



PACIFIC ADAPTATION TO CLIMATE CHANGE

NIUE ISLAND

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 (although this is not necessarily true for Niue Island); 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 Niue (Long 175° East and 178° West and lat. 15° and 22° S) 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 were detected 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 Niño, 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 Niño event compared to a La Niña event and vice versa (Brazdil *et al.*, 2002).

5. Past studies of adaptation options for small islands have been largely focused on adjustments to sea-level rise and storm surges associated with tropical cyclones. There was an early emphasis on protecting land through ‘hard’ shore-protection measures rather than on other measures such as accommodating sea-level rise or retreating from it, although the latter has become increasingly important on continental coasts. Vulnerability studies conducted for selected small islands (IPCC, 2001) show that the costs of overall infrastructure and settlement protection is a significant proportion of GDP, and well beyond the financial means of most small island states. More recent studies since the TAR have identified major areas of adaptation, including water resources and watershed management, reef conservation, agricultural and forest management, conservation of biodiversity, energy security, increased share of renewable energy in the energy supply, and optimized energy consumption. Proposed adaptation strategies have focused on reducing vulnerability and increasing resilience of systems and sectors to climate variability and extremes through mainstreaming adaptation.

6. The need to implement adaptation measures in small islands with some urgency has been recently reinforced by Nurse and Moore (2005), and was also highlighted in the TAR where it was suggested that risk-reduction strategies together with other sectoral policy initiatives in areas such as sustainable development planning, disaster prevention and management, integrated coastal zone management and health care planning should be employed. Since then a number of projects on adaptation in several small island states and regions have adopted this suggestion. Projects aim to build capacities of individuals, communities and governments so that they are more able to make informed decisions about adaptation to climate change and to enhance their adaptive capacity in the long run.

7. 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. These issues are particularly applicable to small islands, which have a low capacity to deal with, or adapt to, such impacts.

8. Thus an adaptation strategy for the Pacific islands and indeed for Niue Island 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)

9. 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. Niue, as one of the participant 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.

10. 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 report

11. As one 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 the Niue in-country consultations on PACC which were held from August 28 to September 01, 2006. The report is divided into five sections: section 1 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 the Niue 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 PACC-Niue 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

12. Niue is the world's largest and highest single coral atoll situated in the Southwest Pacific Ocean (19°S, 169°W), with a land area 259 km². It is approximately 480 km east of Tonga, 930 km west of Rarotonga and 660 km southeast of Western Samoa. Within its Exclusive Economic Zone (EEZ) of 39,000 km², Niue has two reef atolls, Antiope and Beveridge, visible only at low tide, from which commercial fishing is banned. However, a number of seamounts also exist and these attract plentiful fish.



Figure 1: Location of Niue Island

13. Niue Island is comprised of three terraces, the rim of the lower terrace averages 28 m above sea level, with the upper rim averaging 69 m above sea level. The slopes of the terraces are rough, with jagged coral outcrops, which are dissected by many crevices and holes with large boulders, scattered randomly by wave actions during hurricanes. The island has a rugged rocky

coastline, featuring steep cliffs, caves, deep chasms and blowholes. The reef is continuous, and is breached at one small area opposite the Alofi wharf (NEMS 1997).

14. There are 14 villages scattered around the coasts of the island, of which Alofi is the capital. Most villages are within walking distances of each other, especially the western-most coastal villages. A coastal circuit road passes through all villages. There are also two major cross-island roads both of which are sealed. Roads are also sealed within each village, and the circuit road is sealed along the west and south coasts (Figure 1).

15. There is no natural sheltered harbour, though the open roadstead in Alofi Bay is to the west of the Island, in the lee of the prevailing easterly trade winds. The roadstead is served by a wharf, which accommodates smaller vessels otherwise cargo is transferred by lighters. There is a 2,335 m runway in asphalt concrete. Currently there are twice weekly flights to Niue from Auckland (via Apia, Samoa).

16. There is no surface water on Niue, but bores enable a fresh groundwater resource to be tapped for domestic, commercial and agricultural purposes. Current land clearing and farming practices and inadequate waste disposal system pose a potential threat to the present water quality.

17. There are two distinct seasons in Niue: the hot or wet season from December to March and the cool or dry season from April to November. The average annual rainfall is approximately 2,180 mm, but it can vary from 810 to 3,300 mm. The bulk of rainfall is concentrated in the hot season often delivered in torrential downpours, which account for 68% of the total annual rainfall. At this time both temperature and humidity are high, with average temperature at 27⁰C. The cool season is characterised by warm sunny~ days and cool nights, with temperatures averaging 24⁰C. Annual average temperature does not vary greatly throughout the year due to the influence of the sea on a small low-lying island. The annual rainfall pattern is erratic, with very dry or very wet months possible at any time of the year.

18. As Niue is situated near the edge of the tropical cyclone belt, it is subject to gale force winds during the hot season. Indeed, cyclones strike at irregular intervals, the most recent one being Cyclone Heta in January 2004, which has caused devastation to people, properties, government and industry, infrastructure, agriculture and the economy with an estimated damage cost of more than US\$60 million (or NZ\$89.1 million). Since 1863 when records began more than 30 tropical cyclones affected Niue Island with a frequency of one severe cyclone within 2-15 years.

19. Droughts occur from time to time, impacting particularly on agriculture, as there is no irrigation system. Under climate change scenario, Niue is expected to experience drought conditions more frequently, especially in relation to the expected more frequent occurrence of El Niño.

20. The coral atoll origins of Niue Island has made soil conditions marginal for intensive agriculture and long-term monoculture. Much of the land is covered with fern growth, which again indicates the poor structure and nutrient content of the soils (NEMS 1997). Thus up to 40% of land is unsuitable for agriculture while those areas under cultivation are only at the subsistence level. Taro production evolved as a modest export product to New Zealand while other crops such as cassava, sweet potatoes and yam are also grown for subsistence. Small quantities of coconut, lime, banana, fruit and vegetables are also cultivated mainly for domestic use while vanilla crop is being developed as cash crop for export. Livestock raised include chickens, pigs, and a small number of cattle.

21. Niue's economy is dominated by the public sector accounting for approximately 51% of the total local employment, while private sector accounts for 25%, with 18% self-employed. Current development policy focuses on tourism and private sector development through increased employment opportunities and agricultural production as mechanisms to reduce aid dependency.

22. There has been considerable structural change in the economy since the early 1990s with the downsizing by more than 50% and coporatization or privatization of government activities. In 2000 GDP was \$14.2million, which equates to \$7,470 per capita. New Zealand provides almost 50% of the GDP through budget support programmes. New Zealand is the country's major trading partner, however there is a large trade imbalance with imports of approximately \$4million in 2002 compared with exports of approximately \$200,000. Export commodities consist mainly of taro, honey and small quantities of coconut, handicrafts and vanilla.

