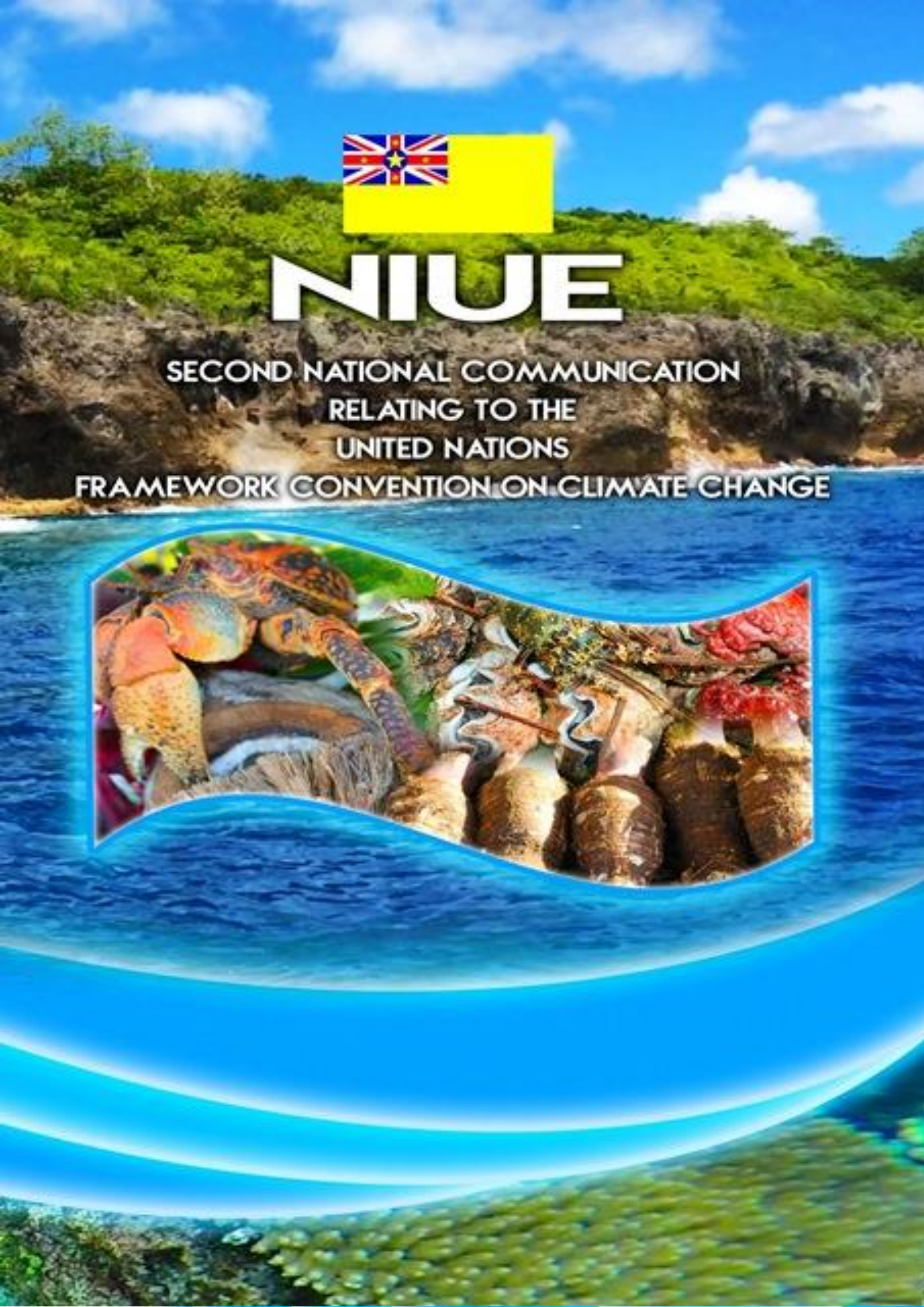

# NIUE

## SECOND NATIONAL COMMUNICATION RELATING TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

# Niue

# Second National Communication

# Under

# The United Nations

# Framework Convention on Climate Change

Prepared by

Niue Climate Change Project

2014

GOVERNMENT OF NIUE

United Nations Framework Convention on Climate Change

UNEP

gef GLOBAL ENVIRONMENT FACILITY INVESTING IN OUR PLANET

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## *Foreword*

Niue is a very small Pacific Island Nation and is one of the most vulnerable to the adverse impacts of climate change. With its small population, economic size and industrial base, it is one of the countries that contributes least to the emissions of greenhouse gases. However with increased intensity and frequency of extreme weather events such as tropical storms, cyclones, floods and droughts over past few decades, climate change is projected to have deleterious impacts on the country's economy, infrastructure, livelihoods, environment, and public health. These adverse impacts of climate change could potentially undermine the efforts of the government and people of Niue to achieve sustainable development.

One of the principal priorities of Government of Niue in addressing the problem of climate change is to work collaboratively with regional and global partners to protect the Earth's climate system within the framework of the UNFCCC. In this regard, the country ratified the Climate Convention on 28 February 1996 and the Kyoto Protocol (KP) on 6 May 1999. In pursuance of this goal, it adopted a National Strategy to respond to Climate Change in 2010.

Niue has also fulfilled its obligations to the UNFCCC by submitting its Initial National Communication to the UNFCCC Secretariat in December 2000 and has now finalised work on its Second National Communication to the UNFCCC. The Second National Communication of Niue to the UNFCCC was prepared by relevant national departments, agencies and individuals through a highly consultative process within the framework of project Niue*: Preparation for Second National Communication to United Nation Framework Convention on Climate Change.* Financial support was provided by the Global Environment Facility while technical and project management support was provided by the United Nation Environment Programme (UNEP).

Niue's Second National Communication (SNC) to the UNFCCC provides information on the national greenhouse gas inventories, impacts and vulnerability assessments of climate change, measures to adequately adapt to climate impacts and measures aimed are reducing the growth of greenhouse gas emissions arising from major social and economic activities of Niue.

I trust that this national report fully complements our continued and sustained efforts aimed at supporting the work of the international community to combat climate change. The Government of Niue will continue to work with other relevant international, regional and national bodies for the successful implementation of the UNFCCC.

I wish to warmly commend all those who have contributed directly or indirectly to the preparation of this national report.

***Hon. Toke Talagi***

Premier of Niue

# 1. Introduction

Despite significant challenges in implementing the UNFCCC, Niue has continued to pursue the common goal of protecting the environment for the benefit of present and future generations of humankind.

In order to fulfil its obligations under the UNFCCC, the Government of Niue has prepared the Second National Communication (SNC).

Niue submitted its Initial National Communication (INC) in June 2000. The INC noted that while Niue produced comparatively minimal greenhouse gases(GHG), the effects of climate change on the small Pacific island nation could be devastating. It is for this reason that Niue takes its obligations under the UNFCCC seriously.

Climate related events, such as Cyclone Heta in 2004, have confirmed to the people of Niue the dangers associated with climate change, and have shown the importance of active participation in activities which mitigate the adverse effects of climate change.

Through the preparation of the SNC, Niue has been able to further build its capacity in various areas relating to climate change at both a technical and policy level. The SNC has been an opportunity to take stock. It both recognises the important positive steps taken by the Niuean people to reduce the effects of climate change, and at the same time highlights the shortcomings, constraints and gaps that face the Niuean people.

It is important that the people and government of Niue continue to adapt to the challenges of climate change. It is hoped that the publication of this SNC will make clear to the people of Niue the specific difficulties that they face in respect of climate change, and will enable them to develop a sustainable way forward.

The Niue Climate Change Project would like to thank the United Nations Environment Programme for its guidance throughout the process of compiling this SNC. The inspiration and support provided has been invaluable for the future of Niue's environment and its people. The Project gives special thanks to Dr George Manful, Senior Task Manager for the Climate Change Enabling Activities, UNEP, for his feedback and assistance.

Within Niue the Climate Change Unit and the Niue Meteorological Service have been instrumental in the development of this project.

Rossylynn Pulehetoa Mitiepo, the National Technical Consultant, has been the Coordinator of the Niue Climate Change Project. She has worked tirelessly to see this project through to its completion. Thanks should also be given to Richard Hipa the Secretary to Government, Sionetasi Pulehetoa the Director of Niue Meteorological Services, and the Government of Niue.

## *II Executive Summary*

### A National Circumstances

Niue is a self-governing state in free association with New Zealand, situated in the South West Pacific Ocean.

The population of Niue in 2006 was 1,358. Population retention and increase are major goals of the Niuean government.

The infrastructure of Niue is modest and is susceptible to significant damage caused by natural disasters such as Cyclone Heta in 2004. The key infrastructures are the public roads, the wharf, and the airport runway.

The Niuean economy is small and relies heavily on financial assistance from other nations, especially New Zealand. Key areas of the Niuean economy include agriculture, tourism and fisheries.

Maintaining Niuean culture is of great importance to the people of Niue. In 2007 a Taoga Niue Department was officially established to promote, preserve and strengthen Niuean cultural heritage.

Niue is situated on the edge of the southern tropical cyclone belt and within the zone of the influence of southeast trade winds. This position makes Niue susceptible to tropical cyclones. There are two distinct seasons in Niue, the wet season and the dry season. The wet season runs from November to April, and the dry season from April to October.

Niue is an uplifted atoll comprised primarily of limestone called *Makatea*.It therefore has no surface water, but a deep freshwater lens. It has shallow soils that support extensive forests and shifting cultivation. It has a narrow fringing reef. The natural resources of Niue are managed by the Department of Agriculture, Forests and Fisheries, the Environment Department, and customary owners of the land and seas.

## B GHG Inventory

The second GHG Inventory for Niue covers the greenhouse gas emissions and removals between 2005 and 2009, it compares these years to the base year of 2000.

The GHG Inventory reveals that Niue has relatively low greenhouse gas emissions.

## C Vulnerability and Adaptation

An assessment of vulnerability to climate change has been conducted using a bottom-up approach that combined a range of methods and primary and secondary data.Niue is vulnerable to climate change, although the pathways between changes in climate and undesirable outcomes are somewhat different for Niue than for other small island states. The major climatic risk for Niue is that of tropical cyclones. Other risks include: a change in the abundance of marine species; the effects of climate change on food security; and changes in the cost of living which may in turn encourage emigration and the loss of cultural heritage. A range of adaptation options are identified, ranging in scale from adopting a precautionary approach to resource management through to resettlement of cyclone-exposed villages and infrastructure.

## D Programmes Containing Measures to Mitigate Climate Change

The period of 2000 (the SNC inventory baseline year) to 2009 saw a number of actions for greenhouse gas emission mitigation implemented in Niue. These include the installation of solar hot water heating, public education campaigns, increased grid penetration and distributed use of renewable technologies, and the promotion of using low emission fuel sources.

Niue faces difficulties in mitigating climate change for two primary reasons. First, Niue lacks environmental base data which would be able to support climate related decision-making. Second, Niue lacks the capacity to monitor and evaluate energy supply initiatives. Without this support there is no way to evaluate the cost or emission reduction effectiveness of programmes and take an adaptive management approach.

## E Development and Transfer of Environmentally Sound Technologies

The cost of procurement and maintenance of Environmentally Sound Technologies (ESTs) is a major barrier to technology transfer in Niue. The electricity, environmental and transport sectors have been deemed most in need of ESTs. There are few relevant endogenous technologies that can be used to assist with mitigation, although it should be stressed that Niue's extensive forest cover, low population, and negligible industrial base mean Niue's net emissions are negligible. There are

elements of resilience in Niue's customary and contemporary resource management practices that facilitate adaptation, such as no-harvest periods for certain species of fish, shifting cultivation of crops, and forest and marine protected areas. These practices are enabled by customary beliefs, legislation, and widespread acceptance by the people of Niue.

**F Research and Systematic Observation**

Research and systematic observation (RSO) indicates how data and information, or lack of data and draws a link to Niue's preparedness and management of hazards, disasters and risks.

**G Public Awareness, Education and Training**

There have been a range of community activities that have increased the public's awareness of climate change issues. These have included a poster competition, a hip-hop competition, power-point presentations, talent quests, short story writing, and a climate change touch rugby tournament.

Educational initiatives have been put in place in the primary school and high school. These initiatives included trips to the Department of Meteorology and Climate Change, and class room based activities.

During the 39th Pacific Island Forum in 2008, Niue was able to showcase the ways in which it was dealing with climate change.

A number of workshops have also been held, which included high level discussion on ways to deal with climate change.

Globally, Niue has been a part of the 350.Org Campaign. A number of activities have been organised under this campaign and have been displayed on the campaigns website.

These activities have been successful in increasing public awareness, education and training in regard to climate change. The small community activities have been able to display the issues climate change poses locally, while the regional and global activities have focused on the dangers of climate change to the global population.

**H Integration of Climate Change Concerns into Sustainable Development Programmes**

There have been a number of recent policies which have integrated climate change considerations into the decision making process. These include the Forest Policy, the Niue National Energy Policy, the Niue National Integrated Strategic Plan, the Climate Change Policy, and the Ecosystems Approach to Fisheries Management.

Furthermore, a number of Government departments have incorporated climate change policies into their corporate plans.

**I Information and Networking**

The human scientific, technical and institutional capacity in information and networking has strengthened over time in Niue and has enhanced efforts in information sharing.

**J Capacity Building**

The general understanding of climate change and its related issues is considered to be strong amongst Niuean people. A number of events have increased the public's interest in climate change. These include the work of the Climate Change Project, Cyclone Heta, the National Climate Change Workshop and a number of Community Activities.

In future, the Niue Met Service and Climate Change Unit together with the National Training Development Council under its Strategic Human Resource Development Plan will encourage scholarships and training opportunities in climate change capacity building. Identification of the immediate and long term needs will be assessed in order to assist with planning.

Areas that will continue to need capacity building and support are;

- General training on education and awareness for the general public;
- Scholarship on tertiary study in climate science for students;

- Specialized training for technology transfer among existing officers; and
- Short term training on policy type issues for decision makers.

## K Constraints and Gaps, and Related Financial, Technical and Capacity Needs

Challenges and constraints experienced throughout the Niue Climate Change Project (NCCP) are attributed mainly to human resources. Other gaps include inconsistent data and information, lack of coordination amongst key government institutions, high costs of community engagement and insufficient local knowledge of climate change issues/impacts and response measures.

With its small population and limited financial resources Niue faces challenges in preparing National Communications to the UNFCCC. The management of the exercise requires skills that are scarce. A significant constraint is the availability of key staff: the Niue public service is small and reporting to international bodies such as the UNFCCC competes with other priority activities relating to sustainable development.

Niue is also effectively part of the Australian and New Zealand labour market, meaning it competes with those countries and their higher salaries to attract and retain the skills needed to complete complex and interdisciplinary projects such as preparing this National Communication.

Niue's infrastructure is also a constraint: there is only one flight a week in and out of Niue, meaning even meetings in the region consume at least one week of staff time, whereas international meetings can take two to three weeks depending on flight schedules.

These constraints cannot easily be addressed by traditional capacity building processes that involve short courses targeted at skills training, indeed, given the high opportunity costs of travel such courses may indeed be injurious to completing reports such as this National Communication.

There may, however, be scope for decreasing the barriers to managing projects such as this National Communication, for example in longer intervals between reporting periods, greater flexibility within the Niue public service with respect to staffing across government agencies, and increased use of international experts who come to Niue to complete certain technical tasks (of particular importance here is the compilation of the GHG inventory, which requires skills that are very scarce in Niue).

***Double Rainbow over Niue***

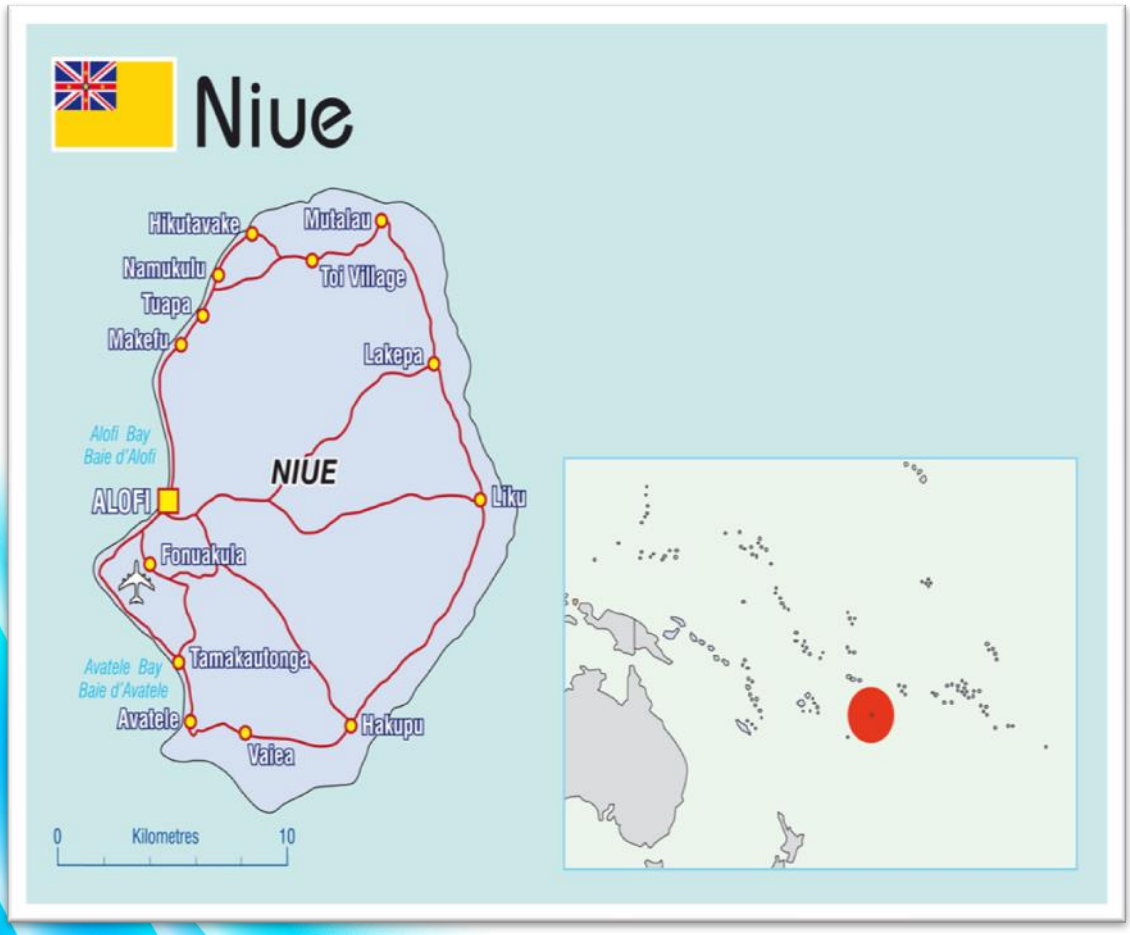
# 2. National Circumstances

## *I Location*

Niue is situated at the South West Pacific Ocean at latitude 19 degrees south and 169 degrees west. It is approximately 480 km east of Tonga, 560 km south of Samoa and 980 km West of the Cook Islands, and 2,200km north east of New Zealand. It is a singular coral raised atoll with a land area of 259 square kilometres and an exclusive economic zone of 450,000 square kilometres that includes Antiope, Beveridge Reef and fourteen seamounts (Figure 1).

The land area varies over three terraces. The high and low terraces average at 69 metres and 28 metres above sea level respectively. As a coral raised atoll, the coastline is of rugged rock, steep cliffs, caves, deep chasms and blowholes. The interior is predominantly of limestone varied over a flat plateau of what was formally an atoll.

**Figure 1: Location of Niue Island**




## *II Climate*

Niue is at the edge of the southern tropical cyclone belt and within the zone of the southeast trade winds. It is susceptible to tropical cyclones. There are two distinct seasons in Niue. The wet season coincides with the tropical cyclone season and runs from November to April. This season is

characterized by high temperatures and humidity. The dry season runs from April to October, and is characterized by warm sunny days and cool nights.

The mean annual temperature remains at around 25 degrees throughout the year. Similarly, there is no large trend in rainfall. Niue's rainfall has a close relationship with the El Nino Southern Oscillation (ENSO). This relationship is modulated by the Interdecadal Pacific Oscillation (IPO): it weakens during the negative IPO phase and strengthens during the positive IPO phase. Since 1950, the annual rainfall has shown a negative trend of 0.7mm/year. Seasonally, the trend is +1.9 and -1.7mm/year for the wet and dry season respectively (Kirono *et al*, 2008).

## *III Government*

Niue is a self-governing State in free association with New Zealand. The legislative arm of Government is the Niue Legislative Assembly ("the Assembly") empowered to make laws for the peace, order and good government of Niue. The Assembly consists of twenty members, fourteen of whom is a representative from each of the fourteen village constituencies. Six other members are elected from the common roll constituency. Elections are held every three years by secret ballot under a system of universal suffrage. A Speaker is elected by members of the Assembly and is responsible for the arrangements of and meeting procedures of the Assembly.

The Executive authority is Cabinet consisting of the Premier and three other members of the Assembly. The Premier is elected by members of the Assembly. He appoints three members of the Assembly to a Cabinet of Ministers. Cabinet has the general direction and control of government. Cabinet is responsible for the establishment and maintenance of hospitals, schools and other institutions necessary to provide a reasonable standard of living for the people of Niue and to secure their economic, social and cultural welfare. Ministers are designated portfolios and responsibility to a specific department or public office. Cabinet is collectively responsible to the Assembly.

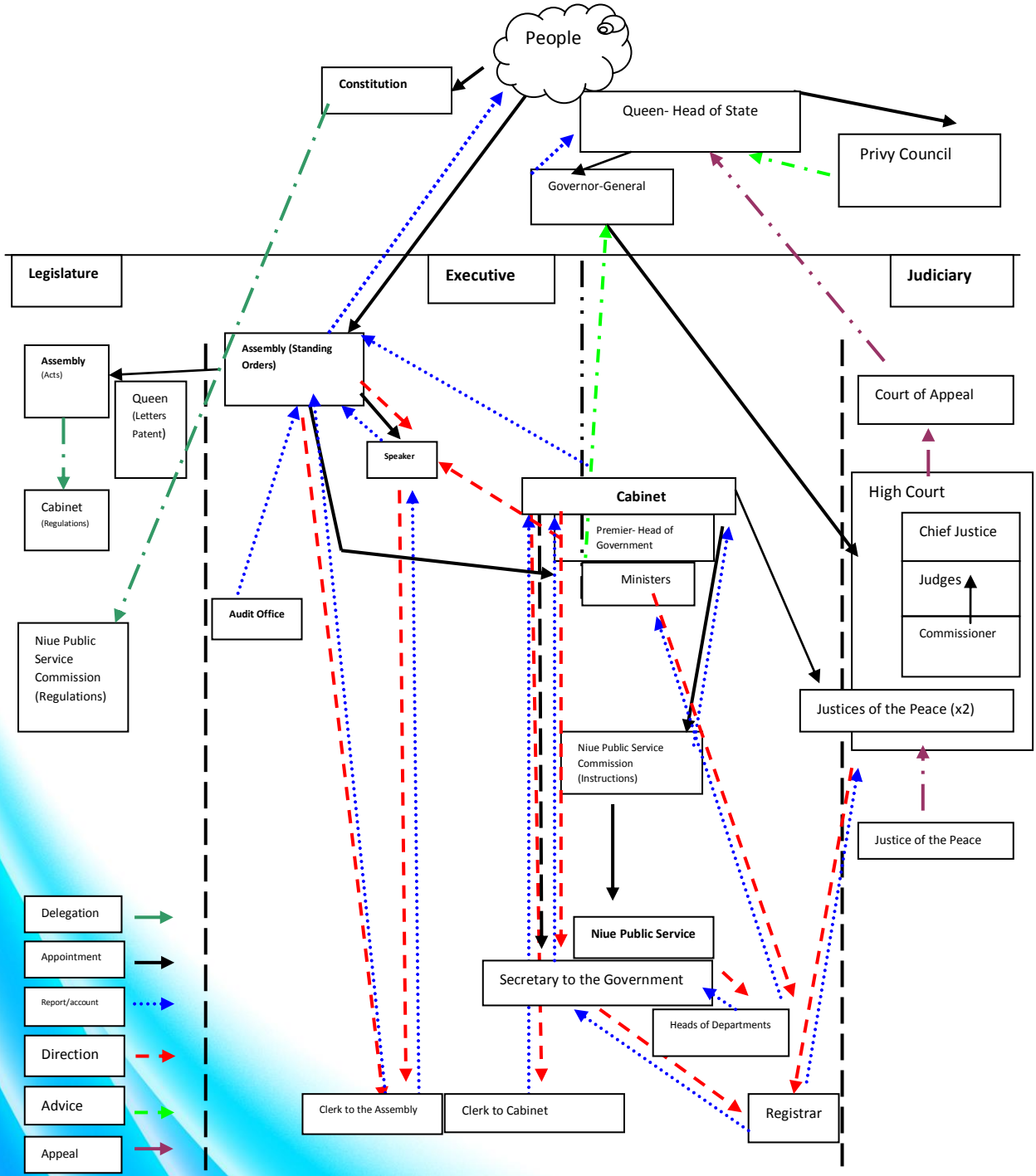
There is a Niue Public Service comprising employees necessary to assist Cabinet in the exercise of the executive authority and performance of functions and powers prescribed by law. From July 2008 to June 2009, the total number of employees in the Service was 351. In the following year the Service had ten employees less than the previous year (Treasury Department, 2010). There are fourteen non-trading departments, six trading departments and two corporations.

The Niue Public Service Commission ("Commission") is the employment authority responsible for all appointments to the Service. The Commission has the general oversight, control and management of the Service and is responsible for the efficiency and economy of all departments and public offices of the executive government. Appointments of commissioners are by Cabinet. Accordingly the Commission reports to Cabinet.

The chief administrative officer of the Public Service is the Secretary to the Government. Appointment of the Secretary to the Government is made by the Commission in consultation with the Premier and concurrence of Cabinet. The Secretary to the Government is responsible to Cabinet for the general direction of the work of all departments and offices of the executive government. The head of each Department accounts for the work of the Department to the Secretary to the Government and the Minister primarily responsible for that Department, or as the case may be, for the functions performed by the Department.

The Judiciary consists of a Chief Justice and Judges appointed under the Constitution to the High Court of Niue. Cabinet may also appoint Commissioners to the High Court who may exercise functions of the Judge of the High Court as may be prescribed by law either generally or within the limits of the jurisdiction conferred upon him. Cabinet may also appoint two Justices of the Peace. The High Court has three divisions namely, the Civil, Criminal and Land Divisions. It is responsible for the administration of justice. Appeals from any judgment of the High Court is heard and determined by the Court of Appeal. Appeals from the Court of Appeal are determined by the Privy Council.

**Figure 2: Constitutional Structure of Niue**



## *IV International Legal Personality*

Niue's constitutional relationship with New Zealand is one where the external affairs and defence of Niue is the responsibility of New Zealand. Up until 1988, treaty action for and on behalf of Niue was undertaken by the Government of New Zealand (UNGA LE, 1988). Niue is now responsible for its own treaty action.

Niue has exercised its international legal personality by entering into bilateral and multilateral relations with other members of the global community. It is a full member of numerous international and regional organizations such as the World Meteorological Organisation (WMO), World Health Organisation (WHO), Pacific Islands Forum (PIF), the South Pacific Community (SPC) and the South Pacific Regional Environment Programme (SPREP). In 2007, Niue established diplomatic relations with China.

## *V Infrastructure*

Niue's main public roads are tar sealed with the total distance of 67 km. Public roads were tar sealed island wide in the last 16 years but without maintenance support. A few cross island tracks used by the general public remain unsealed. There is one wharf for landing and offloading of vessels. It is an open harbour without natural shelter. This causes offloading difficult in poor weather conditions, particularly during storm surges. The wharf infrastructure and open harbour are significant limitations on maritime transport activities. The cargo ship arrives every three to six weeks subject to good weather and good technical standing of the vessel.

Significant damage to infrastructure caused by cyclone Heta in 2004 remains in some areas. The reconstruction of the bulk fuel permanent storage site and the cultural centre and museum remains uncertain.

