consists of five true atolls and four raised limestone reef islands, with a total land area of approximately 26 km². The highest point in Tuvalu is 4.0m above mean sea level. Several climate change related risks have been impacting on Tuvalu for many years now, which include sea level rise, drought and rise in sea surface temperature. Sea level rise ranks highly due to the unusually high King Tides³ that have been plaguing Tuvalu for a number of years now leading to flooding of dwellings and intrusion of salt water into the freshwater lens impacting

³ King Tides are exceptionally high tides which occur with the coming of the full and new moon.

adversely on food security, water, health and general living conditions of Tuvaluans. According to the recently completed National Adaptation Programme of Action (NAPA, 2007) for Tuvalu, drought is on the increase and it is closely associated with the frequency of ENSO, which brings erratic and periods of low rainfall to Tuvalu. This climate related risks coupled with anthropogenic stresses due to over-consumption and increase in population, has impacted severely on Tuvalu's ability to maintain a quality water supply for its population. Efforts need to be put in place now to address these risks and the efforts to be addressed under PACC would go in some way to address some of the many vulnerabilities facing Tuvalu. The Government of Tuvalu has committed USD 1.5 million to continue to improve on the retention capacity of water in Tuvalu. Activities to be undertaken would include:

- Plan and conduct community-base vulnerability assessments in relation to drought events and identify adaptation options.
- Develop a guide for climate proofing existing water reservoirs and water tanks taking into consideration current and future changes in climate
- Improve knowledge of available water resources, demand and prediction of extreme events.
- Develop and use climate information and data for water resources planning and management
- Design and demonstrating alternative water supply systems using energy efficient technologies;
- Expansion of rainwater collection schemes as a long-term strategy and a means of 'climate proofing' to cater for future droughts
- Land use planning and water reserves - protection of water storage facilities from contamination.
- Establish and regulate water reservoirs or 'engineered groundwater protection/storage zones.

PROJECT LOG FRAMES AND INDICATORS

Project Log Frame and indicators for Tuvalu would be finalized during the inception meeting of the PACC project.

Outcome 4			88,758	17752	17752	17752	17752	17750	88,758
Subtotal			88,758	17752	17752	17752	17752	17750	88,758
Total			746,158	153,732	173,832	174,332	140,932	103,330	746,158