23. The economy suffers from the typical Pacific island problems of geographic isolation, few resources, and a small population. Government expenditures regularly exceed revenues, and the shortfall is made up by critically needed grants from New Zealand that are used to pay wages to public employees. The agricultural sector consists mainly of subsistence gardening, although some cash crops are grown for export. Industry consists primarily of small factories to process passion fruit, lime oil, honey, and coconut cream. The sale of postage stamps to foreign collectors is an important source of revenue. Efforts to increase GDP include the promotion of tourism and a financial services industry, although the International Banking Repeal Act of 2002 resulted in the termination of all offshore banking licenses. Economic aid from New Zealand in 2002 was about US\$2 million.

Environmental Planning, Management and Sustainable Development

24. In 1993, the government of Niue developed its National Environmental Management Strategy (NEMS) highlighting the importance in linking economic growth and environmental management in the development of the country. The scope of the NEMS was broad and included the development of appropriate environmental legislation, the development and implementation of environmental management, training and awareness programmes. The Niue State of the Environment Report (SOE) was prepared as a component of the NEMS and provided a comprehensive reference document for the state of the environment of Niue. This report summarized the extent of knowledge in relation to the environment of Niue in areas such as terrestrial environment, marine resources, cultural and archaeological resources and socio-economic environment; it also outlined the environmental challenges facing Niue. Ultimately, the SOE provided a vehicle to enhance the decision-making process.

25. The government of Niue demonstrated its commitment to Agenda 21 by adopting international legal instruments, which were strengthened by adoption of regional agreements. Despite the pressure placed on a limited workforce, Niue has achieved various stages of implementation of the various agreements.

26. A National Assessment was undertaken for World Summit on Sustainable Development in 2002. This assessment includes a sectoral review, which was adopted through a series of collective consultations and concerted efforts by the government of Niue and Civil Society. By involving essential stakeholders, government reaffirms the realisation that resource owners and users should play a direct role in how these resources should be used in a sustainable manner. Essential sectors identified have been prioritized for appropriate action in the future.

27. Niue's environmental legislation is embodied in its Constitution, various Acts of Parliament, Bills Ordinances and customary laws. Provisions pertaining to the environment include the establishment of an environmental institution (the Environment Unit), regulations and guidelines to control the use and to protect the natural resources. The Environment Unit's plan for 2001/02 has a goal of 'effectively managing our natural resources whilst promoting sustainable practices to ensure inter-generational equity.' Its objectives consist mostly of implementing environmental programmes or strategies, largely reacting to different regional and international activities. Among its immediate priorities is maintaining the Huvalu Conservation Area Project, following the end of the South Pacific Biodiversity Conservation Programme that initiated it. Overall, the lack of enacted legislation in the environmental area is seen as a major problem although some proactive work is taking place in community education.

28. An Environment Act 2003 provides a mechanism for the development of environmental policy and law, and establishes an Environment Department and a National Council for Sustainable Development, with one member from each of the following public authorities: Health, Planning, Police, Public Works, Community Affairs and the Tourism Office; two members from Agriculture, Forests and Fisheries; a member to be selected by the Chamber of Commerce to represent private sector commercial interest; two members to represent interest groups or the community generally, and the Director of Environment.

Vulnerability and adaptation

29. A number of important socio-economic development sectors have been identified as key to sustainable development of Niue. Climate change vulnerability and adaptation assessment undertaken as part of the preparation of initial national communication under the UNFCCC indicated that the following sectors would be severely affected by further climate change sea-level rise: coastal zone and coral reefs; agriculture; land use change and forestry; water resources; human health; biodiversity; and socio-economic impacts.

30. Climate change and sea-level rise scenarios for future changes also showed that there will be a warming trend in the decades to come. This trend is reflected strongly by ENSO phenomenon which has created a worst scenario for high warming trends in the Southern Hemisphere since the mid-1970s. Thus Niue will likely experience the strongest impact per capita due to its vulnerability and low adaptive capacity. The impact and experience of Cyclone Heta on Niue in 2004 has been beyond expectations.

31. Variations in rainfall and soil moisture can affect agricultural production, an activity most Niueans rely on for subsistence. Intense rainfall may cause seedling damage, leaching of important soil nutrients and increased competition of weeds in farmlands which may lead to increased use of and dependence on chemical fertilizers/pesticides or herbicides. Lack of soil moisture on the other hand can result increased evapotranspiration leading to a decline in crop yield. Cyclone Ofa in 1990 caused widespread damage to food crops and export bananas, copra and lime while the passion fruit export industry was totally destroyed. The worst recorded drought occurred between 1940 and 1944 when the annual rainfall was 23.6% below the mean for a five-year period and the 1925-26 and 1976-77 drought experienced a rainfall 32% below the mean for a two-year period.

Rainfall and moisture also affect the quantity and quality of water resources on Niue. There is no surface water and Niue depends entirely on its groundwater resources and catchment. The freshwater lens is estimated at 40-80m in thickness in the centre of Niue, while at the atoll rim it is between 50-170m and zero at the coast. Recharge of the freshwater lens is through rainwater infiltration. Based on the thickness freshwater lens it was estimated that approximately 4,000m⁻³

ha⁻¹ year⁻¹ is a safe yield while in an event of a drought freshwater/saltwater could be maintained at 25m below sea level with 222mm of rainfall as an effective recharge. However, in a more recent study by GWP Consultants, it is estimated that the lens thickness is typically 30-40m (i.e. 35m) with a recharge of 662 mm year⁻¹ (GWP 2006).

2.2 Stakeholder Analysis

Process and approach used

32. 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.

33. 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

34. A total of nine ministries, agencies and institutions of government in Niue involving 21 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 12 hours of consultations were held spread over five days.

35. The PACC Consultation Team (PCT) first had discussions with the Niue Meteorological Services which also coordinated the consultations in close collaboration with department of Environment. Briefing from the PCT emphasized the need for Niue to identify very early in the week on the priority thematic area for PACC it would like to focus on. The PACC project focuses on three thematic areas (water resource management, coastal management and

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

infrastructure and food production and food security) and Niue was encouraged to select a thematic area it would like to work on under the PACC so that further consultations would be much more focused.

36. The Director of Meteorological Services mentioned that all three thematic areas are important for Niue and the selection of only one of these would depend on the availability of information and data. He emphasized that while focusing on one thematic area it is also important to make the linkages between the various activities as all of these thematic areas are closely related. Water resources and food production and food security issues are closely related and could be developed under the PACC project for Niue.