The airport runway was extended and improved in 1995-1997 to cater for heavy aircraft. Air services stabilized in the last 4-5 years and Hanan International Airport now receives a weekly Airbus A320Air New Zealand flight, with a second weekly flight implemented in 2014 during peak tourism season. The Civil Aviation Division is established by statute to regulate civil aviation and related purposes. The Division monitors adherence to safety and security standards within the aviation system.

All basic utilities are government managed with the exception of the internet. Water, electricity and telephone communication is connected to most of the households' island wide. Telephone connection operates by an analogue system. The connection from the villages of Avatele to Tuapa is of copper cable while the remaining villages operate by wireless signal. The whole of the island is covered by one internet service provider (ISP) accommodating government and business sectors and village communities (Information Systems Office, 2009).

## *VI Economy*

Inconsistent, infrequent and insufficient demand for goods creates a gap in domestic production and vice versa. The consequence is a trade deficit. Hence, Niue's economy in its current form is not self-sufficient. A low population, scarcity in natural resources, isolation and high transport costs are some of the ongoing challenges for Niue's economic development. Previous initiatives in agricultural development for export have not survived through time. Examples are the export of banana, copra, lime and passion fruit.

In late 2004 a joint venture between the Government of Niue and Reef Company started a fish, noni and vanilla processing plants. Fish were flown to Japan during that period. Due to financial

difficulties, the fish processing factory ceased operation in 2007. Vanilla and noni operations continue at a small scale.

Due to its constitutional relationship with New Zealand, Niue receives provision for administrative and financial assistance from the Government of New Zealand. However, experience in the last 36 years has not been easy. Power disparity and changing political environments throughout time has made access to funds and resources for Niue difficult.

Niue's bilateral relations and membership in multilateral organizations also provide development assistance. Much of the existing protection and sustainable development of Niue's environmental resources has been guided through its membership in multilateral organizations. For instance, the climate change project provides opportunities for evaluating the environmental impacts of changing climatic conditions. Knowledge from these evaluations is useful for planning and adapting lifestyles and livelihoods correspondent to the changes.

Under the Niue National Strategic Plan 2009-2013 (NNSP), the government emphasizes economic development in the tourism, fisheries and agriculture sectors. The vision is '*Niue ke Monuina* - a prosperous Niue'. The objective is building a sustainable future that meets the economic and social needs while preserving environmental integrity, social stability and Niuean culture. The intention through the NNSP is to create opportunities for all Niueans through financial stability, good governance and development in the economic, environment, social and Tāoga Niue sectors.

***Vanilla flower, Tahitian variety (Vanilla tahitiensis) –***
***One of Niue's agricultural export products***

## A Agriculture

Land use and agriculture is predominantly of subsistence nature. The primary food crops grown are *talo*, bananas, cassava, sweet potato, yams, vegetables (cabbages, tomatoes, etc) and mixed tropical fruit trees. The main breadfruit season is from February to April.

Most households own a standing plot of *talo* and coconuts, with some also having vanilla, lime and vegetables. Traditional farming methods of slash and burn impose increased risk to soil fertility. This practice is now gradually being replaced with clearance by bulldozers which also have negative impacts on soil structure.

Food crops sustain damage from feral pigs and chickens. Nuisance caused by these are controlled through traps. Livestock farming, predominantly pigs but including a few head of cattle, also occupies part of each holding. Organic farming is encouraged through the Niue Island Organic Farming Association. A number of farmers are committed to organic farming practices.

From an economic perspective Niue faces the challenges of a small local market, lack of scale, geographic isolation from overseas markets that results in transport and post-harvest problems, brain and labour-force drain and lack of effective and efficient services. Niue agriculture confronts significant risks in development because of the continuing depopulation (FAO, 2009).

**Table 1: Agriculture and Land Use Activity by Villages (2009)**

| Village | Households | Agriculture Activity | | No. Holding | No. Parcel | Area in Acres | Areas in Hectares | Est Total Area Hectares |
|---|---|---|---|---|---|---|---|---|
| | | Yes | No | | | | | |
| Makefu | 17 | 15 | 2 | 21 | 57 | 52.8 | 21.3 | 1,713 |
| Tuapa | 33 | 32 | 1 | 50 | 105 | 168.3 | 68.1 | 1,254 |
| Namukulu | 4 | 3 | 1 | 6 | 6 | 9.0 | 3.6 | 148 |
| Hikutavake | 18 | 18 | 0 | 26 | 47 | 59.8 | 24.2 | 1,017 |
| Toi | 9 | 9 | 0 | 13 | 24 | 28.0 | 11.3 | 477 |
| Mutalau | 34 | 34 | 0 | 57 | 151 | 165.5 | 67.0 | 2,631 |
| Lakepa | 19 | 18 | 1 | 24 | 55 | 70.8 | 28.6 | 2,158 |
| Liku | 26 | 25 | 1 | 30 | 91 | 197.3 | 79.8 | 4,164 |
| Hakupu | 43 | 41 | 2 | 55 | 140 | 306.9 | 124.2 | 4,804 |
| Vaiea | 15 | 15 | 0 | 16 | 32 | 42.5 | 17.2 | 540 |
| Avatele | 42 | 42 | 0 | 56 | 123 | 170.8 | 69.1 | 1,399 |
| Tamakautoga | 35 | 34 | 1 | 40 | 128 | 135.5 | 54.8 | 1,193 |
| Alofi South | 118 | 87 | 31 | 143 | 200 | 294.8 | 119.3 | |
| Alofi North | 54 | 44 | 10 | 56 | 104 | 135.6 | 54.9 | 4,648 |
| TOTAL | 467 | 404 | 63 | 593 | 1,263 | 1,837.3 | 743.5 | 26,146 |

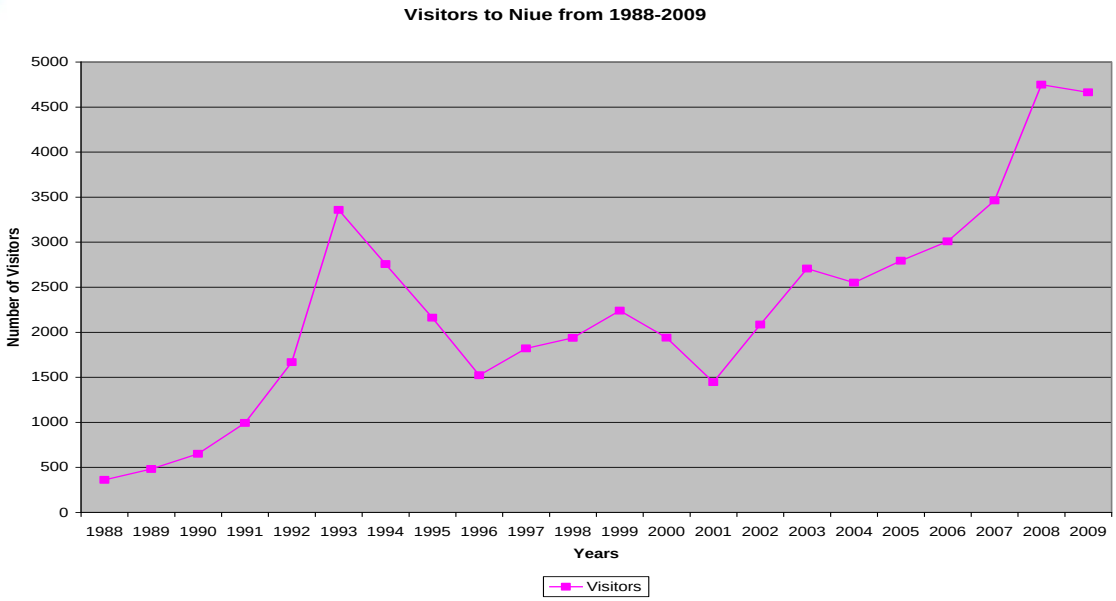
## B Tourism

Niue's tourism strategy revolves around the preservation of its pristine environment and maintenance of the existing infrastructure and Niuean lifestyle. Consistent with these ideals, the Niue Tourism Authority is cautious with the number of visitors allowed per year. Within the last twenty years a positive trend illustrated steady increase in the number of tourist visitors. The targeted number of visitors in 2003 was up to 5000 visitors per year. Notable growth has been steady since 2004.

Several of the factors contributing to the increase are strategic niche marketing to individuals with high financial disposal, commercial contracts with wholesalers in New Zealand and Australia,

internet marketing, and reliable air services from New Zealand. As at the end of 2009, visitor numbers reached 4,662 (Statistics Niue, 2009).

**Figure 3: Visitors to Niue from 1988 to 2009**




As at the end of 2009, government reinforced its commitment to economic development with particular emphasis in the tourism sector (Hall, 2009). Current efforts towards development of this sector include demolition and cleaning of derelict homes and the collection of toxic and non-biodegradable wastes.

***Sunset in Alofi harbour, with visiting yachts/tourists in the bay***

## C Gross Domestic Product

The Gross Domestic Product (GDP) estimate for 2006 was NZD$20 million (Statistics Niue, 2009). This is a small but constant increase from previous years. Government is the major contributor to the GDP accounting for approximately 40% while the agriculture and fishing sectors account for approximately 24% of the total value.

**Table 2: Trends in Gross Domestic Product 1997-2006 (current NZD) (Niue Statistics website: www.spc.int/prism/country/nu/stats)**

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|
| **GDP (000)** | 13, 733 | 14,693 | 17, 170 | 16,788 | 16,711 | 16,245 | 17,821 | 17,771 | 19,441 | 20,541 |
| **GDP/capita** | 6,376 | 7,111 | 8,678 | 8,831 | 8,999 | 9,401 | 10,114 | 9,740 | 11,110 | 12,158 |
| **GDP by Sector (000)** | | | | | | | | | | |
| **Agriculture, Forestry, Hunting, Fishing** | 3,450 | 3,320 | 3,968 | 3,774 | 3,723 | 3,910 | 4,157 | 3,962 | 4,326 | 4,913 |
| **Wholesale, retail, Trade, Repair** | 1,428 | 1,433 | 1,791 | 1,761 | 1,912 | 1,840 | 2,181 | 2,433 | 2,653 | 2,344 |
| **Transport, Storage & Communication** | 1,022 | 1,218 | 1,680 | 2,011 | 1,932 | 993 | 1,623 | 1,088 | 1,273 | 1,057 |
| **Financial Intermediation** | 1,325 | 1,301 | 1,568 | 1,308 | 1,443 | 1,461 | 1,434 | 1,547 | 1,334 | 1,596 |
| **General Government Non-market** | 5,379 | 5,482 | 6,474 | 6,424 | 6,591 | 7,519 | 6,817 | 7,031 | 7,006 | 6,941 |

### D Inshore fisheries

Niue's inshore fishery is shaped by its coastal topography limited to coral reefs and effluent run off mixed with deep oceanic current. The inshore fishery area is 12 nautical miles from the coastline and focused mainly on subsistence and semi subsistence fishing. Fishing activities within this zone are for local based fishing operators consisting of dinghy, traditional canoes, chartered tours and sports fishing.

The Domestic Fishing Act 1995 and Domestic Fishing Regulations 1996 regulate all fishing activities within the inshore fisheries area. There are two declared marine protected areas (MPAs) jointly monitored by the Niue Fisheries Division (NFD) and respective Alofi North and Makefu Village Councils. The establishment of the MPAs was a joint initiative of the International Waters Project (IWP) and the NFD. These were designed and implemented by the community with key considerations relating to total or partial closure and restrictions on selected species. Future restrictions on fishing activities could also be enforced depending on issues arising from the MPAs.

Additional Fish Aggregating Devices (FADs) were installed in 2008 to support local subsistence fishing and promote food security. A three nautical mile no commercial fishing zone is enforced in the FAD area. NFD is at the planning stage on imposing seasonal closure during spawning of the coconut crab (*Birgus latro*) as a conservation measure. It is intended that the first three seasons of the closure will allow to study and analyse the conservation measures that could strengthen the scientific knowledge and set the basis for identifying sustainable management measures. Shifts in marine temperature have affected fisheries patterns particularly in relation to migratory fish. Coral reef bleaching and growth of invasive species have raised concerns regarding the increasing number of cases of ciguatera poisoning in the Alofi area.

## E Offshore fisheries

Niue's total EEZ area is 450,000 square kilometres. The fishery deals with highly migratory fish species. Commercial fishing activities consist of long line vessels targeting albacore, big eye tuna, yellow fin and skip jack. By-catch of other migratory species are sold to the local market. All catches are transhipped in port with 100% observer coverage.

All long-line vessels currently operating in Niue waters are registered with the Cook Islands Fishing Registry under a direct licensing arrangement. NFD has an on-going databank of collected and analysed data of all catches in Niue waters by licensed vessels. Only one fishing vessel operated in 2008 due to the closure of the Niue Fish Processing Plant. There are currently two Taiwanese fishing vessels and seven other vessels registered in the Cook Islands and authorised to fish within Niue waters. Catch and vessel composition for 2006-2010 is summarised in Table 3 below.

**Table 3: Catch and Vessel Composition 2006-2010 (Tonnes)**

| Year | Vessel | Flag | Albacore | Big Eye Tuna | Yellow Fin Tuna | Other | Total |
|---|---|---|---|---|---|---|---|
| **2006-07** | Faimanu7 | French Polynesia | 0.0 | 0.1 | 0.1 | 0.5 | 0.7 |
| | Faimanu 8 | French Polynesia | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 |
| | Jacqui M | Cook Islands | 149.9 | 16.3 | 30.5 | 32.0 | 228.7 |
| | Jay Belinda | Cook Islands | 61.7 | 5.7 | 10.4 | 9.8 | 87.4 |
| | Monuina | Niue | 1.3 | 0.2 | 1.2 | 0.4 | 3.2 |

NFD provides policy, technical and scientific advice regarding the fisheries. Key decisions from NFD are made with the Director of the Department of Agriculture, Forestry and Fisheries (DAFF), Fisheries Director and the Minister. Legal support is provided by the Crown Law Office.

As a party to the United Nations Convention on the Law of the Sea (UNCLOS), Niue as a Port State has control over fishing vessels that enter Niue waters. Vessels are required to comply with all national monitoring control and surveillance (MCS) regulations. MCS is coordinated by NFD. Authorised officers assist with MCS procedures and are appointed under the Territorial Sea and Exclusive Economic Zone Act 1996. Authorised officers are from NFD, Customs Niue and Niue Police. NFD also coordinates regional MCS exercises (Operation Tuimoana).

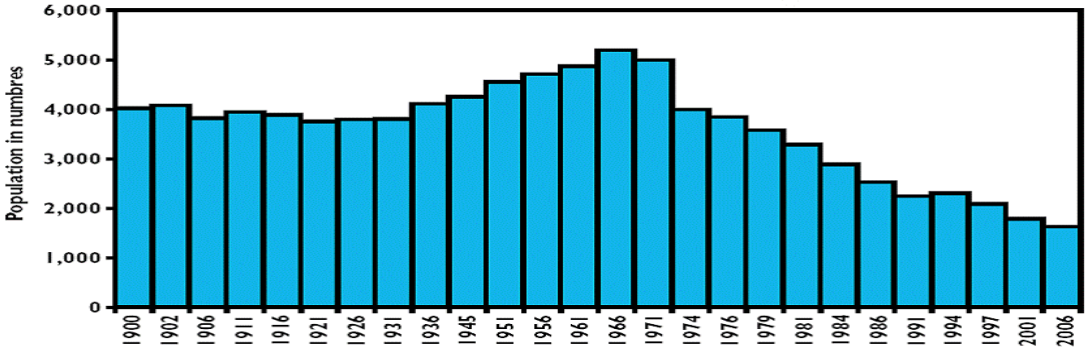
As a party to the Niue Treaty on Cooperation in Fisheries Surveillance and Law Enforcement in the South Pacific Region (The Niue Treaty 1993), support is received from the Cook Islands Maritime Police under the Niue Treaty Subsidiary Agreement Memorandum of Understanding between Niue and the Cook Islands. The Cook Islands Maritime Police are also appointed authorized officers to patrol the Niue EEZ. Aerial surveillance is received from the Royal New Zealand Air Force (RNZAF). The vessel monitoring system (VMS) includes checking of vessels, collection and collation of fisheries data, observer coverage for transhipment, searches for illegal substances of vessels and general investigations on illegal unreported unregulated (IUU) fishing activities.

# *VII Population and Development*

Niueans are people of Polynesia. The official languages are Niuean and English. Relative to its geographic size, Niue's population is small. Over time, a low and declining population has been a constant concern for Niue. Niue's population peaked in 1966 with over 5,000 residents. As Niueans are citizens of New Zealand, there is regular movement to and from New Zealand. The rapid decline in population occurred between 1971 and 1974 coinciding with the opening of the Hanan International

Airport and Niue attaining self-government in free association with New Zealand. Since that period, the population continuously decreased with exception of the year 1994.

**Figure 4: Niue's Population from 1900-2006**




The population density as of 1997 was six people per square kilometre. In 2006, the total residential population on Niue was 1,538 (Statistics Niue, 2006) compared to the 22,476 people of Niuean descent living in New Zealand (Statistics New Zealand, 2006). The youth (15-24 years) account for 16.4 % of the resident population while children at the age of 15 years and younger account for 26.7%. In relation to ethnicity, 81% of the residents are of Niuean descent with the remaining 19% belonging to other ethnic groups. Pacific islanders, comprising mainly of Tongans, Tuvaluans, Samoans and Fijians, account for 11% of the resident population, while 3 % are of European descent, 2.6% are of Asian descent and the other 2.6% descend from other countries.

The ratio for representation in the Niue Legislative Assembly is approximately one representative for every seventy five people (1:75). In November 2009, the provisional result for the total resident population was 1,541 (Statistics Niue, 2009). The departments of Health and Community Affairs intend to implement a strategy for population retention and increase.

## A Health

The current law for public health is outdated and requires revision. There is a draft public health bill pending. The new bill widens the scope of the DOH to include roles and practices not adequately covered under the present law. It also confers protection on its medical professionals who in exceptional circumstances might be required to administer treatment against a refusing patient.

A newly constructed Niue Foou Hospital was opened in 2005 and replaced the Lord Liverpool Hospital destroyed by Cyclone Heta in 2004. The hospital consists of three medical practitioners and forty-five staff responsible for the delivery of health services. The Niue Health Department (NHD) is divided into five sections, being the administration, medical, nursing, public health and dental. The hospital is the only health facility on the island. Health services are provided free for local residents while a fee applies to visitors.

As at 2001-2006, women's average life expectancy is 76 years while men's is 67 years. The crude birth rate is 15.8%. The total fertility rate is 2.6% (Statistics Niue, 2006). There are no reported HIV/AIDS cases on Niue. Similar to its neighbouring Pacific islands, the health burdens on Niue are diabetes, hypertension, gout and obesity.

One of NHD's principal aims is to improve the quality of existing environmental health services. These services include monitoring of the waste management system, water quality, vector control, food premises and community dwellings. Village and food premises inspections are held annually. Island wide spraying against mosquitoes is done quarterly.

Standards for sanitation of buildings and dwellings are also administered by the Department. Recently, a WHO funded sanitation project allowed for the construction of ten new toilet and shower extensions in one village. There is no common burial ground for the dead. A concrete based burial is standard. An internal waste management plan for the hospital is under development.

The DOH aims at developing a population strategy that will increase population within the next three years. The average number of pregnancies is 20-30 women per year. The plan is for this number to increase by half within the next three years. From time to time the hospital can provide services for birth deliveries subject to availability of qualified staff. However, the option is still open for mothers who prefer to travel at their own cost to New Zealand hospitals. Under the services of maternal and child care, there is an ongoing 100% vaccination coverage programme for infants.

Dental staff and oral health awareness visits to schools are carried out periodically. Recently, a new general health clinic was established at the Niue High School to cater for the health needs of students and staff. The clinic will be staffed by a nurse and a medical officer on a part time basis. Starting in 2011, a health promotion officer is expected to pay regular visits to the school and consult with students on health issues.

Proactive community outreach programmes are ongoing. An example is the recent blood survey for the vector borne lymphatic filariasis on the entire population. This was a follow up from a mass treatment programme several years ago. Several cases were found and treated. The hospital expects to establish an ongoing screening system for this disease in the future.

Ongoing promotions through the media are in the areas of HIV prevention and smoking. A Moui Olaola (healthy lifestyle) action plan and an HIV policy are awaiting Cabinet approval.

Awareness and promotion activities are also in the area of mental health. Ongoing support is received from an external service provider with the CMDHB. A draft Mental Health Bill is currently under discussion.

Data collection and record keeping is separated under each sector. There is not yet a centralized database for all health cases or a designated person to create and manage a centralized data system. There are a few areas where monitoring and evaluation is built into the system. Expected outputs and outcomes are reviewed annually during budget discussions.

DOH works closely with and receives mentoring from the Secretariat of the Pacific Community (SPC) and WHO. An assessment carried out by the WHO and the University of Auckland (2012) indicated that climate change will affect Niue in a number of ways by amplifying existing health problems, rather than creating new problems. These include:

- Possible increase in burden of dengue fever with warming temperatures and altered ENSO and rainfall patterns (Hales *et al*, 1999);
- Possible increase in burden of ciguatera with warming sea temperatures, changing ENSO patterns and other factors (e.g. ocean acidification, coral bleaching etc) (Llewellyn, 2010)
- Possible increase in burden of diarrhoeal illness with warming temperatures and extremes of rainfall (Singh *et al*, 2001)
- Possible increase in burden of respiratory infections (e.g. influenza, pneumonia) and obstructive airways disease (e.g. asthma) in warmer, wetter weather (Paynter *et al*, 2010; Hughes *et al*, 2011)
- Possible increase in dehydration, heat stress, hospitalisations and deaths during very hot days (Portier *et al*, 2010)
- Possible increase in burden of NCD's due to compromised food security, decreased physical activity in warmer weather.
- Possible increase in injuries (and deaths) and mental health problems from extreme events such as cyclones (McMichael *et al*, 2003)

- Possible increase in skin infections/infestations with increasing temperatures and altered rainfall patterns (Ebi *et al*, 2006).

The study also found that the overall risk of each climate-sensitive health issue as outlined above is based on the *likelihood* of an increase in the burden of each health problem (given the "climate-sensitivity" of the respective diseases) and the *impact* of such an increase on individuals and communities in Niue (taking into account the current burden of these diseases and the capacity of the health sector to manage them). Thus the assessment is inevitably somewhat subjective, and it is intended that this list of issues and adaptation strategies be reviewed and updated regularly, as circumstances change and/or new information comes to hand.

For now, there is good evidence from research performed elsewhere in the Pacific region and around the world that each of the health issues discussed below (vector-borne diseases, ciguatera, diarrhoeal disease, respiratory disease, heat-related illness, non-communicable diseases (NCD's), health impacts of extreme weather events and skin infections/infestations) is sensitive to changes in climate. Mental health issues may also obviously arise from climate change (e.g. extreme weather events); management of this may become a higher priority into the future.

## B Education and Training

Domestic education services are offered through the Department of Education (DOE). The DOE's objective is to "improve the quality of education and to improve student learning".

There is one primary school and one high school. Intermediate level education is within high school. Up until 1988, there were eight government primary schools around Niue. Issues arising from declining pupil population and maintenance of those schools required significant changes. By the start of the 1989 school year, all primary schools were centralized into a single primary school at Alofi. The Niue system follows the New Zealand school curriculum and works closely with the New Zealand Qualifications Authority as the accreditation body for Niue. The contextualisation of the New Zealand school curriculum requires appropriate changes by inclusion of the Niue context in schemes of work for schools. Teaching methodologies constantly change over time and training of local staff is required. Partnership between schools and homes is necessary in order to raise awareness of the new school curriculum and new teaching methods. Schools and staff have difficulties meeting these changes in time.

Education services is limited to early childhood, primary and secondary level education. Tertiary and vocational education is undertaken in New Zealand and abroad. Management of higher education opportunities is undertaken by a separate office, the National Development and Training Council. Support for higher education is offered by way of donor scholarships and the Niue Government reverse scholarship system. Students under the reverse scholarship scheme may undertake studies in New Zealand at their own cost. When studies are completed and students return and contribute to Niue's development, all school expenses and loans will be paid off by government in increments equivalent to the timeframe of the study period. The scheme is to encourage the return of qualified young people.

Issues with school buildings and facilities arise in relation to standard safety and building code requirements. Both primary and high school buildings have deteriorated over the years and require maintenance and repair. Lack of funding to support maintenance and repair of the two schools are real concerns. Health services, life skills education and special needs are absent because of staff and resource constraints.

The Department of Education is a recipient of the European New Zealand Aid funded Pacific Regional Initiative for the Delivery of Basic Education (PRIDE) launched in 2004. The objective of PRIDE is to enhance the capacity of Pacific Education agencies to effectively plan and deliver quality basic education, through formal and non-formal means.

Community education for the adult population is provided for in law but is yet to be implemented. Cultural and Niuean language education is taught at both levels but requires strengthening. Resource constraints by way of staff shortages, professional development of staff, shortage of textbooks and materials are considerable challenges against provision of quality education. Under the current DOE strategic plan, there is emphasis on development of appraisal systems for staff to enhance teaching capacity. The competence and capacity of current teaching staff is uncertain in the absence of appraisals or inspection systems.

Part of the functions of the Environment Department is to foster knowledge and practices embodying traditional lifestyles that promote the protection, conservation, improvement and management of the environment. Partnership with the Environment Department and Tāoga Niue will be necessary to assist with learning in these areas. The Health Department in its current strategy aims to develop and integrate health education into the school curriculum by 2013.

Niue is bound by the International Covenant on Civil and Political Rights (ICCPR), the International Covenant on Economic, Social and Cultural Rights (ICESCR), the International Convention on the Elimination of all Forms of Discrimination Against Women (CEDAW) and the International Convention on the Rights of the Child (CRC).

The safety and security of children is provided for under criminal provisions that directly relate to the security of children. Guardianship issues of children and contractual capacity of minors is also provided for in law. Since 1995, the Department of Community Affairs implements a scheme for payments to school pupils for each school term. Recipients of the child allowance qualify on the basis of Niuean descent, financial dependence, ordinary residence, enrolment and attendance at school.

## *VIII Tāoga Niue and Culture*

The culture and lifestyle of resident Niueans is directly in relation to its physical environment. The status and welfare of the Tāoga Niue and its environment is indivisible and interdependent.

Niuean culture and traditions can be described by its language, customary practices and usages. Niuean language is said to belong to the Tongic group. A traditional hierarchy of chiefs and titles is absent in the Niuean custom. Customary practice and usage is determined largely within nuclear and extended families. Some aspects of Niuean culture, customs and practices are similar to neighbouring Polynesian islands. However, the defining aspect of the Niuean culture is directly related to its isolation and the unique features of its physical environment.

Protection of Niuean customs and usages is provided for in the Constitution only in respect of Niuean land. Agriculture is predominantly subsistence farming. As a result of its culture and origins, it is imperative that environment led programmes and policies regarding the physical environment consider implications for culture and customs of Niue.

In 1986, a Niue Cultural Council was established to promote all aspects of work connected with the natural history and material culture of Niue. In 2004 at its 30th Constitutional celebration, Niue Government held the inaugural *fono*(meeting) for a Tāoga Niue initiative. The then Premier Young Vivian stated that Tāoga Niue was "to harness all those things which together make up the spirit and material being of *tagata Niue*(Niue person)and secure the sovereign and ethnic identities of all Niueans". The *fono* addressed serious concerns over loss in the Niuean language and culture because of population decline and strong influences of imported economic and social choices.

In 2007, a Tāoga Niue Department was officially established through New Zealand funding. The Department's principal purpose is to promote, preserve and strengthen Niuean cultural heritage, language, values and identity.

The Tāoga Niue and the Vagahau Niue (Niuean Language) Bills are currently in passage at the Niue Legislative Assembly. The objectives of the Bills are: to provide for the development of policy relating to Tāoga Niue; to promote and encourage study of Tāoga by indigenous Niuean; to

encourage and foster the study of Niuean oral traditions, language and creative and performing arts in their traditional and contemporary forms; to promote all aspects of work connected with tāoga and technology related to the documentation, conservation and where appropriate the repatriation of Tāoga; to foster the work of the National Museum and Cultural Centre, the National Library of Niue, National Archives and the use and development of historic sites; and to provide for the intergenerational protection of the Niue natural environment. These aspirations are integrated under the Tāoga Niue development pillar of the NNSP.