SELECTED REFERENCES

- Adger, N., Mace, M.J., Paavola, J., and Razzaque, J., 2003: Justice and equity in adaptation. *Tiempo* 52, 19-22.
- Adger, W. N., S. Huq, K. Brown, D. Conway, M. Hulme, 2003: Adaptation to climate change in the developing world. *Progress in Development Studies*, 3 (3), 179-195.
- ADB (Asian Development Bank) 2004: *Environmental Pacific Regional Strategy, 2005-2009*, ADB Manila, Philippines, 105 pp
- Barnett, J., 2001: Adapting to climate change in Pacific Island Countries: The problem of uncertainty. *World Development*, 29, 977-993
- Brazdil, R., T. Carter, B. Garaganga, A. Henderson-Sellers, P. Jones, T. Carl, T. Knustson, R.K. Kolli, M. Manton, L.J. Mata, L. Mearns, G. Meehl, N. Nicholls, L. Pericchi, T. Peterson, C. Price, C. Senior, Q.C. Zeng, and F. Zwiers, 2002: *IPCC Workshop on changes in extreme weather and climate events*, Workshop Report, Beijing, China, 11-13 July, 2002, 41- 42. Accessed 15.11.2004 at <http://www.ipcc.ch/pub/extremes.pdf>
- Burns, W.C.G., 2002: Pacific island developing country water resources and climate change. In *The World's Water (3rd Edition)*. P. Gleick (ed), pp. 113-132.
- Finin, A.g. 2002. Small is viable: The Global Ebbs and Flows of a Pacific Atoll Nation. Pacific Islands Development Series 15. East-West Center, Honolulu, Hawaii.
- Folland, C.K., J.A. Renwick, M.J. Salinger, N. Jiang, and N.A. Rayner, 2003: Trends and variations in South Pacific Islands and ocean surface temperatures. *Journal of Climate.*, 16, 2859-2874
- Folland, C.K., J.A. Renwick, M.J. Salinger, and A.B. Mullan, 2002: Relative influences of the Interdecadal Pacific Oscillation and ENSO on the South Pacific Convergence Zone. *Geophysical Research Letters*, 29, 21-1-21-4
- Griffiths, G.M., M.J. Salinger, and I. Leleu, 2003: Trends in extreme daily rainfall across the south pacific and relationship to the South Pacific convergence zone. *J. Climatol.*, 23, 847-869.
- Government of Tuvalu, 2002. Review of Priority Environment Concerns in Tuvalu, International Waters Programme, South Pacific Regional Environment Programme, Apia, Samoa.
- Government of Tuvalu, 2006. Tuvalu's National Adaptation Programme of Action, Funafuti, Tuvalu.
- Government of Tuvalu, 1999. Initial National Communication under the UNFCCC, Funafuti, Tuvalu.
- Hunter, J. R. 2002. A note on relative sea level change at Funafuti, Tuvalu. Antarctic Cooperative Research Center, Hobart, Australia.
- IPCC, 2001: *Climate Change 2001: The Scientific Basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881 pp.
- Lal, M., 2004: Climate change and small island developing countries of the South Pacific, *Fijian Studies, Special Issue on Sustainable Development*, V2(1), 15-31.
- Manton, M.J., P.M. Dellaa-Marta, M.R. Haylock, K.J. Hennessy, N. Nicholls, L.E. Chambers, D.A. Collins, G. Daw, A. Finet, D. Gunawan, K. Inape, H. Isobe, T.S. Kestin, P. Lefale, C.H. Leyu, T. Lwin, L. Maitrepierre, N. Oprasitwong, C.M. Page, J. Pahalad, N. Plummer, M.J. Salinger, R. Suppiah, V.L. Tran, B. Trewin, I. Tibig, and D. Yee, 2001: Trends in extreme daily rainfall and temperature in southeast Asia and the south Pacific: 1961-1998. *J. Climatol.*, 21, 269-284.
- Nurse, L., G. Sem, J.E. Hay, A.G. Suarez, P.P. Wong, L. Briguglio and S. Ragoonaden, 2001: Small island states. . In: *Climate Change 2001: Impacts, Adaptation, and Vulnerability*. J.J. McCarthy,

- O.F. Canziani, N.A. Leary, D.J. Dokken, and K.S. White (eds.). Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 842-975.
- Nurse, L., and R. Moore, 2005: Adaptation to global climate change: an urgent requirement for Small Island Developing States. *Review of European Community and International Law (RECIEL)*, 14 (2), 100-107.
- Patel, S. S., 2006. A Sinking Feeling, *Nature* 440(6).
- Pelling, M., and J.I. Uitto, 2001: Small island developing states: natural disaster vulnerability and global change. *Environmental Hazards*, 3, 49-62.
- South Pacific Geoscience Commission, 2006. Coastal change analysis using multi-temporal image comparisons- Funafuti Atoll, EU/EDF9 – SOPAC Project 54. Suva, Fiji.
- White, I. 2005. AusAID Pacific Vulnerability and Adaptation Project: Tuvbalu Water Management Activity, Center for Resources and Environmental Studies, Australian National University, Canberra, Australia.
- World Bank, 2000: *Cities, Seas and Storms: Managing Change in Pacific Island Economies. Vol. IV, Adapting to Climate Change*. World Bank, Washington, D.C. 72 pp.
- World Bank, 2002: *Cities, Seas and Storms: Managing Change in Pacific Island Economies*. World Bank, Washington, D.C.
- World Bank, 2006: *Not If, But When: Adapting to Natural Hazards in the Pacific islands Region: Policy Note*. World Bank, Washington, D.C., USA, 60 pp.

ANNEXES

Letter of Co-Financing (to be attached)