Institutions and stakeholders consulted

<i>Institution</i>	<i>Stakeholders interests/responsibilities</i>	<i>Relevance to climate change/reasons for inclusion</i>	<i>Role in the consultation process</i>
GOVERNMENTAL INSTITUTIONS			
Department of Environment	<p>Implementing agency and operational focal of the GEF and other MEAs; UNCCD, CBD and others</p> <p>Responsibilities:</p> <ul style="list-style-type: none"> - management of the state of the environment; -national coordination of activities and programmes related to MEAs including implementation, monitoring and evaluations -issuance and vetting of projects including permits and environmental impact assessments - Managing or participating in any project, or part of a project, aimed at implementing any aspect of environmental concerns - Disseminating information to local stakeholders and creating public awareness on environmental concerns - Preparing reports, and information papers for the Minister and Cabinet in relation to the implementation of any Convention; -review and improvement of regulations, policies and strategies for implementing environmental concerns. - Provide technical support to any other relevant government department or agency) to implement any obligation under a Convention. 	<ul style="list-style-type: none"> - Member of National Climate Change Country Team (NCCCT) is established under the auspices of the Niue Meteorological Services (NMS). - Responsible for the preparation of the Environmental and Sustainable Development Strategy - Responsible for the NCSA. - Responsible for preparation of the National Biodiversity Strategy and Action Programme under the CBD - Contributed to the WSSD national report and the MDG report 	<ul style="list-style-type: none"> - Consultations on national priorities, Mainstreaming of climate change in national environmental strategies, programmes and other documents, and on current and planned projects. - Regular consultations with the UNFCCC partners for discussion of the proposal of the 2NC in terms of technical issues, opportunities for synergy among various projects and institutional arrangements. - Regular consultations on the needs and priorities for capacity-building F
Ministry of Agriculture, Forests and Fisheries	<p>Ministry responsible for development of agriculture products for export and local markets, forests and fisheries development.</p>	<ul style="list-style-type: none"> - Member of the NCCCT - Collaboration with Environment and Meteorological Services on policy and strategies on agricultural developments as they relate to crop productions, food security, land-use, resources management, vulnerability and adaptation assessment, use of chemicals and inorganic fertilizers, mitigation and other relevant climate change information and data. 	<ul style="list-style-type: none"> - Consultation on data needs for V&A assessment regarding agricultural crops including issues related to invasive species, chemicals usage, and policies review and development. - Discussions on climate-related activities within the agriculture sector - Discussions on possibilities for co-financing of adaptation activities within the agriculture, forests and fisheries sectors. - Discussions on possible areas/activities that could be funded under PACC project - identified food production and security as possible thematic area for adaptation intervention in Niue

<i>Institution</i>	<i>Stakeholders interests/responsibilities</i>	<i>Relevance to climate change/reasons for inclusion</i>	<i>Role in the consultation process</i>
Ministry of Health	- Responsible for public health activities in management, waste management, as well as surveillance and establishing early warning for vector-borne and water-borne diseases	- Member of the NCCCT	- Consultations on information and data on the health effects of changes in rainfall and temperature on public health
Meteorological Services	- Responsible for providing national meteorological services to the public - National Operational Focal point of the UNFCCC	- Chair and Member of the NCCCT - Responsible for all climate change –related activities in Niue - Coordinates and manages the preparation of Niue’s second national communication under the UNFCCC	- Consultations on strategies to enhance capacity-building on climate-related activities including data management activities and technologies including research and systematic observations applications, - Consultations to ascertain the activities that could be implemented under PACC
Public Works Department	- Responsible for design and development of infrastructure of public works and services in communities, roads, bridges, drainage, water works, energy inspection, and development, coastal zone protection and management, building standards and control, land survey information, and waste management.	- Member of the NCCCT -	- Undertakes climate change vulnerability and adaptation assessments, environmental impact assessment work, resource investigations and studies including mapping and planning, development of resources management policies, plans and regulations - Identified water resources management as possible thematic area for adaptation intervention in Niue
Police Department & National Disaster Management	- Responsible for the national disaster management office and national emergency operations centre and Public safety	- Member of the NCCCT - Responsible for preparation of the INC and its submission to the COP Responsible for pre disaster and emergency preparedness,	- Consultations on post disaster response and relief operations and potential for trainings and educational and awareness, including vulnerability and adaptation assessments, and hazards risks assessments.
Department of Economic Planning & Development, Trade and Statistics	- Responsible for administration of foreign aid funding - Responsible for Niue Fooou – A New Niue (Cyclone Recovery Plan) - Responsible for Economic Planning, development, Trade and Statistics	- Responsible for administration and disbursement of project funds	- Consultations on the impacts of climate change on the national economy and needs for data and information on the impacts of natural disasters -

37. Consultations with the Department of Environment revealed that a number of programmes, projects and activities were being implemented in Niue including National Sustainable Development Strategy, Millennium Development Goals, National Capacity self-Assessment, National Action Plan and Sustainable Land Management project under the UNCCD. It had also facilitated the completion of the National Biodiversity Strategy and Action Plan. In collaboration with Department of Agriculture, Forests and Fisheries, it has contributed to development of Biosafety programme. The Director of Environment emphasized that given the large portfolio of environmental projects it is important to assess the ability to deliver on these projects indicating that the selection of thematic area for adaptation under PACC project would also depend on the ability to deliver and to implement effectively.

38. The PCT held consultations with the Public Works Department (PWD) who are also responsible for Water Resources. PWD outlined its programme of work on infrastructure including water works. A number of assessments or studies have been carried out for water sector in Niue including:

- a) Construction of new water reservoirs (150 KI Tanks) for two villages as part of the Cyclone Recovery Project at estimated cost of NZD67,036.
- b) Proposal to monitor groundwater to address vulnerability of freshwater supply both under normal climate and under extreme climate conditions. The proposal was submitted to UNESCO for funding under its Participation Programme for an estimated cost of USD26,000.
- c) Niue Coastal Water Quality Survey March 2004 conducted by SOPAC.
- d) Water Supply and Sanitation: Policy Guidelines prepared by PWD as required under the Water Resources Act 1996. The Act outlines the duties and responsibilities of water resources managers, rules and procedures for water extraction, supply and use.