## A Niuean land

Patterns of land use are unevenly distributed due to variations in physical features. The system for use and distribution of land was initially administered by the Land Court of Cook Islands under the Cook Islands Act 1915 until 1966 with the establishment of the Niue Land Court. In 1986, a land registration system was introduced. To date, the quantity of registered Niuean land is approximately 28 square kilometres. A further 2 square kilometres is Crown land. The remainder is unregistered Niuean land.

## B Land Tenure

All land is vested in the Crown subject to rights held under Niuean custom. Leases are permitted up to 60 years with rights of renewal. Leaseholds on land for public purposes may be subject to perpetual rights of renewal. Compilation of data on registered leases to date is in progress. This is considered a priority since agricultural lands and crops practices need to be reviewed in view of climate change impact.

Land transactions are subject to confirmation and approval of the Niue High Court except for leases less than 2 years. Land transfers are limited to the lifetime of the individual and cannot be transferred as part of an estate under a will. Land held under customary title can be used as security for loans from approved lending institutions.

The sale or outright alienation of Niuean land is prohibited by law. There is no freehold land on Niue except land previously sold or gifted to the Crown before 1969. Determination of ownership to Niuean land is provided for in the Constitution. Niuean land is to be determined in accordance with the customs and usages of Niue. In custom the land owning group is the *magafaoa* (family) who traces their descent to a common ancestor. The *magafaoa* includes family by way of marriage or adoption. Absent family members may claim membership of the *magafaoa* and consequently, their interest in family land. Absentee land owners who wish to participate in decision making processes create considerable challenges for the speed and certainty of land transfers.

## C Land Use

Existing estimates on land use vary. A report under the United Nations Convention to Combat Desertification in 2002 raised concern on the progressive decrease of indigenous forest areas for agricultural use. The deforestation within a 30 year period from 1966 was equivalent to 0.9% per annum of the original forest cover (DAFF, 2002). This estimate is subject to verification on the basis that it does not account for reduction of forest cover through cyclones, declining population and the absence of large scale commercial farming. Future estimates will be obtained through an anticipated land valuation project through the Department of Justice, Lands and Survey.

In a recent survey from the Department of Agriculture, approximately 3% of the total land area is used for agricultural purposes by households (Statistics Niue, 2009). Crown land comprises land used for public purposes and as such, includes government buildings and institutions, public roads and churches. Compilation of data on registered Niuean land and various uses are work in progress.

## *IX Energy and Bulk Fuel*

Electricity is accessible to all households island-wide since the mid-1970s. Electricity is predominantly generated through diesel fuel powered generators. This is now complemented by solar panels through the Renewable Energy project. Substantial changes to electricity supply and consumption are notable after the Cyclone Heta and a fire accident to the power station in 2005.

Fuel is imported on a monthly basis and is managed and distributed through the Bulk Fuel division. The division imports all petroleum products which includes petrol, gasoline for domestic use, aviation gasoline, kerosene and diesel. Since September 2009, the division also manages the import and distribution of gas under an EU funded Renewable Energy project.

## *X Environment and Resources*

Niue's natural environment and its resources have primary significance to its people, culture, lifestyle and livelihood. Of secondary importance is its economic potential, particularly in the areas of fisheries and tourism development. It is therefore the mission of the NNSP to build a sustainable future that meets the economic and social needs while preserving environmental integrity, social stability and the Niue culture.

The Environment Department was established in 2003 and enacted in law under the Environment Act 2003 and the Tāoga Niue Department was established in 2006. Both departments manage culture and environment related issues.

**Figure 4: Niue's Soil Map**

### A Soils

Niue's soil fertility is limited. It is high in calcium and magnesium, low in nitrogen, potassium and sodium and deficient in zinc. Characteristics of Niue soils are a derivation of a blend of volcanic materials. Some soil types are identified as follows (Wright & Westerndorp, 1965);

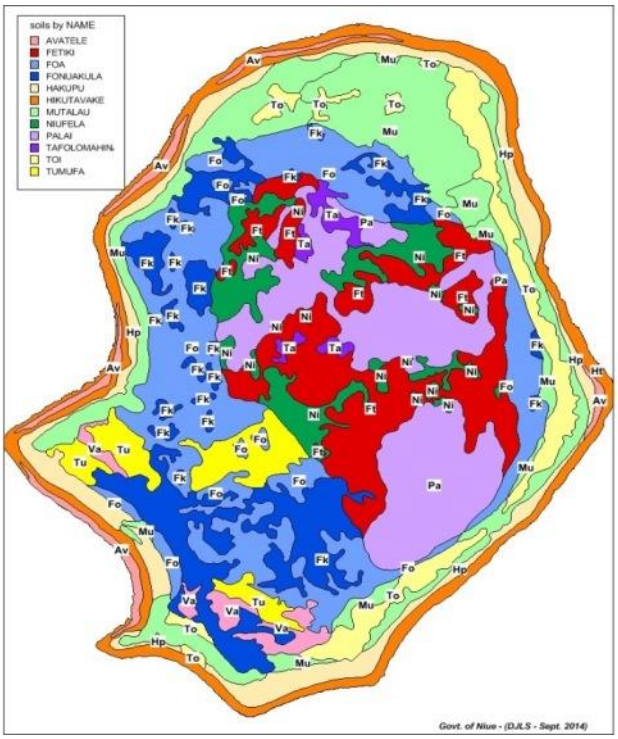
(i) Hikutavake soils: black soils derived mainly from limestone

(ii) Hakupu soils: sub-soils are successively brown and granular

(iii) Fonuakula soils: sub-soils are brownish red-to-red soils.

(iv) Palai Soils-sub soils are brownish red-to-red soils

The Department of Justice Lands & Survey have also produced a soil map identifying other soil types using data from 1965 and 1986 (Figure 4).




### B Water

Niue's main water source is from underground water catchment. The other source is from direct rainfall into water storage tanks. The rainfall seeps through porous coral until it reaches the saline water underlay where the lowest density forms a pool over salt water (Environment Department, 2009). This underground water lens is pumped to header tanks and reticulated untreated for household,

agriculture and industry consumption. Water is considered high in calcium and magnesium but of good drinking quality.

The water lens is susceptible to over-pumping and may lead to salt water intrusion, pollution from solid and hazardous wastes from waste water, chemicals and fertilizers disposed into the ground. A study conducted by South Pacific Islands Geoscience Commission (SOPAC) discovered that Niue's aquifer can only store 3 months of recharge and, given the perceived rapidity of its response to recharge events and subsequent immediate spring discharge, the freshwater lens is likely to reduce considerably during the dry period of 3 or more months of the year.

The study also illustrated high levels of nitrate in boreholes near Alofi suggesting a need for proper treatment and disposal of sewage effluent (SOPAC, 2005). Destruction to vegetation and properties from cyclones also increases the vulnerability of aquifers as a whole.

A recent development in water resource management is the International Water Resource Management (IWRM) project which coordinates a consolidated approach towards management of the water resource. An implementation project that works in collaboration with IWRM is the Pacific Adaptation to Climate Change Project (PACC) focuses on an alternative source of retrieving water through rain water harvesting. Water catchments are provided to households for storing rain water. This alternative water source reduces the risk of shortage during cyclones, prolonged dry periods, droughts and power shut downs.

The Water Resources Act 1996 provides a basis for the investigation, use, control, protection and management of the resource. A draft Bill, currently under discussion, provides for developments not reflected in the current law.

## C Biodiversity

Niue's biodiversity is limited by its geographic location and size. The sources of information on flora and fauna on Niue are dated and require revision. Changing times and circumstances may have shifted the nature and complexities of Niue's biodiversity so that future surveys would be imminent.

Niue signed up to the Convention on Biological Diversity (CBD) in 1996 and has since undertaken strategies to meet its obligation under the Convention. A National Biodiversity Strategy and Action plan was approved in 2001 followed by steady progress of activities. Niue has submitted its Fourth National Report to the CBD at the end of 2009.

### *1 Flora*

There are no recent surveys since Sykes (1970) regarding flora. There are no plant species considered endemic to Niue. There are a number of potential invasive weed pests and aggressive weeds identified by the Environment Department. The Department anticipates an implementing project for the prevention, control and management of invasive alien species by the end of 2010.

***Niue flora - A traditional indicator of a seasonal fish, Kaloama***

There is a land use map of Niue (1994) featuring seven types of vegetation. Crop land and fern land are both grouped as managed vegetation, littoral shrub land, littoral forest; coastal forest, mature forest and secondary forest are grouped as natural vegetation. The largest land cover is from secondary forest followed by mature forest. Littoral forest and shrub land are found in coastal areas. Niue's forests are sanctuaries for most of its significant wildlife.

From 1966 to 1981 it was estimated that cleared areas accounted for 16.2% loss in forest cover. Regeneration also occurred within the same period (Niue National Biodiversity Strategic Action Plan, 2001). Land clearance is predominantly for private agricultural purposes.

There are no plans to develop the timber industry for commercial purposes and land clearance in forest areas has been discouraged. This effectively removes the threat to diminishing forest cover. Customary practices (*tapu*) are recognized and included in conservation and management measures (Environment Department, 2009). Examples are the two protected areas, Huvalu Conservation Area and the Hakupu Heritage and Cultural Site. Conservation measures are also outlined in the Forest Policy (2004). There is a proposed Forest and Protected Area Management project for sustainable management measures over Niue's forest resources. A Forest Bill is being drafted to regulate the sustainable use of forest resources in accordance with the Forest Policy.

*2 Fauna*

There are no endemic species to Niue except for two bird species. In 1998 there were 29 species of birds found on Niue and 13 other species from the central Pacific region thought to be vagrants and are occasionally found on island (Powlesland, 1998). Fruit bat *(Pteropus tonganus),* pacific pigeon *(ducula pacifica)* and the coconut crab *(birgus latro)* are edible species of importance for Niueans. Both the fruit bat and pacific pigeon are identified as endangered species since 2004. A five year ban against hunting of the fruit bat and pacific pigeon was enforced following cyclone Heta.

**Table 4: Species Count: Status, Trends and Threats (Environment Department, 2009)**

| Species –general | Total numbers (current) | Numbers that are endemic | Numbers that are introduced | Numbers of endemic species considered threatened |
|---|---|---|---|---|
| Birds | 31 | 2 | | |
| Terrestrial Mammals | 2 | | 2 | |
| Reptiles | 5 | | | |
| Invertebrates | 376 | | | |
| Insect pests | 4 | | | |
| Land crabs | 8 | | | |
| Marine mammals | 2 | | | |
| Reptiles | 2 | | | |
| Fish | 240 | | | |
| Invertebrates | 25 | | | |
| Plants | 175 | | 35 | 56 |

## References


Department of Justice, Lands and Survey *Annual Report 2008-2009* Government of Niue, Alofi.

Department of Agriculture, Forestry and Fisheries & Statistics Niue *Niue Mini Census Population and Census Agriculture* 2009,Government of Niue, Alofi.

Environment Department *Fourth National Report to the Convention on Biological Diversity* Government of Niue, Alofi, 2009.

Department of Agriculture, Forestry and Fisheries *National Forest Policy*, 2004, Government of Niue, Alofi.

Environment Department *Niue National Biodiversity Strategy and Action Plan*, 2001, Government of Niue, Alofi.

FAO *National Mid Term Priority Framework Niue*, 2009
www.faopacific.ws/Portals/167/progrmmes/...TF/Niue_TF.pdf.

Foote, Church *et al Niue Education Stock take Report* Government of Niue, Alofi, 2004.

Information Systems Office *Report on ISO and National ICT Policies*, Government of Niue, Alofi, 2009.

Kirono *et al*, *Climate Change in Niue*, 2008, Government of Niue, Alofi.

Land care Research. *Niue Forestry Project, Niue Island. Project Implementation Document*,2000. Land care Research, New Zealand.

Lincoln International Report *End of Project Review of the Niue Education Project*, Government of Niue, Alofi, 2002.

New Zealand Government Letter to the UN General Assembly on Treaty Actions into the future (UNGA LE 222 New Zealand 10 Nov 1988).

Niue Education Strategic Plan 2005-2010.

Niue Meteorological Service, 2000 *Niue Island Initial Communication*, Government of Niue, Alofi.

*Niue National Integrated Strategic Plan 2003-2008*, Government of Niue, Alofi.

*Niue's National Report on the Implementation of the United Nations Convention to Combat Desertification 2002*, Government of Niue, Alofi.

*Niue National Strategic Plan 2009-2013*, Government of Niue, Alofi.

*Open Borders- No cases of H1N1 in 2009*, Government of Niue, Alofi.

Powlesland, R & Hay, R *Guide to Birds of Niue* South Pacific Regional Environment Programme, Apia, Samoa, 1998.

Statistics New Zealand (www.stats.govt.nz)

Statistics Niue (www.spc.int.prism/country/nu/stats)

Taoga Niue (Department of Niue Cultural Heritage) *Ko e Fakailoaaga Gahua Ma e Magahala 1 Iulai 2007-30 Iuni 2008* Government of Niue, Alofi.

*The Estimates of Expenditure and Revenue* (July 2008- June 2009) Government of Niue.

*The Estimates of Expenditure and Revenue* (July 2009- June 2010) Government of Niue.

Trevor Hall, 2009 *Niue Report to the New Zealand Foreign Affairs Minister Hon Murray McCully.*

Vienna Convention on the Law of Treaties 1155 UNTS 331

Wright, A.C.S & F.J Van Westerndorp. 1965. *Soils and Agriculture of Niue* New Zealand Department of Scientific and Industrial Research Soil Bureau Bulletin No. 17

# 3.GHG Inventory

# *I Introduction*

The Article 4.1 of the UNFCCC requires that all Parties "must report on the steps they are taking or envisage undertaking to implement the Convention". The UNFCCC contains as a core element of National Communications for both Annex One and non-Annex One Parties, the requirement for information on "emissions and removals of greenhouse gases and details of the activities a party has undertaken to implement the Convention" (Article 4.1a and 12). The information on emissions and removals of greenhouse gases (the 'greenhouse gas inventory') is required to be updated regularly on a timetable that is different for Annex One and non-Annex One Parties.

In 2000 Niue submitted its First National Communication to the UNFCCC secretariat that contained the Niue National Greenhouse Gas Inventory. The first Niue Greenhouse Gas Inventory was prepared for the year 1994, as provided in the guidelines the preparation of national communications from Parties not included in Annex I to the Convention, contained in decision 10/CP.2 of the Conference of the Parties.

In accordance with Article 4.1a of the Convention, Niue now submits its Second National Communication. The greenhouse gas inventory for Niue covers the greenhouse gas emissions and removals between 2005 and 2009, it compares these years to the base year of 2000.

The worksheets contained in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (2006)* have been used throughout the preparation of this inventory to ensure a consistent and comparable approach across sectors and between Parties to the UNFCCC.

# *II The Niue Greenhouse Gas Inventory (NGGI)*

## A Methodology and Data

The COP in its decision 17/CP.8 provided the guidelines for preparation of national communications from non-Annex 1 parties. The inventory for Niue used the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.*

All greenhouse emissions in this Inventory have been compiled at the Tier1 level; that is from national energy statistics and default emission factors.

The IPCC has subdivided emissions into five major source categories. Greenhouse emissions from several of the IPCC source types are not material in the context of Niue and have not been considered further in the context of this inventory. Table 2 indicates how each source category has been considered.

## B Correction to 1994 Baseline Inventory

During the preparation of this Inventory, it was noted that 1994 greenhouse gas emissions reported in the First National Communication (2001) as Gg $CO_2$e were actually emissions calculated in tonnes $CO_2$e and wrongly transcribed. The impact of this change would have reduced Niue's 1994 reported greenhouse emissions by a factor of 1000, to approximately 4.4 Gg $CO_2$e from 4395 Gg $CO_2$e.

**Table 2: Treatment of Source Categories**

| Source Category | Inventory Consideration |
|---|---|
| Energy Activities<br>• Fuel Combustion<br>  ○ Energy Industries<br>  ○ Transport<br>  ○ Residential<br>• Memo Items<br>  ○ International Bunkers | These activities are the main sources of greenhouse emissions in Niue. All fuel is imported over the wharf at Alofi and Niue Bulk Fuels (NBF) keeps detailed records. The different fuels are distributed from NBF for electricity generation, transport uses, domestic energy and aviation use. |
| Industrial Processes and Product Use (IPPU) | Niue has no large-scale industrial facilities. Solvent use and product emissions are non-material and as a consequence detailed records are not kept. |
| Agriculture, Forestry and Other Land Use (AFOLU)<br>• $CO_2$ emissions& removals from stock changes (biomass, dead organic matter, mineral soils on managed lands);<br>• $CO_2$ emissions from fire & liming & urea from managed lands;<br>• Methane from rice cultivation, livestock;<br>• Nitrous oxide emissions from all managed soils;<br>• $CO_2$ and $N_2O$ emissions from managed wetlands;<br>• $CO_2$ and methane emissions from manure management; and<br>• Carbon stock changes associated with harvested wood products. | Most agriculture on Niue is shifting on a medium length rotation. Forestry typically takes to <10 stems per annum and there was no forestry activity in 2009. Emissions from agricultural and forestry equipment are contained in greenhouse emissions from fuel use. Estimations have been attempted for emissions/removals in this sector from land use change, but constrained by the lack of recent satellite imagery. |
| Waste<br>• Solid waste disposal<br>• Biological Treatment of solid waste<br>• Incineration and burning of waste<br>• Wastewater treatment and discharge | Greenhouse emissions from waste on Niue were calculated using the IPCC Waste Model. Calculated emissions were non-material; however they are included for completeness. |

## C Energy Activities

Imported fossil fuels of various kinds are the primary source of energy on Niue. These fuels are used directly for residential, commercial and transportation uses or converted to electric power via the Island's single generating station. Additionally, there are relatively large Jet Kerosene emissions from aviation as air travel is the most common means to enter or leave Niue.

All fossil fuel imports are unloaded from regular supply ships on to the main Niue wharf at Alofi and then distributed to users via Niue Bulk Fuels (NBF). Detailed fuel supply data for each major customer is kept by NBF and in a contained system like Niue; this data alone is sufficient to perform Tier 1 calculations of greenhouse gas emissions. NBF fuel supply data is compiled in volumetric units (cubic metres), which have been converted to mass usage (tonnes) for the purposes of this inventory using the specific gravity (SG) factors listed in Table 3. This table also lists the abbreviations for fuel types used throughout this document.

**Table 3: Specific gravity of fuels used**

| Fuel | Abbreviation | SG |
|---|---|---|
| Unleaded Petrol | ULP | 0.75 |
| Diesel (Electricity use) | Diesel-E | 0.86 |
| Diesel (General use) | Diesel-G | 0.86 |
| Kerosene (general use) | Kero-G | 0.8 |
| Jet Kerosene | Kero-J | 0.8 |
| Liquefied Petroleum Gas | LPG | NA |

Table 4b lists litres and calculated mass equivalents of the various fuels supplied by NBF from 2005 to 2009, including those for year 2000 (see Table 4a).

**Table 4a: Volumetric and mass fuel usage on Niue Island for 2000**

| Fuel | 2000 | |
|---|---|---|
| | Litres | Kg |
| Diesel-E | 1017141 | 874741 |
| Diesel-G | 422071 | 362981 |
| ULP | 289900 | 217425 |
| Kero-G[1] | 1500 | 1200 |
| LPG | 0 | 0 |

**Table 4b: Volumetric and mass fuel usage on Niue for 2005 - 2009**

| Fuel | 2005 | | 2006 | | 2007 | | 2008 | | 2009 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Litres | Kg | Litres | Kg | Litres | Kg | Litres | Kg | Litres | Kg |
| Diesel-E | 891400 | 766604.0 | 819229 | 704536.9 | 834996 | 718096.6 | 846520 | 728007.2 | 742145 | 638244.7 |
| Diesel-G | 574118 | 493741.5 | 1018091 | 875558.3 | 1502926 | 1292516.4 | 405497 | 348727.4 | 395080 | 339768.8 |
| ULP | 538327 | 403745.3 | 571588 | 428691.0 | 569850 | 427387.5 | 534653 | 400989.8 | 733609 | 550206.8 |
| Kero-G | 810 | 648.0 | 1410 | 1156.2 | 1336 | 1095.5 | 1170 | 959.4 | 1520 | 1246.4 |
| LPG | | | | | | | | 14535.0 | | |

In addition the following aviation fuel memo items were recorded, but not included in the inventory.

**Table 4c: Memo item (International Fuel Bunkers) Volumetric and Mass Usage for 2000 & 2005 to 2009.**

| Year | 2000 | | 2005 | | 2006 | |
|---|---|---|---|---|---|---|
| Fuel | Litres | Kg | Litres | Kg | Litres | Kg |
| Kero-J | 144500 | 115600 | 498198 | 398558.4 | 527242 | 453428.1 |
| Year | 2007 | | 2008 | | 2009 | |
| Fuel | Litres | Kg | Litres | Kg | Litres | Kg |
| Kero-J | 551295 | 474113.7 | 642183 | 552277.3 | 522284 | 449164.2 |

*1 Energy Industries*

The only energy industry on Niue is the generation of electrical power by the Niue Power Corporation (NPC). There are 4 diesel generators installed having a total nominal generation capacity of 2 megawatt (mW). Each diesel generator set is rated at 548 kilowatt (kW). Maximum daily peak power demand varies in a range of 420-800 kW, hence there is usually significant generation redundancy and availability is high. The transmission network extends throughout the Island and connects virtually all sources of demand.

[1] The value for 2000 is not available – 1500 tonnes has been used as a default based on 2005 consumption.

Diesel fuel for the generation plant is fully imported. While the diesel fuel for electricity generation is accounted separately, it is of the same technical specification as that imported for other uses (e.g. marine and road transport).

There are a number of other skids or container-mounted generator sets used intermittently on the Island for emergency use. Emissions from these sources are not expected to be material to the NGGI.

Diesel power demand has been moderated recently through the installation of additional low emission (LPG) and renewable capacity. In 2008, a total of 52.5 kW of grid connected photovoltaic capacity was installed; 30 kW at the Niue Hospital, 20 kW at Niue High School and 2.5 kW at NPC. In addition, 300 conversions of electricity to LPG-based energy have been carried out in residential and commercial premises throughout Niue and some 300 kW of solar hot water installed. The anecdotal reduction of electrical power demand of these measures has been in the order of 10%.

**Table 5: Greenhouse Emissions (2000; 2005-2009) for Energy Industries Category (Diesel-E)**

| **Year/GHG (Gg $CO_2e$)** | **2000** | **2005** | **2006** | **2007** | **2008** | **2009** |
|---|---|---|---|---|---|---|
| **$CO_2$** | 2.9 | 2.6 | 2.4 | 2.4 | 2.4 | 2.1 |
| **Methane** | 0.004 | 0.004 | 0.003 | 0.003 | 0.003 | 0.003 |
| **$N_2O$** | 0.008 | 0.007 | 0.006 | 0.007 | 0.007 | 0.006 |
| **Total** | **2.9** | **2.61** | **2.41** | **2.41** | **2.41** | **2.11** |

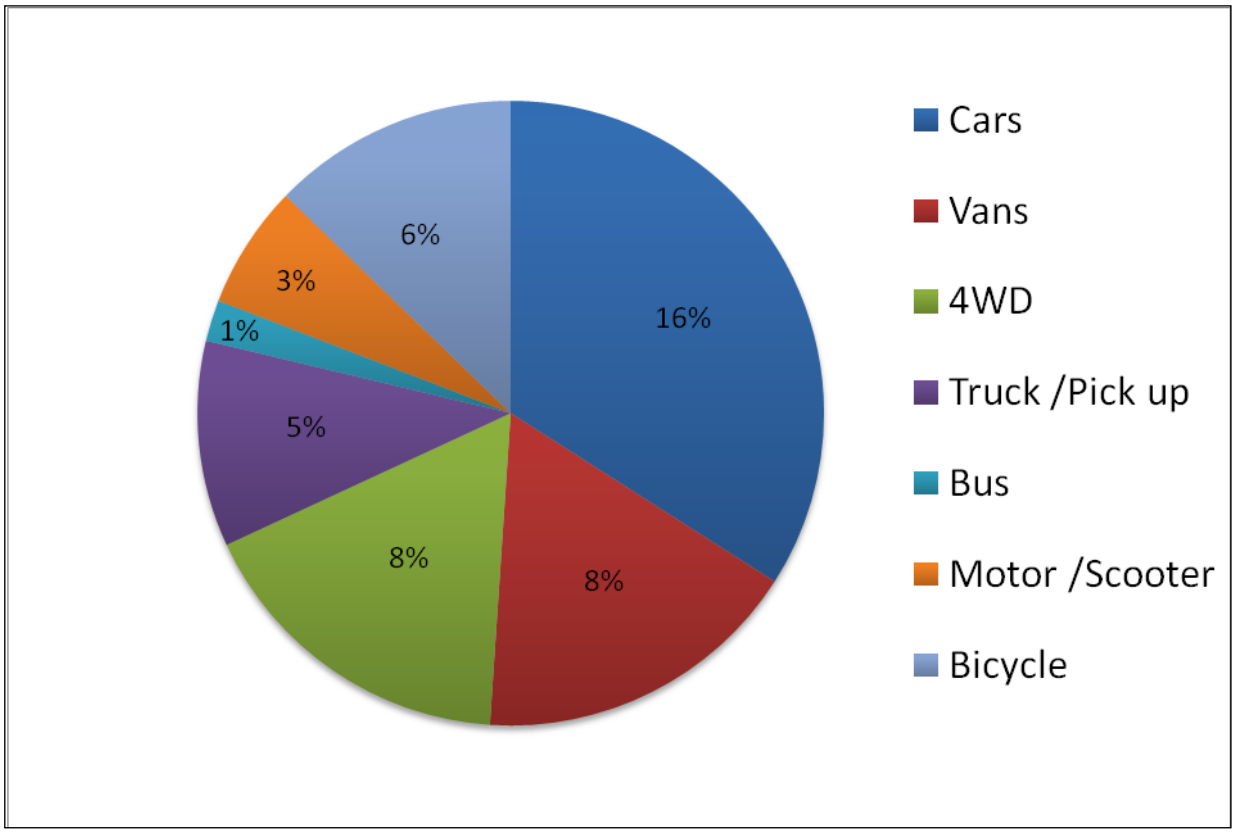
***Communications infrastructure - Seikena tower***

### *2 Transport*

Niue is a large island of some 60km in circumference and private vehicular transport is used frequently for commerce, social and agricultural/horticultural reasons. In addition there is a small fleet owned by the Government of Niue, including some heavy vehicles used for public works. Additionally, expatriate contractors performing work on Niue may temporarily import vehicles for private or occupational use.

A census of vehicles across the 13 main residential centers on Niue (including the capital Alofi) performed by Niue High School students found 319 internal combustion powered vehicles, using both Diesel and ULP. Figure 1 provides a breakdown of vehicular transport by vehicle type on Niue in 2010:

**Figure 1: Internal combustion vehicles on Niue – breakdown by vehicle type (2009 Transport Survey)**




Currently marine use comprises a very small fraction of total fuel use. However, in the period 2005-2009 a small commercial fishing operation was based in Alofi and marine use was considerably higher. No data on specific marine use is available.

Complete data for the total number of vehicles on Niue is not available for 2010 or in the 2005-2009 period of this inventory. However, all diesel fuel for non-electricity purposes and unleaded petroleum (Gasoline) fuel are imported and transport accounts for the majority of demand. Greenhouse gas emissions from transport are calculated for both fuels and presented in Tables 6 and 6a below.

**Table 6: Greenhouse Emissions (2000; 2005-2009) for Transport Category (Diesel-G Fuel)**

| Year/GHG (Gg $CO_2e$) | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| $CO_2$ | 1.22 | 1.66 | 2.94 | 4.34 | 1.17 | 1.15 |
| Methane | 0.0002 | 0.0002 | 0.0004 | 0.0006 | 0.0002 | 0.0002 |
| $N_2O$ | 0.01 | 0.013 | 0.024 | 0.035 | 0.01 | 0.009 |
| **Total** | **1.23** | **1.67** | **2.96** | **4.38** | **1.18** | **1.16** |

**Table 6a: Greenhouse Emissions (2000; 2005-2009) for Transport Category (ULP Fuel)**

| Year/GHG (Gg $CO_2e$) | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| $CO_2$ | 0.7 | 1.28 | 1.36 | 1.36 | 1.27 | 1.75 |
| Methane | 0.0002 | 0.0004 | 0.0004 | 0.0004 | 0.0004 | 0.0005 |
| $N_2O$ | 0.002 | 0.004 | 0.004 | 0.004 | 0.004 | 0.005 |
| **Total GHG emitted** | **0.7** | **1.28** | **1.36** | **1.36** | **1.27** | **1.76** |

*3 Residential Energy Use*

There are some 470 households in Niue and a small number of commercial and Government premises. The majority of energy demand in Niue originates in households and commercial premises. This energy demand is satisfied in the main by electrical power although limited amounts of kerosene are still used. In 2009 a program to convert the cooking arrangements of 300 households from electricity to LPG was implemented by the Niue Government in an effort to switch energy consumption to lower greenhouse emission fuels. All LPG is imported into Niue and distributed in 9kg bottles.