39. The PCT suggested that based on available information water resources management could be a possible thematic area for adaptation implementation under the PACC project as water supply and availability is considered to be critical for farmland irrigation in Niue. Thirteen farmers have developed irrigated horticulture under the FAO/Technical Cooperation programme which uses drip irrigation techniques. However there is a critical need for water storage facilities for these 13 farmers who currently have to pump water from underground source which is deemed expansive and unsustainable. It is estimated that average annual rainfall in Niue is 1,940mm and effective rainfall however is 1,251.7mm. In the dry season water is needed for irrigation especially during peak growing season which apparently falls into the driest time of the year. Therefore for every 0.2 ha farmland 10m^3 of water is needed for irrigation every day during peak growing season. Based on the annual average rainfall of 1,940mm and a rooftop water harvesting efficiency of 75%, a 25m^2 rooftop would be required for a 30m^3 water tank.

40. Further consultations were held with the Department of Agriculture, Forests and Fisheries (DAFF). The PCT introduced the PACC project by outlining the purpose and objectives. The PCT emphasized that the type of activities in any one of the development sectors to be funded and implemented under the PACC would be subject to their alignment with the UNDP-GEF criteria for project development. In response, the Director of DAFF outlined its operational programmes including:

- a) Development of Sustainable Agriculture in the Pacific (DSAP) and the FAO Technical Cooperation Programme on food security are providing impetus to irrigated horticulture which will require better management of water resources. FAO/TCP programme is on "Developing an appropriate irrigation scheduling

strategy for the intensification of import substitution agriculture” with at an estimated cost of USD159,000. The central policy goal of this programme is to increase the island’s agricultural capacity to produce import substitution and export products in order to enhance the economy of Niue and income of its population.

- b) Focus on commercial farming of vanilla and Nonu (*Morinda citrifolia*) and promotion of organic farming practices. There is some emphasis on subsistence farming and some income-generating activities.
- c) In the coastal management sector, Fisheries Divisions was previously responsible but more current work on this was undertaken through an International Waters Project in Niue.
- d) Impacts of land-based activities on marines resources especially on coral reefs and artisanal fisheries is a concern as well as invasive species.

Wrap-up Meeting/Workshop

41. A final wrap-up meeting was held on Thursday 31st August for the PCT to present the outcomes of the consultations and to endorse the thematic area for adaptation intervention for PACC-NIUE. The agenda focused mainly on the proposed focal area for PACC-NIUE as well as the proposed institutional arrangements. During the presentation of the outcomes of the consultation, the PCT also suggested that PACC-NIUE would focus on implementing adaptation activities in water resources management, based on the information made available to the PCT during consultations and on the criteria of UNDP-GEF for project development. Issues that have been raised and agreed upon included:

- a) The endorsement by NCCCT to focus on Water Resources Management as the thematic area for PACC-NIUE.
- b) The appreciation of NCCCT that this pilot project will focus on actual implementation of adaptation activities rather than further assessment work as with many enabling activities currently being conducted in the country.
- c) The expected size for PACC-NIUE pilot is around USD500,000.
- d) 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).
- e) On institutional arrangements, the NCCCT has endorsed that the project management unit be set up directly under the PWD, with the NCCCT 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 NCCCT, UNDP and SPREP for the project.

1.3 Climate Change Programmes, Projects and Activities

42. A number of climate change programmes, projects and activities have been carried out in Niue since the entry into force of the UNFCCC. Niue has prepared and submitted its initial national communication under the UNFCCC in October 2001. It has also prepared its technology needs assessment as part of the Phase Two Enabling Activity (top-up) funding. However, apart from the INC process Niue has not been involved in climate change project implementation at the national level since 2002. It has recently begun the process of the preparation of its second national communication under the UNFCCC with funding and support from GEF and UNEP. PACC-NIUE will be the first project of its kind for Niue.

III. SECTORAL ANALYSIS

43. 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 key 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 would also determine detailed adaptation activities and baselines in each country.

3.1 Methodology/criteria for selection of priority sector

44. 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 selection of PACC priority sector. That the selected adaptation project or activities should have:

- a) A strong fit/alignment with Niue 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.

45. The PCT presented a summary of the findings of the consultations in a workshop. The PCT emphasized that while three development sectors of coastal zones, water resources and food production were of equal importance to all stakeholders that were consulted, only water resources sector would be able to provide sufficient co-financing. Water sector also had sufficient assessment information to warrant adaptation intervention.

46. A number of issues were raised by stakeholders after the preliminary result were presented by the PCT. One of the stakeholders pointed out that they did not have sufficient time to provide information on other sectors but supported the proposal that adaptation interventions would focus on the water resources sector. Another suggestion was made to indicate that a whole of the island approach would be used in PACC implementation given that people live on one island and therefore planned adaptation activities should be aimed at the national level.

Thematic area for adaptation intervention

47. Based on the three criteria outlined above and on the stakeholder consultations (see section 2.2) water resources management was selected as a priority sector for adaptation intervention in Niue Island under the PACC project. Under this theme, an adaptation project entitled "*Piloting climate change adaptation in Water Resources Management and Use in Niue Island*" was proposed. This project would focus on enhancing, and where necessary, developing water resources infrastructure to increase the storage capacity (reservoir) in order to provide adequate supply of water to the communities, farmers and industries during tropical cyclones and to be able

to cope with changes in rainfall regimes and sea-level changes over the longer term. Thus the project would be piloted in 14 villages/communities of Niue Island as a whole.

3.2 Assessment of priority sector for adaptation activities

48. A study on Groundwater Resources Investigations on Niue Island was carried out in 2005 for the Government of Niue. A report “Groundwater Resources Investigations on Niue Island” was published in March 2006. The information in this section draws heavily from this study. The objective of the investigations was to determine the geometry of the freshwater lens on the island, and improve the understanding of the hydrogeological regime within the island to enable more informed estimates of the islands sustainable water yield and its vulnerability to drought and surficial pollution. As part of the cyclone recovery programme put in place after Cyclone Heta, the GON, supported by New Zealand, commissioned a drilling programme to construct additional public water supply wells, irrigation wells and some private wells to support a programme of economic development and diversification on the island. The Government of Niue, with the assistance of SOPAC, recognised this opportunity to use the drilling programme to construct specifically designed monitoring boreholes on the island, with the objective of establishing for the first time the absolute thickness of the freshwater lens on the island.

49. A number of groundwater investigations have been carried out over the years which found that Niue is an uplifted high carbonate island with a land area of approximately 259km² with a maximum thickness of limestone of 68m above sea level with a series of wave-cut terraces and platforms associated with periods of uplift. The island consists of more than 500 m limestone below sea level underlain by a caldera-shaped volcanic structure. Niue topography shows the highest ground to be around the edge of the island with a lower plateau in the centre, widely interpreted as an upthrust atoll reef and a former atoll lagoon centre.