Kerosene is still used by some households. All Kerosene is imported into Niue by NBF, which diverts a small volume of Jet Kerosene to satisfy this demand, and records are kept of all sales. The use of Kerosene in a residential context has been small and static.

Greenhouse emissions from the residential, commercial and Government sector (apart from electricity and transport) are deemed to be from Kerosene and LPG and are presented in Tables 7 (Kerosene) and 7a (LPG).

**Table 7: Greenhouse Emissions (2000; 2005-2009) for Residential Category (Kerosene Fuel)**

| Year/GHG (Gg $CO_2e$) | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| $CO_2$ | 0.004 | 0.002 | 0.004 | 0.004 | 0.003 | 0.004 |
| Methane | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| $N_2O$ | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| **Total GHG emitted** | **0.004** | **0.002** | **0.004** | **0.004** | **0.003** | **0.004** |

**Table 7a: Greenhouse Emissions (2000; 2005-2009) for Residential Category (LPG Fuel)**

| Year/GHG (Gg $CO_2e$) | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| $CO_2$ | | | | | | 0.05 |
| Methane | | | | | | <0.00001 |
| $N_2O$ | | | | | | <0.00001 |
| **Total GHG** | | | | | | **0.05** |

| | | | | | | |
|---|---|---|---|---|---|---|
| **emitted** | | | | | | |

*4 Memo Items*

Aviation fuel (Jet Kerosene) is the only memo item in the NGGI. Since 2005 Niue has been served by one or two international airlines bringing passengers and freight to Niue from New Zealand or Tonga. There is currently one weekly service from Auckland, New Zealand to Alofi. There are no marine bunkers on Niue.

Aviation fuel stocks are imported into Niue by NBF and detailed records are kept of fuel supplied to aircraft. The greenhouse emissions from the supply of Jet Kerosene are presented as Table 8:

**Table 8: Greenhouse Emissions (2000; 2005-2009) for Memo Items (Jet Kerosene Fuel)**

| Year/GHG (Gg $CO_2e$) | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|
| **$CO_2$** | 0.36 | 1.23 | 1.4 | 1.5 | 1.71 | 1.39 |
| **Methane** | 0.0001 | 0.0001 | 0.0002 | 0.0002 | 0.0003 | 0.0002 |
| **$N_2O$** | 0.0035 | 0.0121 | 0.0138 | 0.0144 | 0.0167 | 0.0136 |
| **Total GHG emitted** | **0.36** | **1.24** | **1.41** | **1.51** | **1.73** | **1.40** |

*5 Ozone and Aerosol Precursor Emissions (OAP)*

The 2006 IPCC Guidelines require reporting the ozone precursors Nitrogen oxides (as $NO_2$ mass equivalents), Non-Methane Volatile Organic Compounds (NMVOC) and Carbon monoxide (CO) and the aerosol precursor Sulphur dioxide (as $SO_2$ mass equivalents) "*where the country has prepared an inventory of these gases".*

In the case of Niue, an initial inventory of OAP emissions was prepared as part of the 1994 inventory using the 1996 IPCC Guidelines. This practice has been continued for the years 2005-2009 and Tier 1 calculated emissions are reported below in Table 9. In some cases emission factors have been derived from recent Australian Government sources to better account for regional fuel standards. All sources are fully referenced.

The OAP emissions from Residential sector, LPG and kerosene, have non-significant emissions due to low fuel usage per annum and have not been calculated.

OAP emissions for International Aviation Bunkers (memo items) have been calculated but not added to the NGGI.

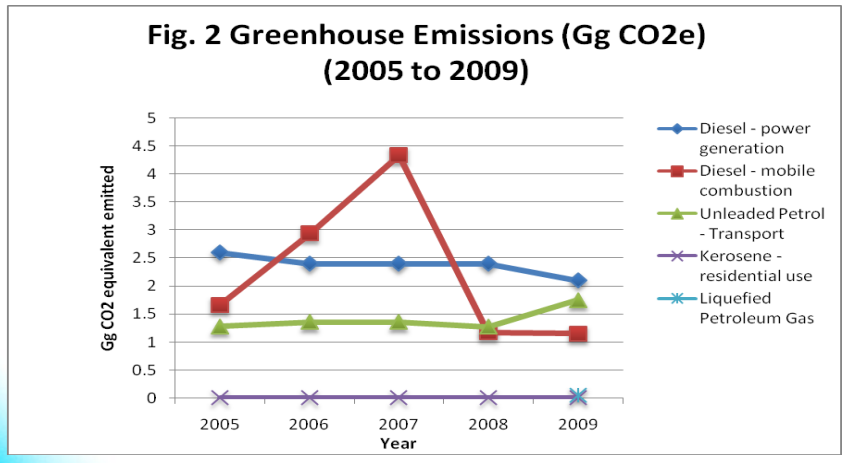
***Scrap metal waste, awaiting shipment overseas***

**Table 9: Emissions of Ozone and Aerosol Precursor Gases (OAP) from Niue (2005 – 2009)**

| YearOAP (Kg) | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|
| **ENERGY INDUSTRIES – POWER GENERATION** | | | | | |
| **CO**[2] | 12479 | 11469 | 11689 | 11851 | 10390 |
| **NMVOC**[2] | 1159 | 1065 | 1085 | 1100 | 965 |
| **$NO_x$-e**[2] | 47244 | 43419 | 44255 | 44866 | 39334 |
| **$SO_2$-e**[2] | 15 | 13 | 14 | 14 | 12 |
| **TOTAL** | 60897 | 55967 | 57044 | 57831 | 52914 |
| **ENERGY ACTIVITIES - TRANSPORT (DIESEL)** | | | | | |
| **CO** | 5224 | 9265 | 13677 | 3690 | 3595 |
| **NMVOC** | 689 | 1222 | 1804 | 487 | 474 |
| **$NO_x$-e** | 17224 | 30543 | 45088 | 12165 | 11852 |
| **$SO_2$-e**[3] | 10 | 17 | 25 | 7 | 7 |
| **TOTAL** | 23146 | 41046 | 60593 | 16348 | 15928 |
| **ENERGY ACTIVITIES - TRANSPORT (ULP)** | | | | | |
| **CO** | 19918 | 21149 | 21084 | 19782 | 27143 |
| **NMVOC** | 1346 | 1429 | 1425 | 1337 | 1834 |
| **$NO_x$-e** | 3607 | 3830 | 3818 | 3582 | 4915 |
| **$SO_2$-e** | 53 | 56 | 56 | 52 | 72 |
| **TOTAL** | 24923 | 26463 | 26383 | 24753 | 33965 |
| **MEMO ITEMS (INTERNATIONAL BUNKERS)** | | | | | |
| **CO**[4] | 863 | 982 | 1026 | 1196 | 972 |
| **NMVOC**[3] | 69 | 78 | 82 | 96 | 78 |
| **$NO_x$-e**[3] | 4487 | 5105 | 5338 | 6218 | 5057 |
| **$SO_2$-e**[5] | 0 | 0 | 0 | 0 | 0 |
| **TOTAL** | 5419 | 6165 | 6446 | 7509 | 6107 |

*6 Trends in Emissions from Energy Activities on Niue*

Figure 2 illustrates the trends in carbon dioxide emissions from energy activities in the period 2005 to 2009.




[2]Australian Government; Department of Environment, Water, Heritage and the Arts. 2008. *National Pollutant Inventory: Emission Estimation Technique Manual for Combustion Engines, Version 3.*

[3]Sulphur in Diesel imported into Niue has been calculated from the standard BP Technical Data Sheet which describes the fuel as having a maximum 10ppm (0.001% w/w) Sulphur.

[4]Australian Government; Civil Aviation Safety Authority. 2010. *Standard Economic Values Guidelines: Part 6 Environmental Values; Section 1.Amount of Pollutants released by Fuel Burn.*

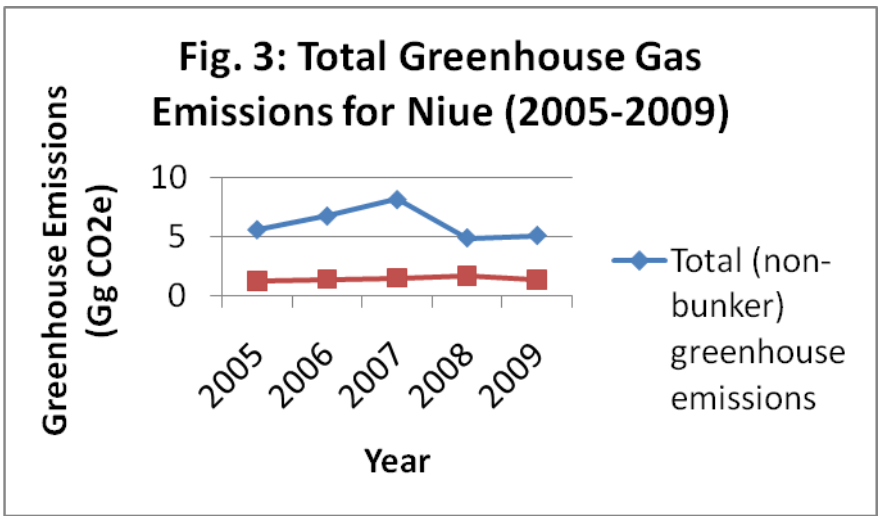
[5]Sulphur in aviation kerosene is negligible and $SO_2$e emissions are zero.

The chart indicates greenhouse emissions from all forms of fuel combustion except diesel for non-power generation purposes (transport, local marine and earthmoving) has been largely constant. Greenhouse emission contributions from LPG and Kerosene for residential use have been small, with LPG introduced into the fuel mix of Niue in 2009.

The spike of non-power generation diesel use in 2006 and 2007 is attributed to the power requirements of a fish processing operation operating on Niue through 2006, 2007 and part of 2008.

Compared to direct $CO_2$ emissions in the energy activities category, the non-$CO_2$ greenhouse gases are not material (<<0.1Gg$CO_2$e) and trends for these have not been plotted.

The total emissions for the period of inventory (2005-2009) are plotted in Figure 3.This figure also contains the memo items (international aviation bunkers) excluded from the inventory. The memo item varies only slightly over time, relative to the number and type of scheduled flights from Niue.




## D Emissions and Removals from Agriculture, Forestry and other Land Use

### *1 $CO_2$ emissions& removals from stock changes on managed lands*

While Niue imports most foodstuffs, there is a significant subsistence-farming sector. The low fertility of the carbonate-derived soils and unfavourable geomorphology limit the potential area for agricultural or horticultural activities to around 40% of the land area. Many families maintain traditional plots on which shifting horticulture of medium rotation length (approximately 5-10 years) is practised. Plots are occasionally burnt with consequent emissions of greenhouse gas, but these emissions are small and the usual practice is planting amongst the cleared vegetation.

A high-level estimate of emissions and removals from land use change from the 2000 has been attempted in this inventory. There are reasonably detailed satellite-based land cover maps available from 1994 (Source: Landcare NZ 2001). As a basis of comparison the recent preliminary census (2009) indicated that 87% of the 470 households on Niue reported being involved in agriculture and the holdings used for this purpose totalled around 744 ha, around 3% of Niue's land area of 26,146 ha.

The 1994 land cover map resolved 6 categories: matured forest; secondary forest; littoral forest; littoral shrubland; managed and bare land. This Inventory assumes that the matured and littoral forest and shrubland categories were unavailable for agricultural purposes due to geologic or edaphic factors and would remain undisturbed. This comprised some 35% of the 1994 land cover of Niue.

Secondary forest (bearing evidence of disturbance) was assumed to be available for agriculture, although it should be noted that disturbance could also be due to past, but not continuing agricultural activity and/or tropical cyclones. Secondary forest was the largest single category (43% of the land area). Managed land is assumed to contain the majority of agricultural activity in 1994, comprising some 5450 ha.

The land use change is deemed to be the difference between the 1994 inventory of 'managed land' and the reported agricultural land in the 2009 census; the discrepancy reveals a decline in agricultural activity of approximately 4700 ha. Most of this is deemed to have been converted in the last 15 years to secondary forest.

A simple Tier 1 biomass-carbon model was constructed that accounts for:

- A linear decline of 'managed lands' from 5450 ha in 1994 to 744 ha in 2009 through conversion into secondary tropical rainforest. The model assumes that the decline in agricultural lands has occurred in a straight line from 2000 to 2009 (this is a necessary simplification as later satellite-based time series imagery has not been able to be sourced at the time of this Inventory);
- Carbon stock changes in remaining crop land (assumed to be perennial cropland with a harvest cycle of 5 years). This assumption is a gross simplification; crops are a mixture of annual and perennial, cycle times are variable and there is abundant growth of woody weeds during a cultivation cycle. In addition, emissions from non-$CO_2$ emissions, changes in soil carbon and dead organic matter have not been calculated.

The model used guidance and default factors found in Chapters 2 to 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Relevant categories were 'Cropland remaining Cropland' and 'Land converted to a New Land Use'.

Results indicated that removals amounted to 1000 Gg $CO_2$ in the 2000 to 2009 period and 144 Gg $CO_2$ in the 2009-inventory year. It should be noted that some of the cropland converted to secondary forest is now nearing the 20-year mark where it should be re-classified into a 'matured forest' category and, in addition, some of the 1994-classified secondary forest will already have crossed into this category. Both mature and secondary forest will have been disturbed by the passage of cyclones, particularly cyclone Heta in 2004. No account of the impact of these changes on biomass carbon has been possible in the above calculation. More recent satellite imagery and a comprehensive forensic re-classification of land use will be required before the Third National Communication from Niue is prepared.

*2 Methane emissions from livestock*

Numbers of ruminant stock are low, with the original herd of some 100 cattle reported in the 2000 inventory now reduced to only a few animals with no replacement intended. The 2009 census recorded approximately 8500 chickens and an undetermined number of domesticated pigs (Government of Niue: 2009 Preliminary Census). These are non-ruminant livestock and thus enteric fermentation emissions were not calculated for this Inventory. For completeness, later inventories should contain estimates of emissions from the manure of these animals.

*3 Other AFOLU emissions*

As shifting cultivation tends to use nutrients released from the breakdown of slashed material, there are only small amounts of artificial fertiliser used on managed soils in Niue. The fate and mechanisms of nitrogen and carbon in the soils of Niue have not been attempted in this inventory, although they may represent a material emission source. Better characterisation of spatial data regarding agriculture is required before soil emissions can be meaningfully defined.

## E Emissions from the Waste Sector

### *1 Solid waste*

Niue has recently prepared an *Integrated Waste Management Strategy 2010* that summarises the available information on waste generation and disposal on Niue. The Strategy reports that household waste characterisation studies from 2000 and 2010 are available, but that a more complete picture of solid waste would require the characterisation of institutional and commercial streams. The results of the household waste characterisation study were used as input to the IPCC Waste Workbook.

**Table 10: Household Waste Composition and Mass (2000 and 2010)**

| Category | Household Waste Composition | | | |
|---|---|---|---|---|
| | 2000 | | 2010 | |
| | % | tonnes/year | % | tonnes/year |
| Organics | 54.3 | 133.07 | 27.7 | 48.62 |
| Metals | 8.1 | 19.85 | 13.2 | 23.07 |
| Paper | 14.7 | 36.02 | 9.4 | 16.51 |
| Diapers | 6.5 | 15.92 | 16.3 | 28.49 |
| Plastics - bags | 6.9 | 16.91 | 8.0 | 14.02 |
| Plastics - bottles | | | 4.9 | 8.59 |
| Plastics - other | | | 7.7 | 13.57 |
| Textiles | - | 0 | 0.4 | 0.68 |
| Others | 8.0 | 19.60 | 9.3 | 16.28 |
| Glass | 1.6 | 3.92 | 3.1 | 5.43 |
| **Total** | **100.0%** | **245.31** | **100.0%** | **175.27** |

Methane emissions from Municipal Solid Waste disposal (using the IPCC Waste Workbook methodology) were substantially less than 1Gg methane. A sensitivity analysis was performed, this analysis assumed institutional and commercial waste doubled the household solid waste stream mass (given the low levels of activity in these sectors this should be a conservative assumption) without significant effect on the non-materiality of methane emissions.

Most solid waste collected in Niue goes to the central, poorly managed landfill at Makato, near Alofi. There is a second minor landfill at Mutalau. The Makato landfill is small scale and is 'pushed up' to make room rather than buried. As a consequence, the waste contents remain in a largely aerobic decomposition environment. Fires are a rare occurrence, but a distinct risk.

### *2 Wastewater treatment and discharge*

Sealed septic systems are the main form of sewage treatment on Niue. Septic tanks are emptied infrequently, typically when they become a problem. The septic waste is collected by a sludge pump truck and transported to a sludge pit for disposal. Liquid contents rapidly evaporate and/or soak into the limestone and quickly out to sea. Greenhouse emissions from this source are negligible. Direct $CO_2$ emissions from the truck-based collection of septic tanks are included in the Diesel – General emissions.

### *3 Incineration and burning of waste*

There is one wood-fuelled medical waste gasifier on Niue at the hospital. No data is available on the frequency of use of this gasifier, but it can process 1.5 bags of medical waste per hour using 5 'buckets' of wood as fuel. This source is regarded as non-material for the purposes of the NGGI.

## *IV Greenhouse Gas Inventory 2009*

**Table 11: Greenhouse Gas Inventory for Niue (2009)**

| | Emissions all in Gg Carbon dioxide equivalent (Gg CO2e) | | | | | | |
|---|---|---|---|---|---|---|---|
| **GREENHOUSE GAS SOURCE AND SINK CATEGORIES** | **CO2** | | **METHANE (CH4** | **NITROUS OXIDE (N2O)** | **SULPHUR HEXAFLOURIDE (SF6)** | **PERFLOURO-CARBONS (PFC)** | **HYDRO FLOURO-CARBONS (HFC)** |
| | **EMISSIONS** | **REMOVALS** | | | | | |
| **TOTAL NETT NATIONAL EMISSIONS** | **5.1** | | | | | | |
| **TOTAL NETT NATIONAL REMOVALS** | | **144** | | | | | |
| ***1.Energy*** | | | | | | | |
| Fuel Combustion | 5.03 | | 0.004 | 0.02 | | | |
| Energy Industries | 2.14 | | 0.003 | 0.006 | | | |
| Transport (includes non-powergen Diesel and ULP) | 2.89 | | 0.001 | 0.014 | | | |
| Residential | 0.00 | | 0 | 0 | | | |
| Solid Fuels | | | | | | | |
| ***2.Industrial Processes*** | | | | | | | |
| ***3. Agriculture, Forestry and other Land Use*** | | | | | | | |
| $CO_2$ emissions & removals from stock changes (biomass, dead organic matter, mineral soils on managed lands; | | 144 | | | | | |
| ions from fire & liming & urea from managed lands; | | | | | | | |
| Methane from rice cultivation, livestock | | | | | | | |
| Nitrous oxide emissions from all managed soils | | | | | | | |
| $CO_2$ and $N_2O$ emissions from managed wetlands | | | | | | | |
| $CO_2$ and methane emissions from manure management | | | | | | | |
| Carbon stock changes associated with harvested wood products | | | | | | | |
| ***4. Waste*** | | | | | | | |
| Solid waste disposal | not recorded | not recorded | <1 | not recorded | | | |
| Biological Treatment of solid waste | | | | | | | |
| Incineration and burning of waste | | | | | | | |
| Wastewater treatment and discharge | 0 | | 0 | 0 | | | |
| ***Memo Items*** | | | | | | | |
| International Aviation Bunkers | 1.39 | | 0.0002 | 0.014 | | | |

### A Commentary on the 2009 NGGI Inventory

The Inventory reveals that Niue has a relatively low Greenhouse emission of approximately 5.1 Gg $CO_2$e (5100 tonnes) arising predominantly from the Energy industries sector. This is offset by removals of approximately 144 Gg $CO_2$ (144,000 tonnes) in 2009 from the conversion of former managed lands, assumed to be cropland, back into secondary forest. This makes Niue a net sink of greenhouse gases.

The *per capita* greenhouse intensity of Niue is thus 3.3 tonnes $CO_2$e based on its current population of 1,542 persons. This is comparable with the 2005 UN FAO *per capita* greenhouse intensities that list Fiji (2.0tonnes $CO_2$e); Samoa (0.8tonnes $CO_2$e) and Tonga (1.2tonnes $CO_2$e). All of these intensities are quoted *without* land use change.

Trends from 2005 to 2009 have also been presented in this report. The Inventory noted the return of greenhouse emissions from non-power generation diesel use to lower levels from a high of

4.34 Gg $CO_2$ in 2007. This has been attributed to the closure of a fishing fleet and packing plant operating on Niue from 2006 to 2008.

Time series data shows that diesel and unleaded petrol emissions have increased slightly during 2009 when compared to historical levels, however emissions derived from diesel powered electricity generation have declined by around 15%. This may be partly due to continuing population decline, however measures instituted by the Niue Government to increase the penetration of renewable and low emission energies, including solar hot water, photovoltaic installations and the introduction of LPG, are demonstrably contributing to lower greenhouse emissions.

Greenhouse emissions from memo items, arising exclusively from international bunkering operations, have only varied within a narrow band since 2005 being reflective of the limited air connections to and from Niue to overseas ports.

## B Limitations of this Inventory

There is high confidence at the Tier 1 level in the data on energy activities used to construct this NGGI. Because all fuel is imported through a central point and accessible and accurate records are kept, it is relatively straightforward to prepare a Tier 1 analysis of greenhouse emissions. Data collection is not yet developed sufficiently to make higher tier inventories possible.

Concerns with the AFOLU sector have been expressed in the above document. To accurately chart emissions and removals from this sector will require an accurate, quality controlled survey of land use status. Up to date satellite imagery and GIS mapping would facilitate this. The Government of Niue has well developed GIS capability and the use of regularly updated imagery products and verification at the local level combined with more precise vegetation and cropping system biomass factors should yield more precise, higher tier removals and emission estimates.

Some very constructive efforts have been made at waste characterisation. However, these currently lack the sample size and coverage to be statistically meaningful. More accurate determinations of greenhouse emissions from landfill may be possible, but given the limited quantity of waste, low level of emissions and the basic management regime, such improvements may not be the highest priority. A National Inventory System (NIS) will be developed to manage the GHG inventory process and archive relevant data and information obtained in the process.

***Clear skies at night***

# 4. Programmes Containing Measures to Facilitate Adequate Adaptation to Climate Change (Vulnerability and Adaptation)

## *I Introduction*

As part of its commitment to the UNFCCC, Niue is required under Article 4.1(b), to report to the Conference of the Parties on activities, programmes and measures taken to adapt to climate change. Paragraphs 32-36of the UNFCCC reporting guidelines for the preparation of national communication adopted by COP in 2002 specify the elements of information that is required in the area of vulnerability and adaptation, including: the scope of the vulnerability adaptation assessment and critical vulnerabilities (para 32); the information on key vulnerable areas and an integrated analysis of their vulnerability and adaptation to climate change (para 33); the evaluation of adaptation strategies in key vulnerable areas (para 35); and policy frameworks and strategies for adaptation (para 36).

The chapter begins by defining key concepts, and discussing the methodology used to collect and analyse data. It then summarises the findings on vulnerability and adaptation to climate change in Niue's first National Communication to the UNFCCC. The chapter then describes the values that are important to Niue and Niueans and which may be at risk from climate change. Next, it describes observed variations in Niue's climate. Niue's exposure to future risks is then discussed, followed by an assessment of the sensitivity of key ecosystems and sectors to these risks. From this an integrated assessment of climate risks is developed, after which there is a discussion of adaptation strategies. The capacity to implement these adaptation strategies is then assessed.

## *II Concepts and Method of Assessment*

The assessment of vulnerability and adaptation in Niue has been undertaken using a range of methods. The overall approach is consistent with what have been called 'second generation', 'vulnerability/adaptation' or 'bottom-up' approaches (Lim and Spanger-Siegfried. 2004, Sutherland *et al* 2005), which do not prescribe 'a common methodology', but rather offer a framework of linked concepts, key questions, methods and principles for assessment that can be combined in various ways to suit the conditions of any given country. They focus their analysis on:

1. Current vulnerability to present day climate;
2. Focus on smaller scales of social organization;
3. Prioritise social systems by focussing on the present and future social and economic forces that create vulnerability;
4. Emphasise the problem of climate extremes (as opposed to changes in mean conditions)
5. Include stakeholders in assessments of vulnerability and adaptation;
6. Integrate a wider range of existing studies and information on, for example, resource management, planning, economic development, household expenditure, and decision-making processes; and
7. Consider the capacity of social systems - including the policy process - to implement adaptation actions.

This is an approach better suited to Pacific island countries (Barnett and Campbell 2010). The people already possess the required information. The approach values traditional knowledge and countries can have more confidence in, and ownership of, the results of assessments and their proposed adaptation actions.

# *III Methodology for Assessment of Vulnerability and Adaptation to Climate Change*

## A Introduction

Article 4, Paragraph 33, of the United Nations Framework Convention on Climate Change suggests that all Non-Annex I Parties (NAI) describe the approaches, methods and tools used to assess vulnerability and adaptation to climate change. This document has two parts.

- First it describes the methodology used, including broad steps taken and the particular methods used to elicit information. It concludes with a summary of the methodology, an assessment of its ability to achieve an integrated assessment of vulnerability and adaptation to climate change in Niue, and
- Second, it includes an assessment of the likely residual uncertainties arising from its implementation.

## B The Methodology

The assessment of vulnerability and adaptation to climate change in Niue has been guided by the UNDP Adaptation Policy Framework, but with some simplifications, reprioritisation, and additions to suit Niue's circumstances – as encouraged by the framework itself and by Article 4.3 of the UNFCCC. This section outlines the methodology and methods used to collect information.

The methodology applied here had four broad steps, namely:

1. Assessment of current vulnerability
2. Assessment of future climate risks
3. Propose and assess adaptation activities
4. Assessment of adaptive capacity.

These steps, and their associated methods, ensured a logical progression through the assessment process. Information about the same issue was often produced by different methods and arose at different steps – for example information about fishing emerged from reports, fisheries managers, and fishers themselves. This is called 'triangulation' of evidence, which helps to eliminate errors in information.

### *1 Assessment of Current Vulnerability*

This step involved examining the extent to which people, places and sectors are affected by current climate risks. It included assessing the effectiveness of measures to manage existing climate risks. This step was necessary as it allowed for the later assessment of future climate risks to be grounded in the current reality of climate vulnerability in Niue, and it assisted in determining adaptation actions that will yield benefits now as well as in the future ('no regrets' actions). Specific activities included:

1.1. Identification of people, places, and sectors in Niue that are presently at risk from current climate:

- Sources and methods:

  1.1.1. Existing studies, including studies of problems in other sectors such as agriculture, biodiversity, fisheries, infrastructure, tourism, and water resources.

  - Method: extensive review of literature

  1.1.2. Expert judgment from representatives of government departments, civil society, the private sector, and village councils.

  - Method: survey and interviews with directors of Government departments, corporations, and agencies, and with Chairpersons of all Village Councils; small private sector focus group.

1.1.3. Assessment of socio-economic conditions to identify social vulnerability (people whose livelihoods are more dependent on natural resources, who have lower incomes, who live in more exposed locations).

- Methods: Analysis of existing socio-economic data from Statistics (e.g. Household income and expenditure survey, census data); survey of all households (on income and consumption of local foods).

1.2. Observations of current climate and extremes, and environmental changes to determine: the extent to which climate varies, the frequency and magnitude of extreme events, and existing environmental changes that may be linked to – or may in the future be exacerbated by – climate change.

- Sources and methods:

1.2.1. Existing climate records: of changes in mean temperature and rainfall, and of frequency and intensity of extreme events such as cyclones and droughts

- Method: CSIRO report

1.2.2. Existing data from government departments

- Method: analysis of existing data from government departments

1.2.3 Observations from resource users such as farmers, fishers (women and men), users of the forest

- Method: interviews with farmers, fishers (from reef and seas), pigeon and bat hunters, *uga* hunters.

1.3. Identify factors that determine vulnerability of key people, places and sectors. Including identifying and assessing current (and past) strategies to manage climate risks, and constraints to their effectiveness.

- Sources and methods:

1.3.1. Analysis of policies and legislation relating to climate extremes

- Method: review and analyse policy documents and legislation relating to vulnerable sectors

1.3.2. Expert knowledge: of policy makers, divisional heads, resource users (farmers, forest users, fishers, etc), and village councils about managing climate extremes

- Method: interviews with directors of Community Affairs, DAFF, SOG, Environment, Health, Police, Public Works, Tourism, Development Bank, Economic Planning and Development, Chairpersons of Village Councils, sample of farmers, fishers (from reef and sea), pigeon and bat hunters, uga hunters.

1.3.3. Analysis of effectiveness of and constraints on management of the environment and resources:

- Methods: analysis of policies, legislation, and practices relating to the environment and resources, including relating to property rights; reports on environmental and resource management in Niue; interviews with directors of Community Affairs, DAFF, Environment, Health, Police, Public Works, Tourism, Development Bank, Economic Planning and Development, SOG, Chairpersons of Village Councils, sample of farmers, fishers (from reef and seas), pigeon and bat hunters, uga hunters.

*1.3.4. Traditional knowledge about managing climate extremes*

- Method: interviews with elders about preparations for, and actions during and after cyclones, drought, and other major shocks; some limited material in historical literature.

1.4. Examination of recent analogous climate events (especially cyclones, but also maybe drought) (see Glantz 1988). In particular, review of arrangements and actions prior to, during, and after cyclone Heta since this offered insight into vulnerability to cyclones as well as more general capacity to manage climate extremes.

- Method: review documents from Government, media, and NZ High Commission on the experience immediately prior to, during, and in recovering from cyclone Heta; interviews with representatives from Government, civil society, the private sector, and the community (especially people along the West coast).

1.5 Determine national values and aspirations to establish some benchmarks of unacceptable loss.

- Sources and methods:

1.5.1. Review related documentation, including the Integrated Strategic Plan, Government Department mission statements, community consultation reports, in particular the Living Community study

- Method: literature review

1.5.2. Views of key groups and individuals

- Method: interviews with Premier, Head of National Council of Churches, National Youth Council members, selected Parliamentarians, representatives from the National Council of Women, Village Council members, NIOFA, others; focus group interviews.

*2 Assessment of future climate risks*

This step considered likely future changes in social, environmental, and climate conditions in Niue – and the potential interactions between these – to assess future vulnerability, and barriers to and opportunities for adaptation to future changes. Specific activities included:

2.1. Characterising climate trends and future climate risks

- Sources and methods:

2.1.1. Synthesised information from General Circulation Models.

- Method: CSIRO scenario report

2.2. Characterising socio-economic and resource and environmental trends, risks and opportunities

- Sources and methods:

2.2.1 Plans for development in key sectors, and on key issues, including agriculture, fisheries, tourism, population, environmental and resource management, and village development.

- Methods: review of available documentation; interviews with Cabinet, directors of DAFF, Community Affairs, Education, Health, Environment, Public Works, Treasury, Power Supply, SOG, Telecommunications and Post, Development Bank, Tourism, Economic Planning and Development, and Immigration, Chamber of Commerce.

2.3. Environment - development scenarios, informed by step 1 and step 2.2.

- Focus group meetings to develop 3 plausible scenarios of future changes in economic development, population, and environment and resources, based on existing trends, namely: A Niue negative (worst case), Niue BAU (business as usual), and Niue Positive (best case).

2.4. Integrating future climate risks with environment-development scenarios to identify future vulnerabilities, 'no regrets' adaptation actions, low risk/low cost policy modifications, and other adaptation opportunities.

- Method: Expert judgment of V & A Working Group

2.5. Characterising uncertainties in assessments of climate and environment-development futures.

- Method: Expert judgment of V & A Working Group

*3 Formulating an Adaptation Strategy*

This step involved developing an adaptation strategy based on the information in steps 1 and 2 of the assessment. It involved:

3.1. Review and synthesis of information in steps 1 and 2 to take stock of findings and develop an initial list of adaptation actions.

- Method: Expert judgment of V & A Working Group

3.2. National review and refinement of/addition to list of adaptation options

- Method: National workshop

3.3. Characterisation of adaptation options in terms of: costs to implement; damages that would be averted through their implementation; their social and environmental affects (positive - such as poverty reduction, and negative - such as reduced access to the sea through relocation); forms of support required from within and outside of Niue; synergies with domestic policies and international agreements.

- Method: Expert judgment of V & A Working Group

3.4. Prioritisation of adaptation actions and draft national adaptation strategy.

- Method: Expert judgment of V & A Working Group

3.5. Cabinet review and adjustments/approval of adaptation strategy

*4 Assessment of Adaptive Capacity*

The methodology used to assess vulnerability and adaptation assisted in assessing the capacity of households, villages, and the national government to implement adaptation actions (adaptive capacity). A picture of adaptive capacity emerged through: identification of existing capacity to implement environment and resource management policies and to manage current climate problems; identification of vulnerable groups and sectors and the factors that determine their vulnerability; identification of the forms of support required to implement adaptation actions; and identification of future trends in environment and development that will have bearing on future capacity.

The methodology used itself contributed to enhancing capacity to adapt to climate change. The active participation of stakeholders is a powerful form of awareness-raising, and in Niue it initiated thinking about adaptation actions at all levels and in all sectors of society. The creation of an adaptation strategy provides a plan of action towards adaptation that supports existing sustainable development policies and plans. This enhancement of adaptive capacity is itself an adaptation action, which is the intention of the UNDP's Adaptation Policy Framework (Lim and Spanger-Siegfried 2002), and the National Communication process.

## C A Note About Sources

The applied, bottom-up nature of this assessment required input from a range of stakeholders across the government departments of Niue and its private sector, civil society, and community (e.g. village-based) groups. However, Niue is almost unique among countries in that it has: a small population; a proportionately large public service (approximately 60% of the workforce); high rates of participation in civil society organizations (in particular churches); and a dual governance structure of village councils and national Parliament. These factors mean that most adults in Niue serve more than one function for the purposes of the assessments. Many are simultaneously active in government, civil society, and village organizations. In addition, the national climate change project is only one of a number of recent projects that require stakeholder participation and extensive consultation. Recent studies have commented on 'stakeholder fatigue' in Niue, particularly given the difficulties the more active members of society have in finding time to attend meetings.

So, there was a real risk of over-consultation arising from the climate change project and in particular this assessment of vulnerability and adaptation. The dangers of over-consultation are two: first, it imposes significant additional time costs on participants; second, fatigue and frustration lead to incomplete or incorrect information being supplied.

At the same time, a large number of reports have been written about various aspects of environment and development in Niue, there is a small number of peer-reviewed academic studies, considerable expertise among key figures in the public and private sector and in civil society, and information in Niue is relatively easily obtained (although not all information is accurate). For these reasons, use of secondary data has been prioritised, and where necessary stakeholders have been engaged selectively and purposefully to avoid over-consultation. This means: careful identification of stakeholders and their primary role in the assessment exercise; the use of short and focussed techniques such as interviews and surveys, to elicit only the most necessary information; and minimal use of focus groups and workshops as these are more likely to involve people unnecessarily. This in turn means that surveys, interviews, focus group meetings, workshops and other methods have often been used to elicit information on more than one subject. The major sources of data for this assessment are shown in the following table.

**Table 1: Major Sources of Data on Vulnerability and Adaptation to Climate Change in Niue**

| *Data Source* | *Number* | *Date* |
|---|---|---|
| Problem scoping questionnaire with Heads of Departments, Members of Parliament, civil society representatives | 45 people | April 2006 |
| Household food survey conducted as part of the 2006 Census of Population and Housing | 435 households | September 2006 |
| Workshop with Niue National Council of Women | 22 people | October 2006 |
| Focus group interviews on social and economic scenarios | 13 people | April 2007 |
| National Climate Change Vulnerability and Adaptation Workshop | 24 people | April 2007 |
| Interviews with fishers about influences of climate on fishing | 13 people | April 2008 |
| Interviews with elders about past experiences with cyclones | 14 people | May 2008 |
| Interviews with growers about influences of climate on crops | 27 people | August 2008 |
| Participant observation and informal interviews by researchers from Melbourne University | N / A | Mar – Dec 2006 |
| Analysis of present climate variability and regional climate projection by CSIRO | N / A | February 2008 |
| Previous reports, data, laws, policies, and speeches about sustainable development and resource management in Niue, including agriculture, biodiversity, climate, disasters, fisheries, forestry, land management, reefs, and soils. | 115 items | 1965 - 2009 |
| Previous reports, data, laws, policies, and speeches about exposed groups and sectors in Niue, including relating to aging, culture, development assistance, economic development, energy health, infrastructure, population, and youth. | 111 items | 1969 – 2009 |
| News and media reporting, including from the Niue Star and Niue Ki Mua /Tau Tala Niue. | 141 items | 2004 – 2010 |
| Academic articles and theses about Niue | 72 items | 1902 – 2009 |

## D Remarks on Methods Used

This methodology for assessing vulnerability and adaptation to climate change for Niue's Second National Communication to the UNFCCC will follow the principles and many of the procedures outlined in the UNDP's Adaptation Policy Framework (Lim and Spanger-Siegfried 2002).

As such, the methodology: seeks to assess vulnerability and adaptive capacity to climate extremes as well as to changes in mean conditions, is based on an assessment of current vulnerability and adaptive capacity, situates vulnerability and adaptation in the context of sustainable development, and seeks extensive involvement from all stakeholders at all levels of society. The methodology is nevertheless modified to suit Niue's particular circumstances.

The methodology is designed to provide an integrated assessment of vulnerability, which comes through an emphasis on the perspective of stakeholders and the interlocking social and ecological processes that shape their vulnerability to climate change. This differs from top-down methodologies that identify and investigate discrete sectors, and seek to make connections between sectors later, through the use of mathematical and conceptual models.

Earlier 'top down' assessments of vulnerability were very focussed on uncertainties in climate impacts, and this created problems for decision-making about adaptation. In these top-down methodologies adaptation was premised on the assumption that the impacts of climate change could be anticipated and that policy makers could then implement presumably (but by no means certainly) effective responses. The principal problem for policy-makers was one of regret: Governments would rue investing scarce resources in solutions to meet anticipated impacts which may not materialise and whose magnitude is uncertain, even assuming that such solutions would be effective should the impact eventuate (Barnett 2001). In contrast, the bottom-up approach reduces some uncertainties in that it produces robust information about the social and ecological forces that create vulnerability to climate change, and no regrets and locally grounded adaptation strategies to reduce this vulnerability. Nevertheless, uncertainties about the magnitude of changes in climate and sea-level rise, about changes in the frequency and intensity of extreme events, and about the timing of these changes will remain. However, Niue does not have the scientific and technical capacity to contribute to the reduction of these uncertainties. Given that it will have to adapt to climate change it is therefore better for Niue to commit to a second generation methodology that can deliver relevant adaptation strategies that build on existing processes and whose implementation will have no regrets.

## IV Values at Risk

Vulnerability is about the potential for loss, and adaptation is about action or actions taken to avoid these losses or to attain potential benefits arising from climate change. Judgments of the success of adaptation actions, and goals for adaptation policies can only be based on some sense of desired outcomes, either in terms of impacts avoided or gains achieved (Barnett 2010). This means understanding the way people value the things that are at risk from climate change. This may include elements of the natural environment such as species, ecosystems, or sites of significance, and they may include elements of the built environment such as settlements and buildings.

There is a need to broadly describe the things that are important to Niue. A good basis for this can be found in the most recent Niue National Strategic Plan (NNSP) (2009-2013) (Government of Niue 2009). The NSSP has as its objective "to build a sustainable future that meets our economic and social needs while preserving environmental integrity, social stability, and the Niue culture". Its vision for Niue is that:

> Niue will continue to be a sovereign nation in free association with New Zealand. Its unique culture, based on spiritualism, language, heritage and social values, will thrive and be celebrated. Her people will continue to enjoy a high standard of living with a unique island lifestyle and a stable and responsible government (Government of Niue 2009).

To pursue this vision the NNSP set six goals under national development pillars, shown in Table 2. Of these, economic development, social development, environmental sustainability, and Tāoga Niue are all particularly sensitive to the effects of climate change, as is explained in the integrated analysis section of this chapter. Tāoga Niue is defined as all the elements that symbolise the people of Niue (*Tagata Niue)*, including their identity, language, culture, and heritage. Financial stability and governance may also be at risk, but in less direct ways.

**Table 2: Niue's National Development Goals**

| **National Development Pillars** | |
|---|---|
| *Pillar* | *Goals* |
| 1 Financial stability | Ensure that sufficient financial resources are secured, and responsible fiscal management is prudent, sustainable and supports healthy development strategies |
| 2 Governance | Ensure that good governance reflects the principles of transparency and accountability and is practised at all levels |
| 3 Economic development | Maximise benefits from Niue's resources in a sustainable manner focusing on private sector development, targeting tourism, agriculture and fisheries supported by safe, reliable, affordable healthy infrastructure |
| 4 Social | Enjoy a harmonious and healthy lifestyle in a thriving, educated and safe community that has access to a wide range of quality social services and healthy development opportunities |
| 5 Environment | Sustainable use and management of Niue's natural resources and environment for present and future generations |
| 6 Tāoga Niue | Promote, preserve and strengthen Niuean cultural heritage, language, values and identity |

These goals of the NSSP are broadly consistent with the values of most Niueans. It is important to recognise the distinction between the Niueans who remain living on the island, and those who have left. Those who remain share an appreciation of Niue's natural environment and culture, and consider themselves to be guardians of it. Tāoga Niue is that which makes Niueans who they are. It is underpinned, however, by a stable and healthy population, economy, society and environment.

The confluence between the values outlined in the NNSP and the values of individual Niueans is reflected in a major study by Lincoln International (2002) which identified through various social research techniques, Niueans' aspirations for their society. The common vision that was developed through this process was of:

> a world example of a country that makes use of its natural and human resources without over exploitation to develop economic opportunities for all its inhabitants whilst at the same time enhancing its culture, community strengths, spiritual values and embracing a modern society (Lincoln International 2002: iv)

The key issues that were identified as being important in the pursuit of this vision were transport, economic development, land tenure, education and training, maintaining village communities, sustaining population, maintaining spiritual values, and managing the relationship with the Government of New Zealand.

Finally, in two focus group interviews conducted for this assessment of vulnerability and adaptation to climate change, respondents revealed very similar values and aspirations for Niue. They both expressed a deep concern to sustain the relationships between Niuean culture and the land and seas of Niue, expressed a desire to develop sustainably based on Niue's natural resources (such as talo, vanilla and fisheries), and recognised the need to develop a strong sense of Niuean identity. They all expressed the desire for a larger population, comprised predominantly of Niueans, and hoped to embrace modern transport and telecommunications to increase mobility, while preserving culture and identity.

It is clear from these and many other investigations that Niueans strongly desire a society that is equally ecologically, economically and culturally sustainable. This reflects the effects of depopulation on culture and economic growth, and a long standing awareness of the fragility of Niue's ecosystems and of the variability in supply of ecosystems goods and services. Most importantly, it reflects a profound and widespread awareness among Niueans that the environment is indivisible from culture and economy, and that changes in one element translate into changes in the others. Thus, the risks climate change poses to Niue are multidimensional, and adaptation strategies that presume some fungibility between the environment, economy and culture will inevitably fail to avoid impacts on the

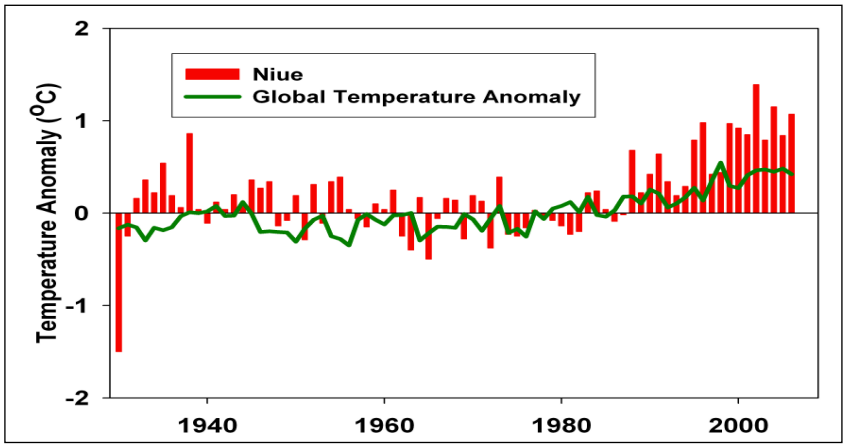
things that Niueans most value.

## V Observed Variability in the Climate of Niue

This section summarises the observed changes in Niue's climate and the nature of climate extremes in Niue.

Between 1930 and 2006 the average annual temperature as measured at the Alofi station was 24.9°C. Between 1956 and 2006 average annual temperature has increased by 1 °C, with the warmest year being 2002, and the ten warmest years being the years since 1995. This is consistent with changes in global mean air temperature, as shown in Figure 1 (Kirono *et al* 2008).

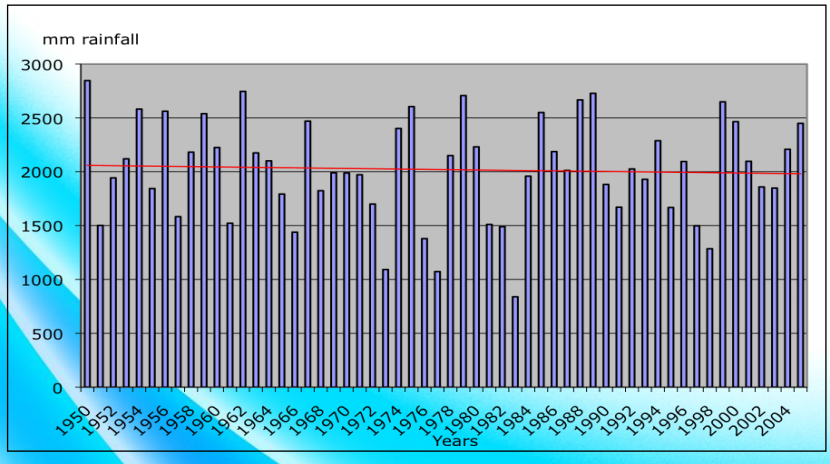
**Figure 1: Niue and global-mean air temperature anomalies 1930-2006, relative to average for 1961-1990**




There are two distinct seasons in Niue – a wet season (November – April), and a dry season (May – October). Temperature does not vary much between these two seasons. Between 1930 and 2006 the average temperature in the dry season was 23.8 °C and in the wet season it was 26.2°C.It is therefore the variability in rainfall and humidity that account for most of the difference between the seasons.

Rainfall in Niue falls mostly in the wet season. The average annual rainfall between 1950 and 2005 was 2021 mm, and of this 66% fell in the wet season. Over this time annual rainfall decreased slightly – by 0.7mm per year, (Figure 2), with changes over seasons being similarly insignificant.

**Figure 2: Variability of Annual Rainfall in Niue 1950 - 2004**



Of greater importance, however, is inter-annual variability in rainfall. Niue often has years of below average rainfall. In twenty of the years between 1950 and 2005, Niue experienced less than 90% of average rainfall, and in eleven of these years rainfall was less than 75% of the annual average. The worst drought was in 1983, when less than 40% of average annual rainfall was received, and this was the third of three very dry years (see Figure 2). For example, between 1950 and 2005 there were 16 years where the island received more than 110% of average rainfall, and in ten of these years rainfall was more than 125% of the annual average. Inter-annual variability in rainfall is closely associated with changes in El Niño Southern Oscillation: El Niño years frequently bring drought, and La Niña years frequently bring above average rainfall (Kirono *et al* 2008).

Niue lies at the edge of the Southern tropical cyclone belt, and the cyclone season coincides with the wet season. Niue is struck by an extreme tropical cyclone every ten years or so. Table 3 shows the major tropical cyclones that have struck Niue since 1915, based on records and oral history. Between 1915 and 2006 at least 24 tropical cyclones have affected the island of Niue. Four of these years (1946, 1956, 1972 and 1989) had more than one incidence of tropical cyclones.

**Table 3: Major tropical cyclones in Niue 1915 – 2010.**

| Year | Month | Severity |
|---|---|---|
| 1915 | March | Severe |
| 1920 | January | Minor |
| 1929 | January | Moderate |
| 1944 | January | Moderate |
| 1946 | January | Minor |
| | December | Minor |
| 1948 | December | Moderate |
| 1955 | January | Minor |
| 1956 | January | Minor |
| | February | Minor |
| 1957 | February | Severe |
| 1959 | February | Severe |
| 1960 | January | Severe |
| 1968 | February | Severe |
| 1970 | February | Unknown |
| 1972 | January | Unknown |
| | February | Unknown |
| 1973 | November | Unknown |
| 1974 | April | Unknown |
| 1979 | December | Severe |
| 1983 | March | Minor |
| 1987 | April | Minor |
| 1988 | April | Minor |
| 1989 | January | Minor |
| | January | Moderate |
| | February | Severe |
| 1990 | January | Severe |
| 2004 | January | Severe |
| 2006 | January | Minor |

## VI Exposure to Future Risks

There are three principal sources of information that inform this discussion of expected changes in climate and sea-level rise in Niue:

- A 2003 study that compared model-based projections of climate, prepared by the Finnish Environment Institute to inform the Fourth Assessment Report of the IPCC, and which was based on a comparison of seven coupled atmosphere-ocean general circulation models (Ruosteenoja *et al* 2003);
- Chapter 16 (Small Islands) of the report of Working Group II of the IPCC Fourth Assessment Report, which reported the results of the 2003 Finnish Environment Institute study, and synthesised findings from various studies about other climate trends (Mimura *et al* 2007);
- A study of climate change projections for Niue prepared by CSIRO, which examined the results of 23 General Circulation Models (Kirono *et al* 2008). This later study noted that despite Niue's small size, projections for Niue can be treated with some confidence as most of the models studied were reasonably able to simulate the present climate.

However, all of these studies have been informed by models that used data on emissions from the latter phases of the 20$^{th}$ century, and which were informed by the IPCC Special Report on Emissions Scenarios (SRES) (Nakicenovic and Swart 2000). More recent research, which projects future concentrations of greenhouse gases based on observations of emissions since 2000, suggests that emissions are tracking along the upper range – or worst case – of the SRES scenarios, so that global mean warming of 2$^{o}$C or beyond is now almost inevitable, and that there is a significant likelihood of mean warming of 4$^{o}$C or more above pre-industrial levels before the end of this century (Anderson and Bows 2008; Meinshausen *et al* 2009). Thus, the upper range estimates of the studies that inform this assessment are given, as these seem increasingly likely to be the estimates that best reflect the future magnitude of climate change in Niue.

### A Climate Drivers

According to these three sources, average annual air temperature in Niue is expected to increase by between 0.7 to 1.5 $^{o}$C by the year 2050 (Kirono *et al* 2008), and by 0.99 to 3.11 $^{o}$C by the year 2069 (Ruosteenoja *et al* 2003). There is unlikely to be much difference between the rate of warming in wet and dry seasons. Increases in extreme temperature events are also expected as warming increases.

Only marginal changes in mean annual precipitation are expected by 2050, and it should be noted that there is considerably more uncertainty about future rainfall than there is about future temperature. Most models show a very slight increase (between 0.3 and 0.8%) in average annual rainfall in Niue by the year 2050. The timing of rainfall is important, and the best estimate is that by 2050 there will be a slight increase in rainfall in the wet season (between 0.5 and 1.1% more), and a slight decrease in the dry season (between 1.4 and 3.2%) (Kirono *et al* 2008). These trends – of more rainfall in the wet season and less in the dry – are fairly robust, and consistent with those that were shown in most other studies.

There may be significant increases in extreme rainfall events, particularly during the dry season, which correlates with fewer days of rainfall. There may also be slight increases in annual mean wind speed due to climate change, with average dry season wind speeds increasing by up to 10% by the year 2050 (Kirono *et al* 2008). Thus, a combination of effects during the dry season – warming, less rainfall on average, fewer but more intense rainfall events, and stronger winds – all point to an increased risk of droughts in Niue due to climate change. Niue experiences drought, particularly during El Niño episodes, and this increased trend of drying in the dry season seems likely to further increase the intensity of droughts.

The effect of changes in mean annual rainfall and temperature on Niue's forests is less well understood, and worthy of further research given that forestry is key to biodiversity conservation in

Niue, and an important part of Tāoga Niue. However, it is known that increasing drought increases the risk of forest fires in Niue.

As an uplifted atoll Niue is less exposed to the risk of sea-level rise than most small island states, which are generally low-lying. However, a rise in sea-level of between 0.19 and 0.58 cms by the end of the century as suggested by the IPCC (Meehl *et al* 2007), presents some problems for Niue. Higher sea-levels, combined with the effects of increased sea-surface temperatures, ocean acidification, and stronger cyclones (see below), may mean the loss of Niue's few beaches, which are important for recreation and tourism. It may also mean coastal infrastructure, particularly the wharf, is increasingly exposed to inundation. Stronger storms combined with sea-level rise will also result in slightly increased wave heights and so increased exposure of coastal settlements and infrastructure to wave damage. These effects may be more pronounced if Ramhstorf's (2007) estimate of a 140cm rise in sea-level rise by the end of the century is accurate.

Climate change is also likely to lead to warming of the sea-surface. In the area around Niue sea-surface temperature is expected to increase by between 0.6 and 1.4 $^{o}$C by the year 2050, with slightly more warming in the wet season (Kirono *et al* 2008). Coral bleaching occurs when the thermal tolerance of coral is surpassed, which usually occurs during episodes of rapid warming of the sea-surface, which in the South Pacific is typically associated with El Niño events. Intense El Niño events lead to intense bleaching episodes, such as occurred throughout the region during the 1997 El Niño event (Brown *et al* 2000). Bleaching impacts on artisanal fisheries, and it is a factor in ciguatera fish poisoning (Cowell and Kench 2001; Hales *et al*, 1999) and bleaching on physically isolated coral reefs, such as Niue's, may be among the slowest to recover from coral bleaching (Ayre and Hughes 2004).

The increased intensity of El Niño events is therefore a risk to Niue reefs, the fish communities they sustain, and the island's few beaches, which are comprised of coral and shell. Possible changes in the direction of ocean swell may also compromise the stability of Niue's beaches (Vassie *et al* 2004).

The effect of gradual and rapid warming of the sea-surface on fisheries and corals in Niue will be compounded by increasing acidification of oceans driven by the increased uptake of carbon and other compounds from the atmosphere. Ocean acidification impacts on shell-forming marine organisms, including plankton, molluscs, echinoderms, and corals, with subsequent effects on the marine food chain, including on fish and marine mammals (Doney *et al* 2009; Orr *et al* 2005). When concentrations of atmospheric $CO_2$ double from pre-industrial levels, ocean acidification will potentially start to dissolve all corals (Silverman *et al* 2009).

The effect of ocean acidification on pelagic fisheries in the water around Niue is far from clear, however the cascading effects of acidification through the marine food cycle seem likely to affect predator species, including tuna (Cooley and Doney 2009). There is an association between changes in the El Niño/La Niña-Southern Oscillation (ENSO) conditions and variations in catch per unit of effort rates across the South Pacific (SPC 2006). If climate change causes ENSO events to become more frequent or more severe, then this may in turn affect the amount of fish caught in Niue's Exclusive Economic Zone, particularly given suggestions that climate change may cause an extension of the present range of tuna to higher latitudes of the equatorial Pacific (SPC 2006).