50. In their review in 2003, Mosley and Carpenter considered the vulnerability of the aquifer, using conservative assumptions for storage and lens thickness. They concluded the freshwater lens could contain as little as three months of recharge if storage was limited to the karst system only, and thus questioned the reliability of using annual recharge estimates as earlier authors had done, to estimate a sustainable yield for the aquifer as a whole. They went onto consider the rainfall record and identified the frequency of 3 month long negligible recharge periods as occurring in 8 years out of 10.

51. The proportion of the rock mass that contains space to fill with groundwater is known as the porosity of the rock. The porosity of the rock or effective porosity determines the storage of water during recharge events and empty during dry months. It is this storage that controls the volume of freshwater held within the freshwater lens geometry. In Niue Island there appear to be two types of porosity within the limestone aquifer, the highly connected voids that form the karst conduits, and the more diffuse voids identified from direct exposure observations (in the cliff faces) and drilling observations (reporting honeycomb type voids). The karst voids are typically expected to occupy no more than 1- 2% of the total rock mass, but allow the rapid transmission and flow of groundwater. The more dispersed storage has been identified from drill cores and estimated at typically 25% of the rock mass, although its effective porosity may be less.

52. The annual estimate of recharge using average monthly values is 410 mm/yr (or 461 mm/yr when assuming negative recharge is not included in the summation). This is 20-23% of average annual rainfall. However great care needs to be taken when using average monthly values of

rainfall and evaporation as these tend to underestimate the actual recharge. Previous studies (Moseley & Carpenter, 2004) using actual monthly estimates derived an annual recharge value of 662 mm/yr for the 10 year period 1990-1999 which is 33% of average annual rainfall and confirms that recharge underestimation occurs from using average monthly values in tropical climatic environments. This is more in keeping with the typical recharge percentages accepted for tropical small island states (Falkland, 2003). Their analysis did however also identify the six month dry season period of June to November.

53. A comparison of Chloride concentrations in rainwater (WQ31 4.2 mg/l) with groundwater concentrations (from samples taken in October 2005) provides an alternative recharge estimate methodology. Chloride concentrations vary from as low as 7 mg/l in the new Tusekolo borehole to 32 mg/l in the production bore at Liku. Chloride concentrations in non-pumped boreholes towards the interior of the island have concentrations of 7-15 mg/l and probably provide the best guide to non-saline influenced water table concentrations.

54. These concentrations indicate recharge to vary between 28-60% of rainfall, the large range perhaps suggesting different proximity to rapid recharge mechanisms. It should of course be noted that daily variations in rainfall can be extreme, whilst daily evapotranspiration tends to be highly uniform, albeit with obvious seasonal fluctuations due to temperature. Actual recharge is likely to be higher than the 33% estimated, given the concentration of recharge within high intensity rainfall events.

55. In the absence of a more reliable estimate of recharge than the actual monthly estimates used by Moseley et al, the best estimate of recharge at this time is considered to be 662 mm/yr. Over the area of the lens (estimated at 200 km²) this equates to 132.5 Million m³/yr of lens recharge.

56. Experience in small island states, and other terrains, demonstrates that the Sustainable Yield should be considered to be no more than 30% of the recharge as an initial estimate (Falkland, 2003) until it can be further justified. This provides an initial estimate of the Sustainable Yield of 39.7 Million m³/yr. As a daily pro-rated yield this equates to 108,820 m³/d (i.e. 1,260 ls⁻¹). When compared to a typical domestic daily water demand of say 2,000 m³/d (23 l/s) it is clear the overall freshwater lens appears to have <2% abstraction of the initial estimate of sustainable yield, using an annual recharge methodology.

57. The annual recharge assessment has shown that there is negligible recharge for six months of the year. During this period groundwater continue to leave the aquifer through pumped abstraction and spring discharges, although the latter are likely to reduce to some extent. The amount of groundwater storage within the freshwater lens is often measured in terms of years of recharge storage, as this gives an indication of how susceptible the freshwater lens is to periods of drought.

58. At this time, the lens is considered to be typically 35m thick, with an annual recharge of 662 mm/yr. What is unclear however is the effective storage in the aquifer. If the karst system storage (1-2%) dominates, then 662 mm/yr of recharge would occupy between 30-60m of saturated rock. If this is the case then the freshwater lens observed on the island (at typically 30-40m thickness) contains between 0.5 to 1 year of recharge storage only. During the dry six month period we would expect to see considerable reduction in the volume of the freshwater lens, including coastal springs and caves becoming brackish and the monitoring bores (mainly CMB) showing a reduction in the freshwater lens thickness.

59. If the effective storage of the aquifer is determined more by the rock mass, then a year of recharge would occupy (assuming 20% effective porosity) approximately 3-4m of saturated rock. This would indicate the freshwater lens contains approximately 10 years of recharge and the lens as a whole is reasonably robust to individual dry seasons and even dry years. During a typical six month dry season we may therefore expect to see a reduction of the freshwater lens of 3-4m magnitude, which is then replenished in the wet season.

60. The hydrogeological analysis indicates that the total domestic water demand to be less than 2% of the freshwater lens sustainable yield estimate, and that initial freshwater lens monitoring suggests a fluctuation in the lens thickness of only 3-4m per year indicating little drought vulnerability to the lens as a whole. Both of these observations appear to demonstrate an adequate quantity of groundwater presently exists and will do into the future even through dry years. As a general observation however, it is clear from the above analysis that the deeper the borehole the more likely saline up-coning will occur, irrespective of the pumping rate employed at this time. All pumps should be set as shallow as practically possible, and all future production boreholes should be drilled to a minimum depth below the water table to allow the required abstraction rate to be withdrawn.

61. The existence of very rapid recharge mechanisms as demonstrated by the immediate groundwater response to the 12/13 February 2006 tropical storm (see Figures 16 and 18), confirms the high vulnerability of the groundwater lens to land use activities. Whilst the storm recharge represents an extreme (but annual) event, it confirms that substances on the ground surface can reach the freshwater within 1-2 days.

62. The more detailed laboratory hydrochemical analyses to date confirm very low levels of ammonia and nitrate in the groundwater, which largely reflects the low population density and the general location of the public water supply boreholes inland (and up hydraulic gradient) of the villages and their septic tank wastewater disposal systems.

63. However Mosley (2004) demonstrated the elevated levels of ammonia, nitrate and phosphate off the coast of Alofi, which were due to both direct coastal discharge (pipeline) and indirect (groundwater seepage) from the sewage disposal systems. Whilst a detailed hydrogeochemical assessment is beyond the scope of this study, the additional results confirm the lack of inorganic contamination within any of the well water sampled.

64. The hydrochemistry and groundwater level responses to recharge events confirms the aquifer is both highly vulnerable but also presently uncontaminated with respect to inorganic contaminants. There is however no analysis to date to confirm the presence or absence of organic contaminants within the groundwater resource. These might include diffuse and soluble compounds such as pesticides and insecticides, or point source insoluble pollutants such as fuel oils.

65. Whilst the lack of commercial activity on the island has to date has largely ensured the protection of the underlying groundwater lens, the planned increase in both agricultural and industrial activity will present an increase in risk to the aquifer unless agro-chemical application and waste management practices are well maintained. It is an obvious but nonetheless necessary statement to make that: prevention of contamination of the aquifer is easier to undertake than remediation and clear-up of its pollution.

66. The estimate of recharge is fundamental to determining the yield of the freshwater lens. The investigations and monitoring so far have confirmed that recharge to the lens can be

exceptionally rapid, and more monitoring is required to determine to what extent this rapid recharge is lost from the aquifer and does not remain within the storage of the freshwater lens. Best estimates of recharge (using a unit area recharge rate of 662mm/yr), suggests that over the freshwater lens area (defined at this time as the full island area (259 km²) less a 1km strip around the coastline (50-60km²) of 200km², that 132 Million m³/yr of recharge enters the aquifer. Assuming 30% of this is available as Sustainable Yield, this provides an initial estimate of the Sustainable Yield of 39.7 Million m³/yr, or as a daily pro-rated yield this equates to 108,820 m³/d or 1,260 l/s. It appears the existing groundwater abstraction from the PWD public water supply wells of typically 2000m³/d represents less than 2% of the freshwater lens yield and therefore is safely within its capacity to sustain these flows.

67. The vulnerability of the freshwater lens to drought is a function of the lens size, the rock storage and the recharge entering it (or lack of it) with time. The analysis of the rainfall and climate data has shown that recharge is limited to six months of the year (between Dec-May) with six months of the year being devoid of recharge (Jun-Nov). The significance of these dry seasons depends on the storage in the lens and how much it reduces during the dry period.. Whilst a full set of dry season data is yet to be gathered, preliminary monitoring of the freshwater lens in the middle of the island suggests that the lens may reduce by 3-4m over the dry season period. Given the lens is some 40m thick at this location, this suggests the lens is relatively robust to dry season and even dry year drought periods.

68. The active storage within the karst aquifer remains unclear at this point in time. The active karst conduits are likely to have a storage of 1-2% of the rock mass. However previous investigations on Niue and other karst islands (as well as Tertiary Carbonates elsewhere in the world) have identified a more diffuse storage within the rock mass of typically 20-25%.

69. However these findings are based on limited monitoring of part of a dry season, and extrapolated thereafter. These conclusions should be treated as preliminary only. There does not seem therefore to be any specific need at this time to consider recharge augmentation or other means to improve the drought yield. However consideration should be given to the temporary loss of some or all of the production bores, perhaps due to temporary sea water inundation or island wide power loss, such as during and after Cyclone Heta.

70. The initial investigations indicate the lens yield to be more than adequate to meet the demands of the island populace. However, the significant depth to groundwater (35-65 m) does constrain abstraction techniques to those of narrow boreholes. Boreholes can, if over-pumped, draw saline groundwater up in to themselves even though the total freshwater lens yield may be adequate. The risk of saline up-coning increases as the abstraction rate increases, as the borehole gets deeper and nearer to the base of the freshwater lens, and as the rock permeability reduces.

71. Initial estimates of risk of saline up-coning indicates Liku, Makefu and Avatele production bores might all be at risk, whilst the other five wells can pump easily enough at 130 l/min. However for many of the bores insufficient data exists to make an assessment even possible. These initial assessment rely upon incomplete borehole construction records, estimate of ground surface, groundwater level dip data at unknown times in the tidal cycle, and using island wide estimates of the freshwater lens base and rock permeability.

72. The monitoring programme has already demonstrated that the groundwater levels response to storm event recharge was observed within 1-2 days. Whilst it would be wrong to suggest all recharge and possible contaminants included therein would also take as little time as this to reach the water table, the high vulnerability of the aquifer and the freshwater lens are evidently

undisputable. The low population density on the island and general lack of commercial activities, have for the most part ensured the groundwater has remained uncontaminated to date.

73. However the future planned increase in agricultural, fish processing and tourism activities indicates not only an increase in water demand but an increase in agro-chemical usage and trade effluent disposal. There will also indirectly be an increase in fuel oil usage and other chemicals associated with machinery maintenance, and waste production necessitating land-filling.

74. Recommendations on how to improve the management and protection of the groundwater resources have been referred to in Section 5 of this report. This section refers to the more immediate and focused recommendations to continue, sustain, expand and improve the groundwater investigations and monitoring network developed in October-December 2005.

75. It is strongly recommended that as budgets permit, and perhaps as part of the on-going economic diversification of the island, that a series of additional monitoring boreholes (90-100m deep), be installed across the island. Ideally there should be perhaps another 10 monitoring boreholes, although a more realistic target of 5-6 might be more achievable. As a priority a monitoring borehole should be drilled into the Alofi Wellfield, which provides the town with most of its supply.

3.3 Current institutional and development baseline

76. As with many small islands developing States, water resources management poses a serious sustainable development challenge for Niue Island. The water resources and supply in Niue comes from groundwater source and rainfall catchments. Rainfall infiltrates the karstic limestone resulting in a freshwater lens underlain by saltwater. This lens provides the freshwater used for human consumption, agriculture and industry. The aquifer is vulnerable to contamination from activities carried out on the surface, and any large scale contamination of the freshwater lens would pose a risk to the population. However there been no know outbreaks of diseases attributable to untreated water.

77. Some measures have been put in place to avoid overexploitation of any particular water bore which would allow salt-water intrusion, although (as described above) the thickness of the lens is sufficient to withstand periods of drought. However, good management and protection of the groundwater is necessary to avoid contamination of the lens.

78. Each village/community has its own water supply consisting of a submersible pump and a water reservoir. These reservoirs often suffer from leakage which affects household consumption. To supplement the groundwater resource the establishment of rainwater catchments has been encouraged. Such community rainwater catchments and concrete-holding tanks with capacity 50-120 kilolitres were also a main source of freshwater particularly during periods of drought. However these tanks have deteriorated over the years as more people relied on groundwater source.

79. It is estimated that there is sufficient water works infrastructure to support a population of 5,000 but the maintenance of the infrastructure would require skilled personnel and appropriate equipment. Funding of water supply has been part of the government budget through its Division of Water Works.