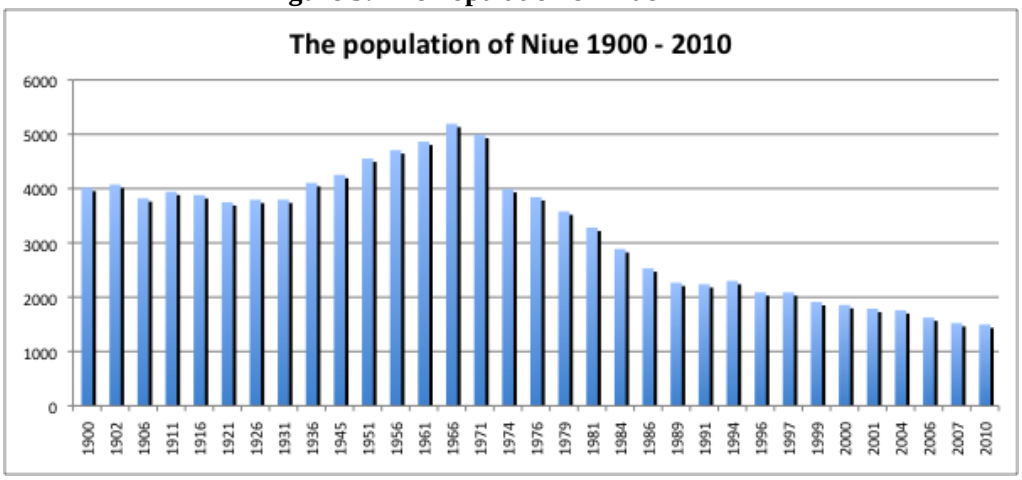
There is uncertainty about the effect of climate change on ENSO, but there is some consensus that there may be a slight shift towards more El Niño-like conditions (van Oldenborgh*et al* 2005). El Nino years tend to increase the frequency of tropical cyclones, and while the relationship between climate change and tropical cyclones is still highly uncertain, there is evidence that they may become more intense in the future – meaning that such cyclones may last longer, exhibit higher wind speeds and unleash more rainfall (Trenberth *et al* 2007, Walsh 2004). In Niue, El Niño brings with it increased risk of coral bleaching, drought, and reduced catches of pelagic fish (with increases during La Niña events). More El Niño-like conditions will increase risks to key ecosystems in Niue.

## B Social Drivers

### *1 Population*

The ways in which Niueans use the island is also a factor in exposure to climate risks. The total number of people on the island is a significant factor. In the past, when the island was more populous (there were at times over 5,000 people on the island prior to the arrival of the first missionaries), drought-induced famines occurred. This is not surprising given that the population would have been almost entirely dependent on production from Niue's thin soils for the supply of carbohydrates and most micronutrients. Famine is now a thing of the past, due largely to the depopulation of the island, which began in earnest in 1971 after the international airport, was opened, and imports of food (see figure 3). An increasing population dependent on cultivation for most of its food needs would therefore increase demand on soils, and increase the risk of drought. Nevertheless, given the ability to import food, and improvements in cultivation practices, Niue's population would probably have to increase to well beyond 5,000 people for drought to cause famine again.

**Figure 3: The Population of Niue**




The number of people is also a factor in the extent and location of settlements. Given that cyclones cause damage along the western coast (and this is the most populous coast), all other things being equal, more people would most probably mean more houses and associated infrastructure exposed to damage from waves and wind. Some decisions about settlement are reducing exposure. For example, the hospital and bulk fuel depot were relocated away from the coastline as part of the post cyclone-Heta recovery program, and the new public service building has been located away from the high risk zone.

### *2 Economy*

Of equal, if not greater importance, however, is the structure of Niue's economy. Approximately half of Niue's GDP is owned by Government, and at least half of all income comes in the form of development assistance. Therefore, a large proportion of the economy is largely unexposed to changes in climate in Niue (but rather, is exposed to changes in development assistance policy in New Zealand) (Government of Niue 2007; Statistics Niue 2009a). Nevertheless, half of GDP comes from local production, and this, and the activities of the Government which rely on facilities on the island, is exposed to climate change.

Efforts to intensify production of key commodities for export – such as vanilla, honey, noni and fish (as identified in the NSSP) – and to increase facilities for tourists are likely to increase the extent and value of things that may be damaged by climate change. Indeed, the damage caused by cyclone Heta to vanilla vines across the island – and in particular to those on the western coast – was significant, and set back development of the industry by two years. Similarly the destruction of one

key hotel and a motel, the Niue Hotel and the Namukulu Motel, during cyclone Heta significantly reduced the island's ability to supply services to tourists. Decisions to expand agricultural and commercial services therefore need to take into account the risk of damage from cyclones and droughts in choosing sites to locate activities, and the design of facilities.

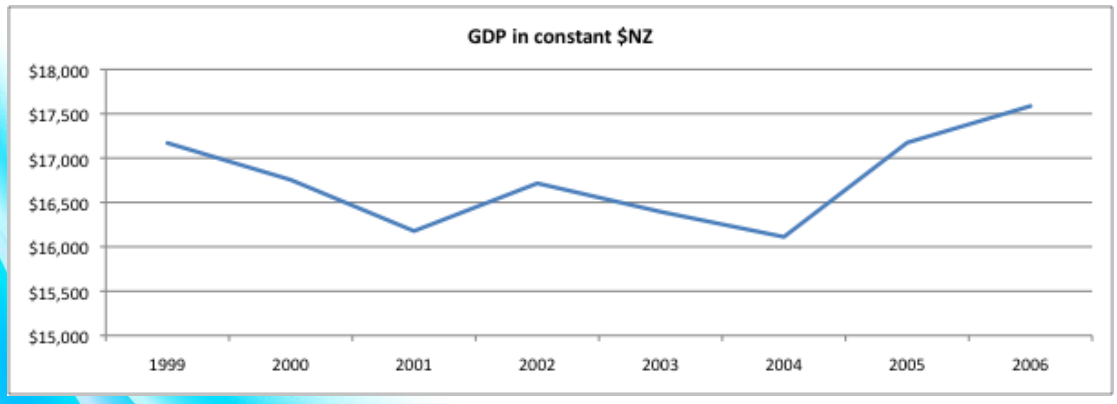
It is nevertheless the case that Niue's major social problems stem from an overly small population and economy, as these constrain the availability of labour, skills, technologies, and financial resources that help implement local processes, as well as creating inefficiencies in markets and other governance institutions (Barnett 2008).

If recent trends are any indication, neither the population nor the economy is likely to grow much in the immediate future. Figure 3 shows the change in Niue's population between 1900 and 2010, and shows a steady decline in the number of people since 1971. However, it should be noted that while the rate of decline is slowing, and despite its very significant effects on Niue's economy and man-made and natural environment, cyclone Heta did not lead to an increased rate of emigration. Further, when temporary emigration is taken into account, there may have been a slight increase in population between 2006 and 2010 (although these people are not included in the data in Figure 3) (as reported in Tauevihi 2009a).

In focus group interviews conducted in 2006 respondents were asked to imagine three scenarios for Niue's future, producing what can be termed a 'best case', 'worst case', and 'business as usual' future. Questions were asked about future population, and the 'best case' was seen to be a population of around 5,000 people, the vast majority of whom would be Niueans. The worst case was described as being one where there were less than 1,000 people (although many imagined the worst case as one where there were no Niueans left on the island). The majority suggested that any population that is comprised of less than 50% Niueans would be a very bad outcome. The business as usual future was seen to involve a steady increase in population, up to a maximum of 5,000 people, but with much of the increase being comprised of people from East Asia and other Pacific islands. However, as suggested by figure X.7, such an increase would be a marked departure from the trend of the past 40 years.

Figure 4 shows the trend in GDP between1999-2006. Over this time Niue's GDP has increased by only 2.4%, with declines over the years 1999 - 2001 (due to reductions in budgetary assistance from New Zealand) and 2002-2004 (due initially to reductions in offshore financial services, and later to the effects of cyclone Heta). Increases in GDP since 2004 can be attributed to the effects of the post-cyclone recovery activities, including major capital works such as the construction of the new hospital.

**Figure 4: Niue GDP 1999-2006 (NZ$)**




The government's share of GDP over the period 1999-2006 fell slightly, from 53.6% in 1999 to 50% in 2006, with the balance being taken up by the private sector. Notable changes in the sectoral

distribution of GDP over this period include: a 78% increase in activity in the hotels and restaurant sector (although it accounted for 4% of GDP in 2006); a 12% increase in wholesale and retail trade; and a 46% decline in activity in the transport, storage and communications sector.

If these trends continue into the future there are unlikely to be any significant changes in population, land use, settlements, and infrastructure of the kind that would significantly increase vulnerability to climate change. Overall, then, the major driver of increased exposure to climate change in Niue is changes in climate and not changes in human activities: these latter changes are likely to be far less in magnitude than the expected changes in climate.

## VII Sensitivity

Niue is therefore very likely to experience changes in its environment due to changes in climate. These changes will be more or less important, depending on the significance of the entity exposed to change to the lives and livelihoods of Niueans, and to society as a whole.

### A Agriculture

The expected changes in mean annual temperature are in themselves unlikely to have a major impact on Niuean agriculture until the latter part of the century. Indeed, it is possible that slight warming coupled with the $CO_2$fertilisation effect may increase plant growth in the short term (all other things being equal). Nevertheless, episodes of extreme heat can damage plants and retard their growth, and once global average temperatures increase by 3$^{o}$C, food production is likely to be adversely affected in Niue (as in almost all places) (Easterling *et al* 2007). Given Niue's shallow and nutrient-poor soils, it is nevertheless rainfall rather than temperature that is the most important driver of changes in terrestrial ecosystems in Niue.

Most locally grown foods in Niue are grown in 'bush blocks', which are cleared using a bulldozer, planted with talo (80% of plantings), cassava, yams and sweet potatoes (together accounting for 10% of plants), bananas (7% of plantings) and other fruits and vegetables such as pawpaw, watermelons, and onions (3% of plantings). Talo therefore dominates crop production, and a 'half hour' block (that is, in an area cleared by a bulldozer in half an hour), which is approximately 1,200 square meters, typically yields between 400 – 500kg of talo (Government of Niue 2000b). As has traditionally been the case, due to poor soils, these bush blocks are then left fallow once the talo has been harvested (typically 9 months after planting).

This practice of shifting cultivation, combined with absence of surface water and the cost of digging bore holes, means that irrigating the major crops in Niue is very difficult, and any such system would be very costly. Thus, crops receive moisture only from rainfall, and talo crops develop better in wetter rather than dryer conditions, so that when rainfall is inadequate, crops wither and can ultimately perish (Bussell and Bonin 1998).

Not all crops are equally sensitive to drought. For example, Cassava, kumara and yams are more drought resistant than bananas and talo (Horton 1988). After talo, the next most widely eaten local crops are coconut and pawpaw – both are eaten at 2/3rds the rate that talo is eaten (Barnett *et al* 2009). Like talo, coconut is rarely purchased (only 16% of coconuts consumed are bought), and is mostly produced by the households that consume them (only 13% of coconuts consumed are given as gifts). Coconuts are the third or fourth most important local food in every village except Liku. Vaiea and Toi consume the most coconuts, and Liku and Namukulu consume the least. Pawpaw is almost never purchased – only 5% of all people who eat pawpaw buy it – because pawpaw is abundant in Niue, and it is easier to pick than coconuts. Pawpaw is one of the five major local foods in all villages. It is eaten most in Namukulu, Liku, Mutalau, Hakupu, and Vaiea, and least in Alofi South.

Drought damage to Talo

Climate change is likely to increase the risk of drought in Niue. Drought brings to Niue significant reductions in all major food crops, in particular talo (*Colocasiaesculenta*). The worst drought on record in Niue was in 1983, which caused exports of talo to fall from 86 tonnes in 1982, to 5 tonnes in 1983, to 0 tonnes in 1984, recovering to 61 tonnes in 1985 (data on imports over this time is not available, but it is known in the island that talo was imported) (TRADESTAT 2010). Drought can also increase the intensity of damage from pests such as aphids and leafhoppers. So, the prospect of a drier winter with fewer rainfall events poses a considerable risk to talo production in Niue.

Cyclone damage to tree crops

Cyclones, cause significant damage to crops in Niue, in particular to tree crops such as breadfruit, mangos, coconuts and bananas. An assessment of biodiversity after cyclone Heta noted that damage to tree crops decreased with distance away from the cyclone affected western coast (Butler 2004). Compared to tree crops, root crops such as talo are generally not greatly affected by cyclones. Wind damage is minimal given the leaves are close to the ground, and while damage to leaves from salt-spray occurs this is generally minimal and restricted to coastal areas.

A recent study has suggested that most of the variability in production of coconuts is explained by variability in climate (Fernando *et al* 2007). However, since coconuts are reasonably abundant in Niue, and are no longer harvested for export, the effects of climate on production are not obvious. In most parts of the world coconuts yield some fruit given as little as 1000mm of rainfall per year (see Rao 1989). Only once in the past 60 years has Niue received less than 1000 mm of rainfall (in 1983), when the lack of supply of coconuts was notable, and contributed to the collapse of a fledgling coconut cream industry (Fleming 1996). However, given its thin and porous soils, the minimum amount of rainfall for a yield of nuts in Niue is likely to be somewhat higher, and in past times, when Niue exported coconuts, drought was known to reduce farmer's incomes substantially (Pollock 1979). Drought can affect yields for up to four years after the dry period, and it can also increase seedling mortality (Rajagopal *et al* 2005). Cyclones, too, have an impact on coconut production, with high wind speeds tearing loose leaves and nuts from trees. During Cyclone Heta in 2004, damage to coconut trees on the western side of the island was high, but it was minimal on the eastern side (Butler 2004). Therefore coconut production in Niue is sensitive to both extreme droughts and winds, both of which may be more likely in the future due to climate change.

Although little is known about the response of pawpaw to soil moisture deficits, it is known that it requires at least 1200mm of rainfall a year to thrive, which is usually the case in Niue (Marler and Clemente 2006, Nishina *et al* 2000). Pawpaw is abundant in Niue in part because it requires well drained soils, which is the case throughout Niue. The plant can tolerate moderate winds, but leaves and fruits are easily damaged in cyclones, and by salt spray (as was the case with trees along the western coast after both cyclone Ofa in 1990 and cyclone Heta 2004).

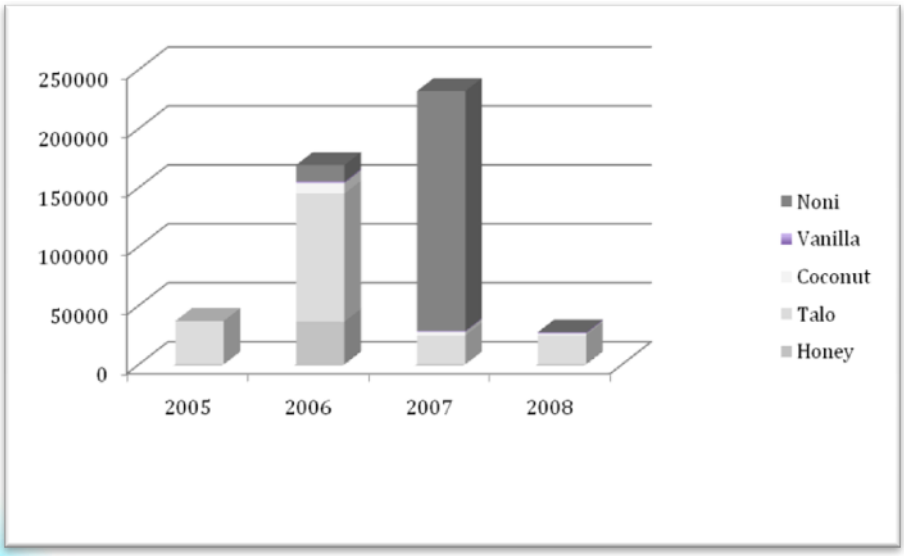
Niuean agriculture is therefore sensitive to changes in climate, and in particular to drought and cyclones. Since the 1950s Niue has attempted to develop a number of agricultural commodities for export, including bananas, coconut cream, copra, honey, kumara, limes, noni, passionfruit, pawpaw, talo, and vanilla (Mitchell 1977, Murray 2000). There are many non-climatic reasons why these export ventures failed, including issues relating to transport (timing, costs, and duration), quarantine, quality control, marketing, competition, declining prices, rising input costs, high labour costs and labour scarcity, and management difficulties. These largely explain the difficulties of sustaining agricultural exports from Niue.

Nevertheless, climatic factors have played a part in triggering the demise of agricultural exports: copra exports were devastated in the years immediately after the cyclones in 1959 and 1968; the export of bananas began to decline after plant diseases wiped out the crop in the mid-1950s, the

cyclone in 1959 impeded efforts to recover, and exports had all but ended as a result of the cyclone in 1968; Niuean kumara were infected by black rot after the cyclones in 1959 and 1960, and this disease severely affected exports between 1960-64; the passionfruit industry never recovered from the cyclone in 1979; lime production never recovered from the major decline caused by cyclone Ofa in 1985; exports of pawpaw ceased after the 1983 drought; attempts to develop a cattle industry failed after a reduction in feed during the 1983 drought caused starvation among half the herd; and, as discussed earlier, drought had a major impact on talo exports in 1983-4 (Barker 2000, Fleming and Blowes 2003, Mitchell 1977, Murray 2000). Cyclone Heta, in 2004, caused widespread damage to some of the island's largest vanilla plantations along the west coast, many of which were due for certification as organic growers in early 2004. The Niue Island Organic Farmers Association (NIOFA) suggests that Heta set back development of the organic vanilla sector by 3 years.

Niue currently exports small amounts of coconuts, honey, noni juice, talo, and vanilla, and intends to increase exports of noni juice and vanilla as part of its strategic development plan. At present exports of all these agricultural commodities varies from year to year (see Figure 5), and in the best years amounts to less than 1% of GDP (Statistics Niue 2009b). Present and planned agricultural exports must contend with the same non-climate barriers to export success that have always constrained the sustainability of agricultural exports (discussed above, and in Cohn 2003, Mitchell 1977, and Murray 2000). These barriers explain the variability in exports in recent times as well, as shown in Figure 5. As discussed above, production and export of coconuts, talo and vanilla are sensitive to drought and cyclones, and it is telling that there were no exports of coconut, honey, vanilla and noni in the year after cyclone Heta (2005) (see Figure 5).

**Figure 5: Value of Agricultural Exports from Niue 2005 - 2008 (NZ$)**




Climate change is likely to increasingly constrain agricultural exports. Vanilla, for example, requires an annual average of rainfall of between 1900 and 2300 mm, which needs to be evenly distributed throughout the year (Rao and Ravishankar 2000). Between 1950 – 2006 average annual rainfall in Niue fell below 1900 mm 21 times – this is to say that two out of every five years there is insufficient rainfall to grow vanilla in Niue. Over this time there were also 15 years in which rainfall exceeded 2300 mm, although excess rainfall is less likely to be a problem for vanilla in Niue given its shallow and rapidly draining soils. Regular rainfall throughout the year is also necessary, for example a report from the Department of Agriculture in July 1998 showed that one month of very low rainfall (May 1998) destroyed almost all of the new cuttings planted in March of that year (DAFF 1998). An

earlier report in 1997 suggested that flowering begins in May with the start of the (cooler) dry season, but that the duration and intensity of the flowering season seems to be influenced by rainfall: steady but not extreme rainfall events in the dry season seems to stimulate the abundance of flowers, but intense rainfall events seem to diminish the abundance of flowers (DAFF 1997). The possibility that climate change may increase variability in rainfall within and between years, and increase extreme rainfall events, therefore mean that conditions conducive for vanilla production will deteriorate in the future.

The average minimum and maximum temperatures required for vanilla production are 24 and 30°C respectively (Rao and Ravishankar 2000). Between 1930-2006 the average minimum and maximum temperatures in Niue were respectively 21.2°C and 28.4°C. So, up to two degrees of warming is unlikely to affect vanilla production, but the higher rates of warming expected beyond 2050 may constrain production.

Apart from a few hundred dogs and cats, the only major populations of animals in Niue are pigs (both domestic and wild), and chickens. In the past there have been attempts to develop herds of cattle and llamas, but these failed for a variety of reasons. There are approximately 8,700 chickens in Niue, few of which are caged and fed, most of which are free ranging and seem to be thriving. There is little evidence to suggest the ways in which changes in climate may impact upon chickens in Niue.

There are 1164 pigs kept in pens in Niue, with possibly more than twice this number roaming free (Tauevihi 2009b). Penned pigs are well looked after by their owners (as pigs are valued for their meat, and their cultural significance). They are well fed and watered, and there is little reason to think that climate change will have any impact on domestic pigs in Niue. Nor is there any evidence or reason to think climate change will have an impact on the population of feral pigs in Niue, whose number is determined largely by the ability of people to keep domestic pigs in their pens, rather than by climate. Nevertheless, given that in some villages over two thirds of plantations are damaged by wild pigs, an increase in their numbers for whatever reason would be of concern to Niueans.

## B The Coastal Zone

Niue Island is made entirely from coral-reef limestone and associated calcareous sediments which form a cap, more than 300 meters thick, that sits atop a volcano (Nunn and Britton 2004). Its coast is characterized by a continuous shore platform formed at approximate mean sea-level, which is up to 130 meters wide, has an area of 620 hectares, and has limestone cliffs developed in uplifted terraces (Kennedy and Marsters 2009). The shore platform is one of a series of terraces that have formed at various stages of the island's evolution.

The island initially developed as an atoll formed on top of a volcano that subsided at least 300 meters below sea-level over a period of approximately 5 million years. The remnant of this atoll now comprises the upper terrace of the island, called the Mutalau Reef, which is up to 70 meters above sea-level. Some 500,000 years ago the island began uplifting, and at various stages this process of uplift appears to have paused, allowing the development of fringing coral reefs, the main one of which (the Alofi terrace) sits some 25 meters above sea-level and is the terrace on which most of the villages along the western side of the island are located (Nunn and Britton 2004). Nunn and Britton (2004) speculate that the terraces may also have formed during periods when the uplifting of the island occurred at the same rate that sea-level was rising, allowing coral reefs to develop into broad platforms fringing the island. The present fringing reef, which is submerged at high tide, has formed over the last 10,000 years (during the Holecene) (Nunn and Britton 2004).

The uplifting of Niue is likely to continue for another 500,000 years, and the island is likely to rise a further 50-70 meters above sea-level (Nunn and Britton 2004). This is a rate of uplift that will, over time, exceed the maximum expected rate of sea-level rise due to climate change. However, the rate of uplift of Niue over the past 10,000 years is between 0.13 and .16 mm/year (meaning since human occupation the island has risen by some 20-30 cms), which, if this rate continues over the next

100 years, is far slower than the expected rate of sea-level rise of between 1.9 and 5.8 mm/year over this time (or 14mm/year if Rahmsotorf's 2007 estimate is correct) (Nunn 2004).

Therefore, despite the very long-term uplifting of Niue, Niue's shoreline (taken here to be the platform along the intertidal zone) will nevertheless experience sea-level rise in the next 100 years. As discussed above, it will also experience rapid changes in sea-surface temperature which can induce coral bleaching, increasing acidification of oceans, both of which can effect coral growth and the growth of shell-forming organisms.

None of these expected changes are likely to cause a major disturbance to the structure of the shore platform. However, they pose significant risks to the organisms that inhabit the platform, including corals, benthic organisms, crustaceans, and species of fish that rely on the fringing reef as a habitat for breeding and food supply. It is estimated that there are 43 different families of corals in Niue's coastal zone (Dalzell *et al* 1993). Based on data collected during a survey of resource users conducted in 1999, Thaman *et al* (2004) report that from this zone Niueans harvest 23 species of shellfish, 16 species of marine crab, 30 species of marine invertebrates, and two species of lobster. The shellfish that are most frequently harvested include giant clams, turban shells, drupe shells, vase shells, cone shells, star shells, and cowries, most of which are used in the production of handicrafts – an activity that is almost exclusively the preserve of women, and which is a source of income for women and an important cultural practice. Some of these shellfish, such as giant clams, cone shells, and star shells, are in short supply. Marine crabs are harvested for food, and among these ghost crabs, grapsid rock crabs, red legged swimming crabs, and ghost crabs are said to be in short supply. Octopus are also frequently harvested from the reef (these are said to be in short supply), as are beche-de-mer species such as the surf redfish, lolly fish, and small black holothurian. Sea urchins and starfish are also frequently harvested (Thaman *et al* 2004). Seaweed, too, is harvested, in particular edible seaweed called *caulerpa* (Tuara 2000). Very little of these harvested resources are sold in markets, although the handicrafts made from shells (usually necklaces) are most often made for sale.

It should be noted that this evidence about most frequently harvested species is now more than ten years old, and it has been reported since that time that there has been a significant decrease in consumption of those species harvested as a food source (Vunisea 2005). In the 2006 survey of household food consumption, 37 households reported eating crabs in the last 24 hours, and 46 reported eating shellfish. There is no evidence to show that the rate of harvesting for handicrafts has changed since 1999. There is a need to update data about harvesting practices as it can reveal much about changes in the structure and composition of the reef eco-systems in the past decade.

As discussed above, the ability of these species of corals, shellfish, and crabs to produce their shells and skeletons will diminish as concentrations of $CO_2$ in the water leads to increasing acidification of the water around Niue. There is no evidence from Niue to suggest that this is having an effect on these species at present. They are also susceptible to damage from cyclones, which cause a reduction in numbers and a destruction of habitats. Cyclone Ofa, which struck in 1990, was reported to cause large scale mortality of corals in Niue's coastal zone, along with a decline in the numbers and diversity of reef-based organisms including giant clams (Dalzell *et al* 1993). Recovery from this event was impeded by widespread coral bleaching in Niue in 1997. Cyclone Heta (2004), too, caused major reductions in coral cover along the western coast, including complete removal of all living material in some parts of the north-west coastal platform; a substantial reduction in the abundance of macro invertebrates, including the local extinction of some species; and the widespread coverage of algae across many reef flats and pools along the northern coast (possibly due to higher nitrogen concentrations) (Fisk 2004). Recovery of reef communities since the cyclone has been very slow.

Beaches comprise less than 1% of Niue's coastline, they are found in protected coves along the shoreline and are rarely more than 12 meters wide and 50 meters long (Kennedy and Marsters 2009). Niue's beaches are ephemeral, forming during quieter sea conditions, and eroding during high wave energy events, with complete removal of all material possible during cyclones (such as cyclone Heta in 2004). The sediment on these beaches is derived almost entirely from benthic communities

living on the shore platform, in particular the skeletons of very small jellyfish-like creatures called foraminifera (Kennedy and Marsters 2009). The existence of beaches in Niue is therefore very closely linked to the biological productivity of the reef environment, as well as to the return period between cyclones (Kenedy and Martsers 2009). Whilst few in number, the few that exist are important for recreation, tourism, as habitats for some crab species, and as access points to the reef for fishing and harvesting.

Climatic conditions appear to influence the presence of the toxic algae that grows on reefs in the Pacific(which leads to the bioaccumulation of ciguatoxins in the marine food chain), leading to ciguatera fish poisoning(which is a serious illness that affects people who eat ciguatoxic fish). In Niue, as in the rest of the South Pacific, ciguatera poisoning is associated with coral bleaching (Hales *et al* 1999), and rates of infection were reported to increase in Niue in the years following cyclone Heta. However, that ciguatera poisoning is almost exclusively a problem experienced in Alofi North suggests that there is a significant human driver of this problem, possibly due to one or more of the effects of higher traffic of boats including ocean-going vessels who may empty their ballast tanks in the area, and a higher concentration of septic tanks which may leach nutrients onto the reef (Yeeting 2003).

Niueans have observed a number of changes in the coastal zone, as well as the likely drivers of those changes. For example, in interviews conducted with people living in the villages of Alofi North and Makefu, (Leolahi 2007) found a high level of concern about the declining number of tube worms, clams, shellfish and fish; an increase in the number of birds that feed on marine organisms; coral bleaching; and pollution, in particular from dumped solid wastes, oils, and plastic bags. Many causes of these changes were identified including among other things, damage to reefs from unsustainable harvesting practices; poaching and illegal fishing; unsustainable harvesting techniques (such as spear fishing); the flow of sediment and nutrients from the land onto the reef; leaking septic tanks and inadequate systems for the disposal of solid and other liquid wastes; and discharges of fuel and wastes from boats.

It is nevertheless the case that Niue's coastal zone is relatively pristine compared to many others in the region, largely perhaps due to its small population and moderate levels of affluence. It is also due in part to a generally high level of awareness of the need to sustain coastal resources, and it is notable that the country has three protected areas with a marine component: the Anono (Namoui) Marine Reserve, which was registered in 1998; the marine component of the Huvalu Forest Conservation Area established in 1996; and an Alofi North to Makefu no-take area (established in 2005).

Climate change is therefore not going to cause losses of coastal land in Niue, as it seems likely to in many other islands. Yet in many ways the ecosystem goods and services provided by the coastal zone are sensitive to climate change and sea-level rise. Niueans rely on the organisms that live on the coast, they have cultural value, are a source of nutritious food, and are important for recreation and tourism, and they collectively comprise a significant share of the island's biodiversity. These elements of Niue's environment are sensitive to changes in sea-surface temperature, to acidification of the oceans, and to cyclones.

## C Fisheries

In Niue, as in most Pacific islands, fish is an important source of protein (Bell *et al* 2009). Data from the household food survey conducted as part of the 2006 Census shows that on any given day 73% of households in Niue eat fish caught in Niuean waters, 56% of which is either consumed by the people who catch it or is given as a gift (Barnett *et al* 2009). In an average week 35% of households eat fish at least four times, and 23% of households eat it almost every day. Households in almost all villages consume fish between one and three times per week. Fish is the second most important local food (after talo) in almost every village. Fish is eaten most in the village of Vaiea,

where 82% of the population eat it almost every day. That fish is both frequently purchased and given as a gift shows its importance to both diets and customary practices in Niue.

Niue's fisheries are also a source of income for some households who either catch and sell fish, or work in the Niue Fish Processing factory. Local fishers harvest shellfish and shells, corals, crustaceans, marine plants, finfish and other species for sale on the domestic market. About half of the total non-commercial catch in Niue is from the reef area, and about half is from the waters beyond the reef (Dalzell *et al* 1993). The key near shore species include snappers, groupers, scads, mullets, soldierfish, goatfish and cods. Key pelagic species are wahoo and yellow fin tuna (Dalzell *et al* 1993).

Fish caught in Niue's Exclusive Economic Zone (EEZ) are also a source of revenue. Prior to 2005 deep water fishing nations (largely Japan and Taiwan), whose boats operated in Niue's EEZ, paid the government a licensee fee for the right to fish in Niuean waters. Between 2005 and 2008 fish caught in Niuean waters were processed and exported from Niue as part of a joint venture between the Niue Government and the Reef Group of Companies.

Niueans are highly skilled at fishing from the reef, canoe, and motorised boat. They possess a rich body of knowledge about where and how to catch fish (Loeab 1926, Ryan 1981). Yet this knowledge relies on some certainty in the variability of conditions that determine species range and abundance. Climate change is introducing greater variability in the factors that determine species range and abundance. In terms of artisanal (near-shore) fisheries, the degradation of reefs due to cyclones, coral bleaching, and ocean acidification seem increasingly likely to impact on the habitats of key species. The effect of increasing variability in abundance for these reasons will affect nutrition and the incomes of households that sell products from these fisheries.

In terms of the tuna fishery, changes in ENSO conditions cause variations in catch per unit of effort (CPUE) (SPC 2006). Niueans have observed that CPUEs are lower than average in El Nino years, but higher than average in La Nina years. If, as suggested by climate models, climate change causes a more El-Nino like state in the region, as well as more El Nino events, this may in turn affect the amount of fish caught in Niue's EEZ, meaning both less revenue from licenses paid by distant water fishing nations, or less supply of fish to the fish processing plant in Alofi. Climate change and ocean acidification may also cause a decrease in net productivity and increasingly variable catches (thereby decreasing catch per unit of effort), with subsequent impacts on the costs of production and prices, and in turn potentially increasing pressure on the most valuable species of bigeye and yellow fin (in an attempt to offset increasing costs) (SPC 2006).

Increases in storm damages due to climate change in Niue may also impact on fisheries development through damage to and loss of boats, boat launching facilities, fuel facilities, and fish storage and processing facilities. For example, cyclone Heta caused severe damage to sea tracks from which fishermen launch canoes, as well as to both of the derricks used for lifting small vessels into and out of the water, with the result being that fishing for subsistence purposes ceased for some weeks. Through changes in fish habitats, in migration patterns, and in fishing-related infrastructure, climate change poses significant risks to Niue's fisheries.

***Spinner dolphins off the reef in Niue***

## D Water Resources

Niue's water resource problem is not so much one of scarcity as of access to available water. The island has no surface water, but it does have a deep freshwater lens that is between 15 and 44 meters thick, depending on location and the season, and which is estimated to be at least 35 meters thick in the central areas (more than 1km from the coast) (GWP 2006). In total the groundwater reserves in Niue are estimated to be 7,000 Million $m^3$.

On an annual basis Niue's aquifer receives considerably more recharge (water in) than is withdrawn by people or is lost to sea through coastal springs (discharge) (GWP 2006). On balance it appears that Niue has enough groundwater to maintain supply during even very dry years (GWP 2006). However, much remains to be known about Niue's water resources, and it is notable that, a) excessive withdrawals from bores can cause localised draw-downs of the aquifer and associated saline up-coning (water being drawn into the borehole), meaning that the gross abundance of water does not prevent water supply problems associated with extraction from bores; and b) for the six months of the year between June and November, Niue's aquifer receives no recharge (GWP 2006). Further investigations and on-going monitoring of water depth and quality are required.

Niue's water problem is more about the cost and security of accessing the freshwater lens. Up until 1957, apart from one well, Niueans accessed water by carrying it up from caves, or from rainwater harvesting. Since then a series of narrow boreholes with pumps have been installed, and a reticulated water supply system services all households. The cost of pumping water into the reticulated system is high – accounting for up to 25% of the island's electricity use (all of which is supplied from diesel-powered generators). When the electricity system fails the supply of water also begins to fail. Further, unless the pumps from the wells are set near the surface of the bore, saline up-coning during dry-periods is also a risk to freshwater supply.

Thus, water in Niue is expensive and its availability at times is unreliable. Given rising fuel prices and the increased risk of drought due to climate change, costs and risks to supply are likely to increase in the future. Changes in the water supply system, including resetting the depth of pumps, ongoing investigations and monitoring of groundwater, the use of renewable energy to power pumps, and greater investments in rainwater harvesting can help reduce the vulnerability of Niue's water supply to climate change.

## E Terrestrial Biodiversity

Niue's terrestrial biodiversity faces fewer challenges from human activities than in many other islands, largely because of Niue's small population. Nevertheless, like many island ecosystems, large-scale perturbations can have significant impacts on biodiversity. There are three pathways of change between a change in climate and a change in biodiversity in Niue. First, cyclones can cause large scale habitat destruction and species mortality. Butler's (2004: 2) assessment of the impact of cyclone Heta was that it "had a widespread and significant impact on the islands ecosystems associated with what is expected to have been substantial mortality of native species". Key species, such as fruit bats and pigeons, as well as old trees, were damaged.

Second, climate change will increase the risk of fire in Niue's forests, including the biodiversity-rich primary forest and the Huvalu Forest Conservation Area. Factors that lead to this increased risk are longer and more intense dry spells, coupled with a possibly drier climate. Ways to offset the risk include addressing the various human activities that can ignite fires, such as burning to clear land for planting, improper disposal of cigarettes, and unmanaged fires.

The third major climate driver of change in biodiversity in Niue is from invasive species, which can compete with native plant and animal species. There is some evidence, for example, that invasive species increased as a consequence of disturbances to terrestrial ecosystems after Heta. While climate change is unlikely to change the mechanisms by which invasive species are introduced into

Niue, it may create new climatic niches that favour the establishment of new species, undermining the conditions of existing species, and consequently reducing the effectiveness of strategies for managing invasive species.

## F Health

More rainfall in the summer (as expected) and less rainfall in the already dry months means more favourable conditions for the spread of mosquito borne diseases such as dengue fever and malaria. While the *Aedes aegypti* mosquito that carries dengue fever and malaria is not presently found in Niue, it has been present in the past and so, if reintroduced, can establish itself in Niue. Another mosquito-borne diseases – Filariasis – has been present in the island until recent times, but now appears to be eradicated. Gains in controlling mosquito borne diseases such as these may be jeopardised by climate change.

Cyclones of course pose major dangers to human health in Niue, causing mortality and injury, and increasing the risk of post-event diseases through disruptions in water, sanitation, and power services. As mentioned above, the risk of ciguatera fish poisoning increases after cyclones (and during El Nino events) (Hales *et al* 1999). Heat stress is unlikely to be a major driver of morbidity and mortality in Niue in the near future given its warm but not extremely hot climate, the absence of an urban-heat island effect, and some degree of acclimatisation to heat among the population.

As discussed further below, reductions in the supply of healthy local foods such as talo and fish may mean a shift to important substitutes that are higher in fat, salt, and sugar and this may exacerbate existing problems with non-communicable diseases.

## G Settlements and Infrastructure

The major risk that climate change poses to settlements and infrastructure in Niue is damage caused by both waves and wind during cyclones. This has long been a problem in Niue, and cyclones have had such an impact on Niue that Barker (2000) argues that they have powerfully shaped the structure of contemporary Niuean society.

While cyclones have long had an impact on Niueans, it was not until the first major cyclone to occur after the development of a significant capital stock that they created major damages to settlements and infrastructure. So, during successive cyclones in 1959 and 1960 most of the housing stock on the island was lost, leading to a large scale New Zealand government funded, but locally administered, housing reconstruction program (Barker 2000, Matheson 1986). When maintained, the houses built during this time – called 'hurricane houses' – are generally resistant to damage from cyclones, although large wave events can damage them. Many of these houses are still in use, although most now lie abandoned. These houses were built with asbestos roofs, and throughout the island damaged asbestos sheeting and piles of sheeting that have been collected awaiting removal, can be found posing a major public health risk.

Subsequent cyclones have also caused considerable damage to settlements and infrastructure in Niue, including cyclone Ofa in 1990, which caused widespread damage to the wharf, cargo sheds, the main public service building, the hospital, the airport, many houses, important elements of the communications network, sea-tracks, community halls, and a hotel (Barker 2000, Terry 2004). The costs of recovery were estimated to be over NZ$30 million (Barker 2000). The most recent severe cyclone, Heta in 2004, caused much damage along the island's western side. It destroyed 43 houses that were more than 25 meters above sea-level, as well as the national hospital, the bulk fuel depot, the cultural centre, the museum (and 90% of its collection), the Niue Hotel, the church at Makefu, a petrol station and a supermarket. The wharf and most of the sea-tracks were damaged. In total the cost of damages from cyclone Heta equalled three times GDP (Ellemor and Barnett 2007). Most of Niue's population lives in eight villages along this western terrace, and these settlements, as well as critical

infrastructure such as the Assembly House, primary school and wharf remain in these cyclone-exposed areas.


***Fuel Depot in Alofi damaged by Tropical Cyclone Heta 2004***

### H Tourism

Tourism is expected to increase income and employment in Niue in the future. Tourism is to some degree a climate-sensitive sector; however there has been no attempt to understand the risks climate change poses to tourism in Niue, which would in part require understanding why tourists choose to visit Niue. For example, the loss of beaches may have some negative effect, although Niue is not marketed as a surf and sand destination. Declining numbers of whales would seem likely to reduce demand from tourists, although much would depend on the impact of declining whale numbers on competing destinations such as Tonga. Damages to the infrastructure necessary to service yachts would cause a decline in tourist arrivals.

Niue's main source of tourists is New Zealand, but it is yet unclear the extent to which tourists from New Zealand to Niue is seeking to escape the New Zealand winter. Arrivals data shows that the months of January, July and October are the peak periods, which suggests no obvious winter-escape pattern (Statistics Niue 2009c). Given that the majority of visitors at present are expatriate Niueans, the number of arrivals is determined by family events, the holiday season in New Zealand, and the cost of flights. The perception that Niue is an unsafe destination for reasons of dengue fever or hazardous cyclones may also reduce tourism demand.

On the supply side of the tourism market, the impacts of cyclones on tourism infrastructure can reduce the capacity to meet demand, as was the case after cyclones Ofa (1990) and Heta (2004) when major accommodation providers were damaged.

## VIII Integrated Analysis of Impacts

Given this analysis of exposure and sensitivity to climate change in Niue, and assuming there is no significant increase in planning or spending on activities to adapt to climate change, potential impacts on four major aspects of Niuean society can be identified: food security, the economy, population, and culture. These are now discussed in turn.

## A Food Security

Food security is defined as a situation "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary and food preferences for an active and healthy life" (FAO 2002: 26). Food security has three components: food availability, the ability to access food, and access to nutritious, safe and culturally preferred foods (Eriksen 2008).

Niueans rarely, if ever, experience periods of hunger and/or an inadequate supply of calories. Further, given their reasonably high incomes, good access to imported calories and processed foods that store well, food stockpiles, and an environment that is now reasonably productive (relative to population), it seems very unlikely that climate change will ever cause widespread hunger in Niue. However, climate change may well cause significant increases in the cost of food, and shifts in the composition of consumption such that there is less consumption of nutritious foods and foods that are culturally preferred.

Most Niueans prefer the taste of talo to alternatives such as kumara, potato, or rice. Talo is cheaper than the alternatives and growing, consuming and exchanging talo is a traditional practice that signifies belonging to the land and to society (all the more so as it is something that distinguishes Niueans in Niue from those in New Zealand). But very few (if any) Niueans will go hungry if climate change causes periodic declines in the availability of talo, because they have sufficient incomes to purchase substitutes. Nevertheless the cost of substituting for the calories otherwise supplied by eating talo will be significant. Whereas the cost to produce talo is in the order of $0.04/kg (input costs are largely the hire of a bulldozer for land clearing, and herbicides, which are used in plantations on more rugged terrain), the costs of substitutes such as potatoes ($3/kg), rice ($2.50/kg), or pasta ($3.40/kg) are far higher.

According to Horton (1988), talo crops yield, on average, 98 kilocalories of energy for every 100g consumed, and only 0.2 grams of fat / 100g. It is therefore a good, low fat (and low salt) source of energy, as well as fibre. Talo also provides moderate amounts of calcium, vitamin K, magnesium, potassium, and zinc (Horton 1988, Huang *et al* 2000). However, talo is not a good source of protein, and it is not a good source of vitamins such as thiamin, riboflavin, and nicotinic acid (the quantities of which decrease substantially after cooking) (Bradbury and Holloway 1988). Talo leaves, however, are a good source of protein and vitamins, especially vitamin A, riboflavin, and vitamin C (Bradbury and Holloway 1988).

Given its relatively high delivery of kilocalories, and the preference for talo over other cereals, roots and tubers, talo is by far the most important source of calories in Niue. It is also by far the most accessible with the average household having 3.4 plantations (in various stages of cultivation). Land for talo production is owned by the *magafaoa*, cannot be bought or sold, and is rarely rented. The work of planting, weeding, and harvesting is typically done by the male head of the nuclear family, and in times of planting large crops for consumption at ceremonies the extended family and members of the village may help.

In an average year Niuean growers produce a quantity of talo far in excess of household consumption needs. Some talo is usually exported, although in recent years the quantity of exports has been small. In the past, when exporting arrangements have been well organised and growers have been paid for their talo (such as between 1994 and 2002, under the *Moui Faka Niue* scheme) production has increased significantly, with close to 300 tonnes being exported in the year 2000, and an average of 185 tonnes being exported each year over this time (that is, approximately 100k of extra talo produced per person). So, in an average year talo production is well below the theoretical maximum.

A significant proportion of talo produced in Niue is also consumed in ceremonies (such as haircutting ceremonies, weddings, and events in the religious calendar), and a good deal of talo prepared for consumption goes uneaten (and is usually fed to pigs). So, because there is scope to increase production, the possibility of reducing supply for export, and gains to be made in terms of the efficient use of talo, climate change would have to have a very significant impact on talo production in

Niue in order for it to impact on nutrition. Offsetting these factors determining talo production, however, is a decline in the agricultural labour force due to the contraction and ageing of the population, along with a growing proportion of youth who show less interest in talo cultivation.

It seems unlikely then that the expected changes in mean climatic conditions will impact on the supply of talo to households in Niue in coming decades, and this is a key reason why climate change is not a major threat to food security in Niue. While unlikely, if climate change were to cause a reduction in the average supply of talo, such increased scarcity may give rise to two responses. First, a higher proportion of households may seek to acquire talo via the local market, which would slightly increase the cost of access talo (to the benefit of growers, but not consumers), but would not have a major impact on nutrition (as talo is a culturally preferred food, and its cost would need to rise very considerably before imported foods become a competitive substitute). Second, there may also be an increase in locally produced substitutes, which may be more abundant than talo in dry years (because they are more drought resistant) including cassava, yams, and kumara. However, these, like the more drought resistant varieties of talo (such as *kape* and *pulaka*), may not be the substitute of choice given the strong taste preference Niueans have for the 'pink' variety of talo. If, as occurred in 1983 (when Niue went from being an exporter of talo to being a net importer), talo production was very significantly reduced, for example due to drought or disease, then households may spend more importing talo from elsewhere. However, the possibility of importing talo from other countries may be minimal since the main exporters in the region are Fiji, Samoa and Tonga, who experience drought conditions when Niue does. Even assuming imports were possible in drought years, prices would be far higher than in the local market in a normal year (given transport costs and the effect of scarcity in times of drought). So, while detrimental to household budgets, consuming more imported talo would nevertheless have no effect on nutrition. It may also be the case that under such circumstances households may spend more to purchase imported substitutes such as potatoes, rice, pasta, or other less nutritious foods, which may have an effect on nutrition as well as on household expenditure.

As shown above, fish caught from near shore and deeper waters are an important part of the diet of most Niueans. Rather like the situation with talo, declining consumption of fish may not mean hunger, although it may mean increased expenditure on imported substitutes such as tinned tuna ($14/kg) or chicken ($6.50/kg).

It is not only that Niueans have a taste preference for fresh talo and fish, they also have a cultural preference for them in that these foods have been traditional staples for as long as there have been Niueans (Churchill 1908; Loeb 1926).Thus, as important as talo and fish are to nutrition in Niue, as a source of energy and nutrients they can theoretically at least be replaced by other food stuffs. However, the cultural values of talo and fish are not so easily substitutable. This issue is discussed further in the later discussion of culture.

The local production of food, especially staples such as talo and fish, is the primary determinant of the ability of people to access food, because so much of this food is produced within the household or given as gifts, rather than purchased on the market. However, Niueans do eat a lot of imported foods, with over NZ$2 million of food being imported in 2008 (equating to 20% of imports), 95% of which was imported from New Zealand (Statistics Niue 2009b). On average, households spend approximately $100 a week on imported foods, representing 20% of average household income, with wealthier households spending more on food than lower income households (Barnett *et al* 2009). The costs of these imports are determined by the cost of food in New Zealand, plus the cost of transport. Climate change may increase the costs of food in New Zealand due to impacts on food production (Darwin 2004), and rising energy costs (which may affect some processed foods). Transport costs to Niue are likely to rise irrespective of climate change due to the monopoly on shipping to the island, rising fuel prices, and increasing labour costs. Climate change may add to transport costs through increasing damage to and interruption of shipping due to more hazardous conditions, as well as higher fuel prices due to efforts to reduce emissions. In all, then, there are reasons for concern about the rising cost of imported foods in Niue.

There are some important differences among people in Niue in terms of their access to food. Many of the gifts of food are given by children to elderly parents, who depend on this to meet their food and other basic needs (Barker 1994). The food survey administered in 2006 shows that there are 66 households in Niue with only one occupant and of these two-thirds report incomes that equal less than NZ$200 a week, and 40% report weekly incomes of less than $100 a week. Given all other expenses, these people rely on extended families to meet their food needs, and the extended families rely on meeting these needs through local produce (which is cheaper than purchased foods). Thus the food security of the elderly depends critically on the abundance of local foods and on family members to provide these foods.

Another group that is more exposed to changes in the abundance of local foods are the 35 migrants from Tuvalu who live in the village of Vaiea. This group shows a distinctly different income and food consumption profile to the rest of the Niuean population. These are the largest (average size 5 people), and poorest (household incomes are less than 50% of the national average) households in Niue (Barnett *et al* 2009). They eat far more fish than the average Niuean household, consuming fish every day, almost all of which they catch themselves (indeed some of these households rely on the sale of fish as a main source of income). However, apart from fish these households consume fewer local foods overall, explained largely by their below average consumption of talo, which is restricted because they have minimal access to land for farming. To offset this, these household spend more on imported foods than the average Niuean household in both absolute terms (spending is in the order of 25% higher than the national average), and in terms of the share of incomes spent on food (which is in the order of 50% of household income, as compared to the national average of 20%) (Barnett *et al* 2009). Thus, the food security of the population of Tuvaluans in Niue is far more at risk from declining abundance of fish, and rising food prices, than that of other residents of Niue.

## B Economy

Niue's economy is by and large driven by funding from the Government of New Zealand. It is an economy in which the budget is larger than GDP. For example, in 2003 GDP was estimated to be NZ$17.25 million whereas the budget for that year was NZ$17.7 million (Government of Niue 2004a). In the period 2006-2008 Niue imported an average NZ$8.6 million of goods per year, 95% of which came from New Zealand, and 38% of which was fuel. For the same period the island exported an average of $1.8 million worth of goods per year (Statistics Niue, 2009b). Over this time the island paid nearly twice as much to import fuel as it earned from exports.

However, the years 2006 to 2007 were remarkably good years for exports, driven by the operation of the Fish Processing Plant. It ceased to operate in 2008, causing a 99% decline in exports relative to the previous year. To compare, over the years 1999-2003 Niue imported an average NZ$4.2 million of goods per year, and exported an average of $310,000 worth of goods per year, most of which was sales of talo to New Zealand (Statistics Niue 2005). In 2004 the island paid 8 times as much to import fuel as it earned from exports.

This data shows three things: first, Niue's economy is far more vulnerable to changes in New Zealand's policy towards Niue than it is to changes in the climate; second, continued rising fuel prices will have a large impact on Niue's economy; third, exports of processed fish can be a major driver of growth in the economy. Therefore, both reducing dependence on imported fuel, and sustaining the fish processing enterprise seem to be very important policies, and because they would increase the ability of the Government and households to spend elsewhere, they can be seen to be useful climate change adaptation policies.

As with the economy overall, for most households it is changes in the Government of New Zealand's policy to Niue, rather than climate, that pose the greatest risk to household incomes. In 2007 the budgetary allocation for personnel was $7.1 million, which was disbursed among an estimated 348 permanent workers (with an additional 114 people paid from the budget as contractors, trainees, and

members of the Legislature). A further 20 people were employed from external funding (largely from development assistance agencies of various kinds). Thus, almost all Niuean families rely on a publicly-funded job (or pension) as their principal source of income. Climate change is unlikely to affect these jobs and payments as these are largely funded by assistance from New Zealand, and so are immune to environmental changes in Niue *per se*.

However, climate change may impact on the small private sector, which is dependent on climate sensitive resources for income and employment. The small and intermittent talo export sector may find it even more difficult to sustain production and maintain its market in New Zealand. The tourism industry already struggles to recover from cyclones, and more intense cyclones may further retard the development of supply. It is notable that the majority of people employed at the fish processing plant and in the largest tourist hotel are migrants from other Pacific islands.

In terms of future growth, the three sectors targeted for further economic development in the 2009 to 2013 NNSP, namely tourism, agriculture and fisheries, are sensitive to climate change (Government of Niue 2009). Climate change may retard growth in these sectors, and in turn undermine Niue's desire to achieve economic independence, in turn keeping the Niuean economy firmly tied to New Zealand.

Nevertheless, while climate change may do little to affect the Niuean economy and the income of Niueans in the immediate future, it may affect their expenditure. The Government already struggles to meet the rising costs of infrastructure maintenance from its budget: in recent years the electricity supply has increasingly failed for periods of time, the water supply system leaks, roads are deteriorating, and the phone system frequently fails. The costs of providing modern infrastructure on such a remote small island are exorbitant and largely underwritten by New Zealand aid.

Climate change will further exacerbate the costs of infrastructure in Niue. In recent times the costs of damage to containers landed at the wharf have been passed on to consumers in the form of higher prices. Cyclones and rising sea-levels will further compromise the functioning of the wharf and this may increase freight costs and/or increase the cost of providing an effective and efficient cargo handling system. Damage from cyclones is very expensive – the cost of repairing and replacing Government assets after cyclone Heta was estimated to be NZ$25.7 million, the cost of recovering private sector assets was estimated to be NZ$5 million and the cost of repairing and replacing lost houses was estimated to be NZ$4.1 million (Government of Niue 2004b). Thus, the cost of repairing infrastructure and assets in Niue after cyclone Heta was more than twice GDP in the preceding year. The cost of protecting assets from cyclone damage may be no less expensive, for example the relocation of the hospital cost over NZ$6 million, the cost of moving a house – even assuming land is available – is NZ$150,000.

In 2004 cyclone Heta destroyed the hospital that was rebuilt after it was destroyed during cyclone Ofa in 1990, and the lesson from this is clear: the costs of climate change cannot be avoided, they will either be paid in the form of damage (and hopefully their recovery), or adaptation actions that seek to avoid damages. Either way, at least some of the costs will be paid by the people of Niue, both in terms of personal costs to manage private goods, and taxes to the Government to manage public goods. It is likely that the Government of New Zealand will to some degree help meet these private and public costs, but it is the share that it is willing to bear that shapes the costs of climate change to Niueans.

Expenditure on food, freight and fuel is also likely to rise in the future, and climate change will be a factor in these price increases to some degree. Climate change may increase costs to the national economy and households in Niue, through increased private costs (of damage or of adaptation), increasing taxes to pay for damage or adaptation of public goods, and increasing costs of food, freight and fuel.


***Young athlete throwing a 'Tika' - a traditional Niuean artform***

## C Culture

There are cultural values at risk due to climate change in Niue. A distinguishing feature of Niuean life is enjoyment of the land, plants, animals, and the sea. Indeed it is striking to compare the attitude of soon to depart Niueans in the late 1970s who described 'bush work' (gardening) as a key reason to leave (Mitchell 1977), with those who remain who describe it as relaxing, enjoyable, and a significant part of what it means to be Niuean. A key element of this enjoyment is the production of food – and in particular talo which is consumed and exchanged at ceremonies – from bush blocks. Should talo productivity decline or become more variable, the enjoyment of the land for many Niueans may decline and one of the key distinctions between Niueans in Niue and Niueans in New Zealand may disappear. The same is arguably the case for crafts such as weaving of hats and mats from local plants, jewellery made with shells collected from the reef, hunting (of coconut crabs mainly but also pigeons and bats), fishing and gleaning from the reef and fishing from boats, and canoe building – the enjoyment of which all depends on access to an abundant supply of local materials. Nature sustains culture in important ways in Niue, and it remains a bulwark against the corroding effects of modern lifestyles and values. Should the supply of those natural things that are important to the Niuean culture diminish, then so too may those things that remain distinctly Niuean.

The risk climate change poses to the abundance and quality of talo and fish is perhaps as significant for Niuean culture as it is for health. These foods define Niueans and in particular 'traditional' Niuean culture in important ways. Thus in a society where food can always be purchased, the food that is pride of place in ceremonies remains talo and fish. Similarly, the giving of talo and fish remains an act laden with significance and symbolism, reflecting well on both the giver and the recipient. Such gifts are also a mainstay of harmonious social relations, reflecting reciprocity, and care for the elderly, extended family, friends, community, and leaders. Were such foods to be less abundant, of poorer quality, or unsafe to eat (for example due to ciguatera poisoning) the loss to Niueans would be far more than the loss of a cheap source of calories and micronutrients; it would as much be a loss to Tāoga Niue.

Thus, in Niue, talo and fish are important signifiers of tradition and identity (see Linnekin 1990). This symbolism takes on added importance in times of high mobility, where urbanisation and emigration challenge notions of tradition and identity, and this is no more so the case than in Niue

where there has been very large scale emigration to New Zealand. For the Niueans in Niue, locally procured talo and fish delineate those who stay (who belong to the land and sea, as signified by their cultivation of talo and catching of fish) from those who leave (who are no longer connected to the land and sea and who must purchase these foods from a shop). Talo and fish, then, are far more than a source of food, they are ontological anchors in an increasingly fluid world.

Finally, it is worth remembering that the largest driver of cultural change in Niue is population mobility, which exposes a significant majority of people who call themselves 'Niuean' to modern lifestyles, where English is the main language, and diets, customs, and natural and built environments differ. This mobility is creating serious concerns about the retention of those aspects of Niuean culture that Niueans themselves value, including viable village populations able to sustain important community institutions such as show days, churches, village councils, and sporting teams.