80. Water Resources Management is part of an overall strategic objective of the GON on environment which allows for “sustainable management of Niue’s natural resources for future generations”. The Water Resources Act 1996 sets out the policy and guidelines for extraction, supply and use of water. Under the strategic objective for infrastructure development for water, the aim is to provide a quality potable water supply to all residents. In the Cyclone Recovery Plan the focus on water resources is to increase the reliability and quality of water supply to all sectors.

81. There are many institutions, departments and agencies involved in water resources management either through coordination of activities or through the implementation of their respective mandates. The key institutions and organizations include:

- a) Department of Environment – pursuit of government policy (e.g. strategic objective on Environment), international environment and development policies (e.g. WSSD/JPoI, BPoA/MSI, MDG, NBSAP, NCSA, UNCCD/NAP & SLM), Environment Act 2003 – Environmental Policy and Law, Environment Department, National council for Sustainable Development
- b) Department of Police, National Disaster Council
- c) Donor-community (NZ AID, AusAID, EU/EDF9, etc) and non-government organizations(e.g. OXFAM, others)
- d) Department of Meteorology and Climate Change – provision of climate information, rainfall and temperature, ocean-atmosphere conditions, Operational Focal Point of the UNFCCC,
- e) Department of Works
- f) Department of Agriculture, Forests and Fisheries
- g) Department of Health
- h) Reef Fishing Company
- i) Villages/communities

82. While most stakeholders’ roles and responsibilities are driven by their own mandates with respect to water resources, there appears to be some level of coordination and collaboration on programmes, projects and activities.

3.4 Impacts of climate change on the priority sector

83. Perhaps the most devastating impact of climate-related extreme event ever to be experienced in Niue was that of cyclone Heta in January 2004. The total loss was estimated at NZD 89.1 million (USD60 million). Some of the losses included the following:

- a) The damage to communities was most severe in the western coastal villages from Hikutavake to Avatele with Alofi district sustaining the most damage to both housing and property.
- b) All government housing and private homes at the Aliluki housing estate were totally destroyed together with the only hospital and health institution on Niue, Justice & Lands Department, Museum and Cultural Centre, the Niue Hotel, Industrial Centre,

- community halls, churches and supporting facilities for community and NGOs activities. In one community alone a church building was totally destroyed.
- c) Extensive damage to family outside kitchens, garages, toilets, fruit-bearing trees, farming lands, and the surrounding eco-system, which provides stable food sources and food security to all village communities.
 - d) 90% of total housing on Niue (570 occupied and 432 unoccupied) mostly built in the 1960s to 1980s period sustained some form of damage.
 - e) 30 occupied houses were totally obliterated (not including 13 government housing) and 20 no longer structurally sound.
 - f) The total damage to occupied dwellings is estimated to be \$2.9M. Personal property losses of \$1.2M, and the overall estimated loss to community housing is \$4.1M. The basis of this valuation is the replacement cost for same size dwellings (2-3 bedroom dwellings) at \$70,000-80,000 per house.
 - g) Damages to unoccupied housing has been assessed as \$1.0M. Of this amount, 50% were totally destroyed or are now in no conditions for occupation. The issues regarding remedial actions for these houses is beyond the scope of this assessment and the sole purpose of including these assessments here is to quantify the total housing loss.

84. Cyclone Heta was a category 5 storm which generated over 50m waves breaking up to 50m inland in some areas of the island. In terms of the economic loss, the GDP for Niue is \$14.2million but the damage cost was estimated at \$37.2million while loss to the environment was \$50 million representing a total of \$87.2 million. This total would mean that Cyclone Heta has cost every man, woman and child a loss of \$51,294 and 200 years worth of annual exports to make up for the losses caused to the agriculture sector.

85. Up to 30% trees were knocked down or destroyed resulting in massive losses to native biodiversity while there was an estimated 97 % loss to the fruit bat population, so distribution of native forest has to be supported by government and civil society. Invasive species on the other hand prevailed and survived the cyclone, further placing pressure on the struggling native species to survive.

86. Studies on Groundwater Resources on Niue Island was carried out in 2005.² While initial investigations indicate the lens yield to be more than adequate to meet the demands of the island populace during the rainy season, it emerged that the lens yield is not able to meet demands during dry season. As a result, water shortages are regular occurrence in Niue but not necessarily due to the lack of water resource. The situation is expected to worsen in a climate change scenario where droughts are expected to fluctuate. The analysis of the rainfall and climate data has shown that recharge is limited to six months of the year (between December-May) with six months of the year being devoid of recharge (June-November). The significance of these dry seasons depends on the storage in the lens and how much it reduces during the dry period. Thus, an aquifer having only 1-2% storage is a concern as it suggests the aquifer is highly vulnerable to the annual dry season let alone a more serious and lengthy drought period.³ Therefore, the PACC interventions in Niue aim for the water supply to be able to withstand changes in rainfall regime in a climate change scenario.. The pilot will focus on introducing rainwater harvesting during the rainy season and increase the water storage capacity for communities. In terms of baseline funding, the government supports water resources supply and maintenance from its budgetary

² SOPAC Study??

³ Carpenter 2004

support estimated at NZ\$135,000 which also includes the water supply maintenance and reticulation component under the Cyclone Heta Recovery Plan.

IV. DELIVERY MECHANISM FOR FULL-SIZE PROJECT

4.1 Institutional Arrangements

87. All climate change programmes, projects and activities are being coordinated by the Climate Change Section of the Department of Meteorology. Climate Change Section currently has two full-time staff that carry out tasks/activities relating to climate change in the country such as the preparation of second national communication. The Climate Change section also serves as a secretariat for the National Climate Change Committee (NCCC).

88. Under the PACC-NIUE project, the Climate Change Section will continue to coordinate climate change activities relating to PACC. However, given that PACC is focused on implementation of adaptation activities, the implementing agency for PACC-NIUE will be the Public Works Department (PWD) who will also serve as secretariat to the NCCC on issues relating to the implementation of PACC-NIUE.

89. In addition to the implementation of PACC-NIUE, PWD will host at least two full-time staff that will provide the day-to-day operation of the PACC-NIUE. 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 Public Works Department.

90. At the national level, PACC-NIUE will be implemented by various stakeholders within their respective mandates while scientific, technical, policy and management oversight will be provided by the NCCC. The NCCC comprises representatives from various government ministries, agencies and institutions and the private sector and was established during the preparation of the initial national communication.

4.2 Assessment of existing and potential barriers to adaptation implementation

91. PACC-NIUE is underpinned by its policy and regulatory framework on environment of which water resources management is a part. Its strategic objective on environment focuses on “sustainable management of Niue’s natural resources for future generations. Water Resources Act 1996 provides the policy and guidelines for extraction, supply and use of water resources which is also reflected in the strategic objective of the development of water infrastructure where it aims to provide a quality potable water supply to all residents. Water resources management also features prominently in the Cyclone Recovery Plan to increase the reliability and quality of water supply to all sectors. Such a wide-ranging policy framework on water resource sector means that many stakeholders are involved in water resources management issues

92. A number of climate change enabling activities (e.g. national communication and national capacity self-assessment) have also involved numerous organizations, institutions and individuals in carrying out various tasks and activities. These activities have been

supported by the NCCC 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-NIUE. Some of these barriers include, competing demands on staff time, inadequate staff resources, equipment, and lack of incentives.

93. 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 GOALS, OUTCOMES, OUTPUTS AND ACTIVITIES

Goal:

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

Specific Objective:

95. The main goal of this project is to “increase the resilience of water resource sector to impacts of climate change and sea-level rise.” This goal will be achieved through a project “Piloting climate change adaptation in water resources management in Niue Island.”

Specific Outputs:

Output 1.1: Relevant plans and programmes incorporate climate risks in the water sector in the Island of Niue.

Output 2.1.1 Practical guidance to design water storage systems on a raised atoll island to enhance resilience to prolonged drought situations.

Output 2.1.2 Climate resilient water storage systems (with co-financing support)

Description:

Output 1.1: Relevant plans and programmes incorporate climate risks in the water sector in the Island of Niue.

95. 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.

96. 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 2.11.1a Practical guidance to design water storage systems on a raised atoll island to enhance resilience to prolonged drought situations.

Output 2.11.1b Climate resilient water storage systems (with co-financing support)

97. This output will assist the Department of Public Works and the Department of Environment and key stakeholders to develop their capacity to design and demonstrate water supply and storage systems from underground water sources to reduce impacts of decline in precipitation on livelihood activities in Niue. It would involve capacity training and application of vulnerability and adaptation assessments using climate information on current water resource management and its impact on agricultural production, design and demonstration of an approach to climate proof the water supply systems of key sectors, development of an integrated land use management plan that takes underground water conservation into consideration.

98. Niue is the world's largest and highest single coral atoll situated in the Southwest Pacific Ocean (19'S, 169'W), with a land area 259 km². It is approximately 480 km east

of Tonga, 930 km west of Rarotonga and 660 km southeast of Western Samoa. As Niue is situated near the edge of the tropical cyclone belt, it is subject to gale force winds during the hot season. Indeed, cyclones strike at irregular intervals, the most recent one being Cyclone Heta in January 2004, which has caused devastation to people, properties, government and industry, infrastructure, agriculture and the economy with an estimated damage cost of more than US\$60 million (or NZ\$89.1 million). Droughts occur from time to time, impacting particularly on agriculture, as there is no irrigation system. Under climate change scenario, Niue is expected to experience drought conditions more frequently, especially in relation to the expected more frequent occurrence of El Niño. The people of Niue dependent largely on agricultural produce from their farms for food sources and this is under threat due to decline in precipitation which lead to lack of soil moisture and thus affect crop yields. Due to the coral atoll origins of Niue Island, soil conditions are already marginal for intensive agriculture and long-term monoculture. Much of the land is covered with fern growth, which again indicates the poor structure and nutrient content of the soils. Coupled with lack of rainfall, the situation for farmers look bleak into the future. As prices of food increase to unprecedented levels due to fuel costs and redirecting the use of food grains to other uses such as green fuels, the people of Niue would be seriously vulnerable now and into the future.

99. Specific activities to be undertaken would include:

- Develop a guide that would use climate change models and historical data to determine current levels of vulnerability of communities and key economic sectors to current and future water supply and demand;
- Design and demonstrate an approach/model (top-down and bottom-up) to climate proof current water supply system of key economic sectors and communities;
- Design of an integrated land use plan that takes underground water conservation into consideration;
- Conduct water usage studies to improve water management in critical economic sectors;
- Use of climate models, water recharge models etc to guide investment decisions and demonstrate cost effective adaptive measures for use during projected six months drought durations;
- Develop database on climate and water resources information.

PROJECT LOG FRAMES AND INDICATORS

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

BUDGET

Responsible	ERP/Atlas	Budget Description							
	Budget Code								Total
				Year 1/08	Year 2/09	Year 3/10	Year 4/11	Year 5/12	Budget
Outcome 1	71200	International Consultants (including national regional staffing)	10,000	10,000	0	0	0	0	10,000
	71300	Local Consultants (including national staffing)	30,000	5,000	5000	10,000	5,000	5,000	30,000
	71400	Contractual Services - Ind	20,000	5,000	5,000	5,000	5,000	0	20,000
	71600	Travel	20,000	0	5,000	5,000	5,000	5,000	20,000
	72100	Contractual Services - Co	40,000	10,000	10,000	10,000	10,000	0	40,000
	72200	Equipment & Furniture	10,000	5,000	1,000	3,000	1,000	0	10,000
	72400	Communication & Audio Visual equipment	4,000	2,000	500	500	500	500	4,000
	72500	Supplies	1,000	500	100	100	200	100	1,000
	72800	Information technology and Outreach	3,000	500	1,000	500	1,000	0	3,000
	74200	Printing, Publishing & Production	2,000	0	500	500	500	500	2,000
Subtotal			140,000	38,000	28,100	34,600	28,200	11,100	140,000
Outcome 2									
	71200	International Consultation	10,000	10,000	0	0	0	0	10,000
	71300	Local Consultants	40,000	5,000	15,000	15,000	5,000	0	40,000
	71400	Service Contracts - Ind	50,000	5,000	20,000	15,000	5,000	5,000	50,000
	71600	Travel	20,000	2,000	5,000	5,000	5,000	3,000	20,000
	72100	Contractual services - Co	297,400	60,480	60,480	60,480	60,480	55,480	297,400
	72200	Equipment & Furniture	10,000	0	5,000	5,000	0	0	10,000
	72500	Supplies	40,000	5,000	10,000	10,000	10,000	5,000	40,000
	72400	Audio Visual Equipment and Communication	10,000	2,500	2,500	2,500	2,500		10,000
	72800	Information Technology Equipment and Outreach	10,000	3,000	3,000	2,000	1,000	1,000	10,000
	74200	Printing and Publications	10000	1,000	3,000	3,000	2,000	1,000	10,000
Subtotal			497,400	93,980	123,980	117,980	90,980	70,480	497,400
Outcome 3									
	71200	International Consultants							
	71300	Local Consultants							0

	71600	Travel	20,000	4000	4000	4000	4000	4000	20,000
	72100	Contractual Services - Co							0
Subtotal			20,000	4000	4000	4000	4000	4000	20,000
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

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ANNEXES

Letter of Co-Financing