***Generations combine, MP Hon. Va'aiga Tukuitonga and a young admirer***

## D Population

The reasons for population decline in Niue are many and varied, but underlying issues include the lure of the larger labour market and expanded range of goods and services (including education) on offer in New Zealand (and increasingly Australia) (Connell 2007, Douglas 1987, Nosa 2009, Tuhega 1977, Walsh and Trilin 1973). These motivations are of course not unique to Niueans. However, some distinctive characteristics of the Niuean situation since 1971 have been noted, including: the absence of barriers to movement to New Zealand and Australia given that Niueans are New Zealand citizens; increasingly cheap transport costs (relative to income) since the opening of the airport in 1971; a lack of prior investment by colonial authorities in key institutions such as vocational training and schools; a school curriculum that promotes modern values and the norm of white collar employment; a history of promoting the merits of life in New Zealand over the 'backwardness' of island life; access to the welfare system in New Zealand; a desire to be free from the authority of elders, the church, and the Niuean government; and the cumulative effect of chain migration, where those established in the new destination help others overcome information and cost barriers to settlement (Barker 1994, Bedford *et al* 2006, Connell 2008, Douglas 1987, Heyn 2003, Mitchell 1977, Matheson 1986, Nosa 2009, Pollock 1979, Tuhega 1977, Walsh and Trilin 1973). Climate change is unlikely to exacerbate many of these

problems, which are deeply rooted in past and present practices associated with development and governance. However, climate change may affect the underlying economic determinants of migration.

It is true to some extent that the number of jobs on offer in Niue determines the number of people who remain on the island (Bertram and Watters 1984, Douglas 1987, Matheson 1986, Nosa 2009). Moreover, the jobs that seem to retain and attract Niueans are those that pay well, which are typically those associated with Government employment. When there has been an expansion in low-skill and low-wage employment in the private sector, such as work in hotels, the fish processing plant, and the noni and honey farms, these jobs have largely been filled by migrants from other Pacific islands rather than by Niueans. Thus, as stated earlier, it is Government employment, funded indirectly by the Government of New Zealand that will most determine the number of Niueans living in Niue. If the costs of adapting to (or the damage of) climate change fall largely on the Government of Niue such that it has to reduce employment, then this may have some effect on emigration from Niue.

Where there are changes in employment in the private sector, which is, as noted earlier, more sensitive to changes in climate (for example in fish processing, tourism, and commercial farming), these changes will mostly be felt by the small number of migrants to Niue that have migrated from other Pacific islands (such as Fiji, Samoa, Tonga, and Tuvalu) and Asia (for example from India and the Philippines). The effect of unemployment, underemployment, or a reduction in wages on these migrants may not be such that they are motivated to leave. Much depends on their reasons for migrating to Niue, but it could be assumed that higher living standards and services in Niue, as well as the perception of improved chances for migration to New Zealand via Niue, will remain attractive even if labour market conditions deteriorate. Indeed, it has been noted by people in Niue that the relatively greater impacts of climate change on other countries in the South Pacific may mean increased demand for migration to Niue, a possibility which has been discussed between the Governments of Tuvalu and Niue in the past, but about which Niueans remains uneasy.

The effects of climate change on Niue may have less to do with income, and more to do with expenditure. It is potential increases in the costs of living in Niue that might stimulate increased migration from Niue to New Zealand and Australia. The people who remain in Niue do so in part because, while wages are lower, so too, generally, is the cost of living (despite higher prices for food and fuel). This is largely because land in Niue cannot be bought or sold, so housing does not have to involve paying for land (although a few Niuean households do rent land in Alofi). It is also because so much of a household's food needs can be met from subsistence production. Thus, on balance, the average Niuean household in Niue may have no less, and indeed more disposable income than the average Niuean household in New Zealand (if not Australia – see Nosa 2009).

There are three reasons for thinking that Niueans in Niue may be no worse, and may indeed be economically better off, than those living in New Zealand and Australia. First, the choices made by the Niueans who remain are a good guide to the economics of migration; Niueans understand well the trade offs in expenses and income associated with life in Niue and New Zealand and Australia, and those who remain have made rational choices based on economic information. Second, the level of savings and expenditure on luxury goods in Niue is not insignificant. On average, households in Niue have enough disposable income to save money, and to spend on vehicles, electronic goods, and travel. These levels of savings and expenditure in Niue are arguably comparable to (if not superior than) those of Niueans living in New Zealand. Third, while data about remittances for Niue is scarce, the flow of remittances between Niue and New Zealand appears to be bi-directional, which is to say that as many if not more households in Niue report sending money to New Zealand (largely to support children undertaking education, people receiving medical treatment, and family ceremonies held in New Zealand) as report receiving money from New Zealand.

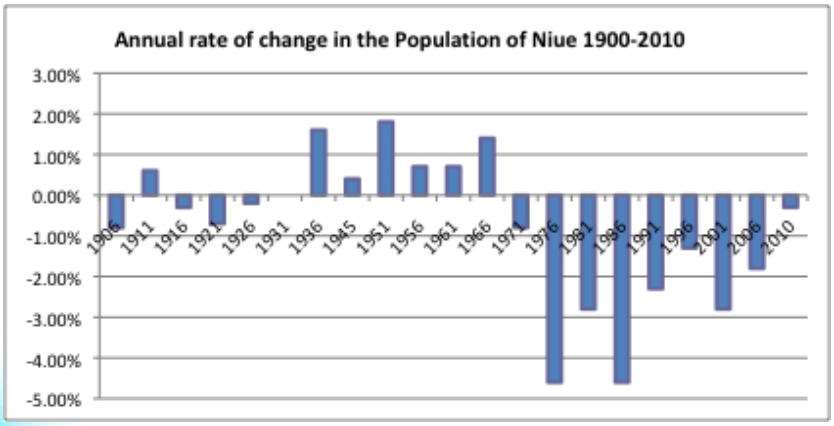
All of this is to say that, even given lower wages in Niue, the costs of living are relatively even lower, so that compared to living in New Zealand (and maybe Australia), the Niueans in Niue are economically better off, and this motivates their decisions to remain. However, should climate change increase the costs of living in Niue more rapidly than it does in New Zealand and Australia, this may

change the calculation, and increase the likelihood that Niueans may move away. It was suggested earlier, for example, that climate change may increase the costs of food in Niue, by potentially reducing the supply of local foods that are very cheap (fish more so than talo), possibly causing a shift to increasing consumption of expensive imported foods. Increasing fuel prices seem likely. The costs to households of damage from cyclones, or of adapting to avoid such damage, is likely to increase, and households may well be expected to pay for some of the costs of damage to, or of adapting to avoid damage to public goods (such as the wharf, sea-tracks, schools, and the legislative building) as well as important group goods (such as churches). If, through these and other unforeseen pathways, it becomes more expensive to live in Niue, then increasing emigration may result.

There are risks to other aspects of life in Niue that Niueans enjoy. As noted earlier, a distinctive characteristic of Niueans in Niue is that they seem to relish cultivation and fishing, and if these become less enjoyable activities due to climate change (because it becomes more arduous or hazardous, or harvests fall and/or the quality of produce declines), then a key aspect of the lifestyle that Niueans enjoy may be diminished. Niueans also enjoy living in a healthy environment and access to primary health care is good and cheap. If climate change introduces significant public health problems – for example the introduction of dengue fever – then this too may be an impetus for emigration.

There is some evidence, however, to suggest that these concerns about the risks climate change pose to the population of Niue are overstated. Despite media reporting and the beliefs of a number of Niueans, the very considerable damage wrought by cyclone Heta on the people, economy, and natural and built environment of Niue did not lead to any increase in the rate of emigration. Since 2006 the census of population has counted the difference between the population resident at the time of the count, as well as the resident population absent at the time of counting. Following this method, the total residential population in 2006 was 1,666 people (1538 on the island, 128 temporarily absent), and in 2010 it was 1,647 (1,496 on the island, 151 temporarily absent). On this basis, Niue's population declined by only 19 people between 2006-2010, an annual rate of population change of -0.3%, the lowest annual rate of change since 1966 (see Figure 6).

**Figure 6: Annual rate of change in the Population of Niue**




So, it may be that the population of Niue has now stabilised. The reasons for this may be because of some stability in the number of public service jobs in recent times, as well as a small amount of migration of people from other Pacific islands and Asia. However, it is also due to a discernable commitment of the remaining population of Niue to remain on the island, as reflected in their descriptions of themselves as 'stayers' and people 'committed' to Niue. Such resolve may explain why, despite cyclone Heta and the introduction of a consumption tax in 2009, Niueans have ceased leaving

Niue. It is possible that this resolve may persist, and the effects of climate change will not cause Niueans to leave Niue.

Much of this discussion about migration assumes that migration is a unidirectional movement of people away from Niue. However, if Niue's population is viewed instead in terms of flows of people between the island and expatriates, then the population of Niue is far larger than those who claim residence on the island. So, as Bedford *et al* (2006) observe, the effective population of Niue – including those who intend to return, and who return for periods on a regular basis – is larger than the population counted during censuses. This effective population may be growing too, for, as Bedford *et al* (2006: 16) note, "overseas Niueans are coming to view Niue as central to their own ethnic identity and spiritual quest" and this gives reason to assume "that Niuean people always will occupy, and maintain, and return to, their ancient homeland".

Finally, as discussed below, Niue's small population constrains its capacity to adapt to climate change. Thus, population decline is in many respects not only an object of vulnerability, but also a cause of vulnerability. Should climate change cause a further decline in Niue's population, then this would further reduce its capacity to adapt to subsequent changes in climate.

## IX Adaptation

The analysis thus far suggests that climate change will not cause significantly new problems for Niue, but rather it will make existing problems worse. Ongoing problems associated with sustaining development from fisheries and agriculture may increase, cyclones may become even more damaging, dietary problems may increase, difficulties in achieving sustainable economic growth may increase, the struggle to maintain Tāoga Niue may become more difficult, and the challenge to retain and increase the population of Niueans on the island may become even harder. In this sense in Niue, as elsewhere, climate change seems likely to exacerbate existing problematic trends (see O'Brien and Leichenko 2000).

Given this, adapting to climate change to avoid these problems becoming more pronounced need not entail radically new changes in policies and practices. Indeed, as Dovers (2009) argues, there is much that is already known about effective responses to climate given the long history of addressing problems associated with climate variability(for example in sectors like agriculture and fisheries) and disaster management, ongoing social problems like maintaining the Niuean language, sustaining the economy, and maintaining public health. This is not to say management of these problems is always effective, but it is to say that Niueans possess knowledge and experience about what does and does not work, and ways to overcome barriers to better management, that must be respected and harnessed when devising strategies for adapting to climate change in Niue. It follows, that devising and implementing adaptation responses is something best done in close association with people in Niue.

Table 4 shows a ranked list of 44 actions to adapt to climate change in Niue. This was developed at a national workshop attended by representatives from government departments and civil society in April 2007. The list is indicative rather than exhaustive.

## Table 4: Actions to Adapt to Climate Change in Niue

| Rank | Sector | Adaptation Activity |
|---|---|---|
| 1 | Education | Maintain awareness of climate change |
| 2 | | Apply a precautionary approach to resource management |
| 3 | Energy | Renewable energy to offset costs of diesel |
| 4 | Health | Disease monitoring system |
| 5 | Climate Risk or Disaster Risk Management | Maintain, improve, and test cyclone tracking, warning, planning, response and recovery systems |
| 6 | Water | Comprehensive water quality monitoring program |
| 7 | Health | Maintain mosquito eradication programs at village level |
| 8 | Health | Quarantine vigilance for mosquitoes |
| 9 | Agriculture | Creation of an agricultural gene bank |
| 10 | | Increase household gardening |
| 11 | | National septic tank assessment and upgrade scheme |
| 12 | | Map groundwater flows |
| 13 | Coastal zone | Coastal and fisheries monitoring systems |
| 14 | | Environmental Impact Assessment on all new developments |
| 15 | | National library and archives |
| 16 | | Screening all new developments in terms of vulnerability to climate change |
| 17 | Coastal Zone | Protected reef and near-shore areas |
| 18 | Climate risk and Disaster Risk Management | Dedicated evacuation centers and emergency supplies |
| 19 | | Protect primary forest with a no clearing buffer zone |
| 20 | Health | Develop and test a mosquito borne disease response plan |
| 21 | | Population debate and policy |
| 22 | Coastal Zone | Relocation of vulnerable infrastructure from coast |
| 23 | Coastal Zone | Wave damage risk maps |
| 24 | Fisheries | Adaptive management of fisheries |
| 25 | Water Resources | Restrictions on land use based on groundwater flow |
| 26 | Tourism | Tourism development plan |
| 27 | Environment/natural resources management | Clarification of property rights. Develop a code of practice to foster co-management of natural resources |
| 28 | Climate Risk and Disaster Risk Management | Disaster insurance scheme |
| 29 | Fisheries and Marines Resources | Value adding to marine resources |
| 30 | Agriculture | Value adding to proven crops |
| 31 | Water Resources | Water bores for sustained irrigation of plots |
| 32 | Health | Maintain nutritional awareness programs |
| 33 | Coastal Zone | Integrated Coastal Zone Management |
| 34 | Health | Consumption taxes on unhealthy foods |
| 35 | Agriculture | Sustainable agricultural practices such as mixed cropping, mulching, composting |
| 36 | Disaster Risk Management | Review and enforce building codes |
| 37 | Agriculture | Soil moisture monitoring and warning system |
| 38 | Agriculture and Disaster risk management | Total fire bans |
| 39 | Agriculture | Drought resistant cultivars |
| 40 | Coastal Zone | Strengthening structures on west coast |
| 41 | Settlement and Infrastructure | Relocation of villages and infrastructure on lower terrace, western side, to top terrace |
| 42 | Fisheries | Individual Transferable Quota schemes for uga, *peka*(bat) and *lupe (pigeon)* |
| 43 | Climate risk and disaster risk management | Emergency food pricing system |
| 44 | Agriculture and Disaster Risk Management | Fire truck and Huvalu fire volunteer service |

# X Adaptive Capacity

The capacity to implement each of the actions listed in Table 4 will be determined by a combination of the key properties that determine adaptive capacity, such as financial resources (to pay for adaptation); governance (how well society can steer the adaptation process and how legitimate that process is); information (to anticipate climate risks, devising of appropriate adaptations, and learning from their implementation); social resources (networking and bonding among people and groups so that social responses to climate change are cohesive, equitable, and robust); infrastructure, and technology (tools and crafts that help adapt) (Adger *et al* 2007). The importance of each of these factors will vary depending on the specific task, but further discussion of this is beyond the scope of this report.

There are, however, three key cross-cutting factors that determine the capacity to implement many of the adaptation actions listed in Table 4, namely access to financial resources, human resources, and systems of governance. These are now briefly discussed in turn.

## A Financial Resources

As discussed earlier, development assistance from New Zealand is the major driver of Niue's economy. The origins of this lie in the housing scheme fund provided by New Zealand to assist with recovery of the housing stock after the devastating cyclones in 1959 and 1960 (Mitchell 1977). Since then, development assistance from New Zealand has had mixed, if overall positive, effects on Niue. The main positive is undoubtedly the higher living standards Niueans enjoy compared to almost all other Pacific island countries. For example, the Human Development Index score for Niue is 0.774, and in the region only the Cook Islands and Palau have higher HDI scores, and it is noteworthy that both are also states that are self-governing in free association (with New Zealand and the United States respectively).This HDI score – which characterises Niue as having medium levels of human development, equivalent to countries such as China and Thailand – reflects the good access to health care, education, and employment that Niueans enjoy – most of which is funded by the Government of New Zealand (see Table 5). This level of access to education, health care and employment suggests that Niueans have a reasonable degree of capacity to adapt to climate change in a generic sense, although this says little about the ability to undertake the kinds of specific adaptation tasks listed in Table 4 (see Adger *et al* 2004).

**Table 5: Estimates of GDP/Capita and Aid in Niue and its Near Neighbours (sources: ADB 2004, Laplange *et al* 2001, Sampson 2005).**

| Country | GNI/Capita (US$) | Annual aid per capita (US$) | Ratio of aid to GDP (1992) |
|---|---|---|---|
| Cook Islands | 5,570 | 210 | 24% |
| Fiji | 2,130 | 40 | 4% |
| Niue | 7,000 | 2,350 | 121% |
| Samoa | 1,430 | 197 | 35% |
| Tonga | 1,440 | 210 | 25% |
| Tuvalu | 1,380 | 667 | 49% |

However, financial assistance from New Zealand has some countervailing and less positive effects. It has probably stifled the growth of the private sector in Niue, through its effect on wages and employment, the provision of free services that reduce incentives to engage in private production, and excessive subsidisation of agricultural developments so that the risks of failure were not borne by growers. However, it should be remembered that Niue has no comparative advantages in the world economy or even when compared to its island neighbours (Bertram and Watters 1984, Matheson 1986,

Mitchell 1977). Nor has it ever had a domestic market big enough to develop a competitive manufacturing sector.

Development assistance increases the finance available to the Government of Niue – at least in as much as without such assistance it is doubtful that the Government of Niue would ever be as well funded. However, having access to some money is not necessarily the same as having the freedom to spend it (see Barnett 2008). For the Niuean Government, a downside of aid dependence is that it is not the sole arbiter in determining how its budget is to be spent. Beyond the recurrent budget support, which in 2007 was in the order of NZ$7 million, all of the other aid that flows to Niue is for projects (Government of Niue 2007).

The recurrent budget support gives the New Zealand Government considerable indirect influence over the budget, and every year the budget is subject of intense negotiations between the Governments of New Zealand and Niue. Forward commitments for the provision of recurrent budget support have typically ranged from between three to five years, and have been known to change according to changes in policy in Wellington. In as much as planning spending for adaptation may require certainty about the volume of resources available in the future, in Niue it is constrained by uncertainty about the volume and expectations of the recurrent budget support that comes from New Zealand. This degree of dependence on New Zealand therefore means that decisions to spend on adaptation are not the Government of Niue's alone, requiring as well negotiated consent from the New Zealand Government and other donors.

It is also worth noting that while on a per capita basis Niue appears to have some ability to finance adaptation, the aggregate size of the budget and economy is very small. There are costs associated with running a country that are not proportionately reduced by a smaller population, for example an airport runway capable of accommodating a 737 aircraft does not get significantly cheaper because it gets used less in Niue than in Auckland. The same may therefore be true with the costs of adaptation, for example the base cost of technology required for disease monitoring, groundwater monitoring, quarantine monitoring, and fisheries monitoring is likely to be the same in Niue as it is everywhere else, even if the extent of its use may be less. Nevertheless, this problem of economic size relative to the costs of adaptation is not so much a function of aid as it is of low factor endowments with which to develop the economy.

Having noted that dependence on the New Zealand government constrains autonomy in spending, including on adaptation, it is also important to recognise that it enables considerable flexibility in times of crisis. This was clear in the wake of cyclone Heta (2004), where the cost of short term and many longer term responses were met by New Zealand and other donors – for example there was a 240% increase in New Zealand Government transfers in 2004/5 following cyclone Heta (NZ Aid 2005).

Many of the actions listed in Table 4 are very cheap. Perhaps only five activities listed would cost in excess of a million dollars, namely: development of renewable energy systems (#3), development of a national library and archives (#15), infrastructure relocation (#22), a disaster insurance scheme (#28), and relocation of villages (#41). However, although financial resources are not always the major constraint on adaptation in Niue, they are nevertheless important, and Niueans and their government do not have enough to implement adaptation, and so will require additional assistance in order to meet the costs of adapting to climate change.

### B Human Resources

It takes people and skills to implement adaptation. Many of the activities listed in Table 4 require a number of skilled individuals dedicated to such tasks, including for example, establishing monitoring systems for diseases, water quality, and fisheries; mapping groundwater flows and wave damage risks; implementing a system for environmental impact assessment; and enforcing building

codes. In none of these cases does Niue have the required number of people with the requisite skills to implement these activities.

The reasons for this are largely due to smallness of the Niuean labour market, which contracts as population declines. There is insufficient demand to sustain employees with specialist skills, who for reasons of salary, job satisfaction, and career development, frequently choose not to work in Niue (Connell 2007). For example, there are doctors, but no medical specialists, and there are few if any people with adequate training in accounting, environmental impact assessment, civil engineering, surveying, town planning, and other such skills required to implement adaptation.

However, Niuean workers are generally very flexible and have the skills necessary to service many basic needs that the labour market struggles to supply. For example, most Niueans have completed high school and are excellent farmers and/or fishers and/or artisans (a combination of skills few people in developed countries can match). Many have completed undergraduate degrees or vocational training. Relative to the populations of most countries, Niueans are competent automobile mechanics and builders, have basic knowledge of electrical wiring and plumbing, and yet also have a body of lore about the land, sea, and climate that helps them to minimise the risks posed by life in a fairly unforgiving island environment. Niueans also therefore tend to have multiple roles in society, for example a pastor can find himself also being a grower and fisher, the coach of a sporting team, a marriage counsellor, and a leader of community projects; a member of the legislature can find himself being an elder of the church, an entrepreneur, master fisher, international negotiator, and a member of boards of companies.

The ability to apply the available people and skills to implement adaptation activities is also constrained by the smallness of the population. There is a lot to be done in Niue, and few people to do it. Almost all Niueans have a job, as well as obligations to the church and village, so that weekends are not so much a time for rest as for meeting social obligations. Most Niuean families have bush gardens from which they grow their talo, and this requires a few hours work at least twice a week, as well as increased work around planting and harvesting time. There are *magafoa* (extended family) responsibilities, to do with land titling and management, maintaining the vacant properties of absent family members, maintaining relations among families spread across two or more countries, and managing key events such as weddings, haircutting and ear-piercing ceremonies, and funerals. Travel, too, is more time consuming than in many other countries. There is one flight a week to and from Niue, so that travel for professional, medical, educational, or family reasons is measured in weeks rather than days.

So, despite the remarkable flexibility and industriousness of Niueans, there are too few people in Niue to enable effective and efficient adaptation to climate change. This does not affect all of the activities listed in Table 4, but it affects many of them. The larger lesson here is that vulnerability to climate change may be quite high in very small populations such as in Niue because the capacity of the population to adapt is so constrained.

In the absence of a larger population in Niue the solution to this problem is to import labour on short-term contracts, as occurs in other cases where highly skilled or large amounts of labour have been required – for example for engineering, telecommunications, building projects, and financial management – although it is not without its financial and social costs.

## C Systems of Governance

Making adaptation happen requires making good decisions that will achieve effective, efficient and equitable outcomes, and having the ability to implement those decisions. Thus, even though there may be recognition that adaptation to climate change is required, and even if capacity to implement adaptation exists, adaptation may not necessarily happen, and/or may not be effective (Adger and Barnett 2009). The ability to steer the adaptation process to achieve successful outcomes is a matter of the systems of governance, which refers to the maintenance of order and collective action,

and so includes government in cooperation with the commercial and civil sectors, and various kinds of economic, informational, cultural, legal and social transactions within a society (Rhodes 1996, Stoker 1998).

In Niue the two main institutions that steer society are the church and the government. Other than the church, civil society groups are few, and their influence tends to be restricted, although those such as the Niue National Youth Council, the Niue Organic Farmers Association, and the Niue Women's Council play prominent roles in society.

The dominant church in Niue is the Ekalesia Niue, which originated from the London Missionary Society. Approximately 60% of the population identifies with the Ekalesia Niue. There is an Ekalesia Niue Church and pastor in every village. The pastors are the spiritual leaders of a deeply religious society, welfare workers and counsellors, and they are all indirectly political figures in as much as the church is the only legitimate authority other than the government. While the church is an important institution for governance in Niue, and one which is concerned about climate change, it is not likely to manage any of the significant adaptation activities shown in Table 5, as most of these are national scale activities that are the purview of the government. Smaller village scale activities may well be managed by the Church or the Village Council.

It is the government that dominates governance in Niue. The Legislative Assembly is comprised of 20 members – one elected from each village and six Common Roll members elected by the whole population. Cabinet is formed from four members of the Assembly, and is led by the Premier. There are fourteen villages each with its own village council, member of the Assembly, and church and pastor. There are fourteen non-trading departments and nine quasi-departments under the Premier's department, as well as seven trading departments and two corporations. The Niue Public Service Commission and the Secretary to the Government also play key roles in the system of government (Chapman 1976).

This complicated set of institutions of government has become increasingly unwieldy as the population declines, an issue that was explained in the 2005 Hunn Report, which provided an analysis of options for government reform, and initiated a whole of Government review process supported by both the Governments of Niue and New Zealand. The changes to follow those recommended by this review are yet to be announced; changes need to take account of their implications for climate change adaptation.

As alluded to earlier, the Government of Niue's dependence on financial assistance is also an impediment to governance in as much as the Government of Niue must work hard to sustain these flows. A consequence of this is that much of the Government's effort at providing accountability is directed towards the source of its income (the New Zealand Government).The small Niuean government spends so much of its time reporting and accounting to the New Zealand Government that it arguably leaves insufficient opportunity for a systematic public discussion about spending in Niue (Barnett 2008).

Multilateral environmental agreements also create some problems for governing adaptation. Niue has signed at least 29 global and regional environmental agreements, including the UN Framework Convention on Climate Change (UNFCCC), the UN Convention on Biological Diversity, and the UN Convention to Combat Desertification. There is some concern, given Niue's small public service that keeping up with the reporting and meeting requirements of many of these agreements comes at the cost of servicing domestic environmental and resource management needs. In addition, the difficult and very time consuming process of seeking support from the financial instruments of these agreements to support domestic activities, and then of managing those projects that are successful, gives rise to some further inefficiencies in improving environmental and social outcomes in Niue. Nevertheless, for their part Government departments seek to host such projects as they help meet operating costs that are otherwise not adequately met by the budget. One consequence of this is that department activity tends to move to the tempo of project funding, so that in periods where there are many projects staff can be extremely busy and there can be labour shortages. Another

consequence is that the supply of projects by donors is as influential in project selection as the demands for environmental and social gains.

These problems of governance may well beset the implementation of adaptation activities. The solution lies in more programme-based and less project-based funding for climate change adaptation – that is to say, long-term funding commitments for staff and activities will lead to far more efficient and effective adaptation to than the present cycle of short-term projects.

## XI Conclusions

Niue is vulnerable to climate change, although the pathways between changes in climate and undesirable outcomes are somewhat different for Niue than other small island states. The major climatic risk for Niue is that of tropical cyclones of increased intensity, since these already cause catastrophic damage in Niue. Change in the abundance of marine species is also of concern. Key sectors targeted for future growth, in particular tourism and fisheries, may struggle to develop as these are sensitive to the effects of climate change. The cumulative effects of these changes in the natural environment of Niue include the risk of: increased food insecurity (in particular relating to nutrition), further entrenchment of dependence on New Zealand financial assistance, further emigration, and an erosion of Tāoga Niue.

Options for adaptation have been identified, and while most of these are by global standards not expensive, and do not require sophisticated technologies or highly developed skills, the small size of Niue's economy, budget, workforce, and public service all pose considerable barriers to implementing adaptation in Niue.

The risks climate change poses to Niue are therefore significant, and the ability of Niue to effectively respond to minimise or avoid these risks is minimal. Niue therefore must rely on the international community to avoid the dangers of climate change. This requires both significant reductions in greenhouse gas emissions so that climate is stabilised to allow Niue's natural and social systems to adapt and partnerships between Niue and more developed nations to implement effective and efficient adaptation responses.

## References


ADB (Asian Development Bank), 2004. *Key Indicators 2004: Poverty in Asia: Measurement, Estimates, and Prospects*, ADB, Manilla.

Adger, N. and Barnett, J. 2009. Four reasons for concern about adaptation to climate change. *Environment and Planning A*,41: 2800 – 2805.

Adger, N., Agrawala, S., Mirza, M., Conde, C., O'Brien, K., Pulhin, J., Pulwarty, R., Smit, B. and Takahashi, K. 2007. Assessment of Adaptation Practices, Options, Constraints and Capacity, in Parry, M. Canziani, O. Palutikof, J. van der Linden, P. and Hanson, C. (eds.). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge: 717-744.

Adger, N., Brooks, N., Bentham, G., Agnew, M. and Eriksen, S. 2004.*New Indicators of Vulnerability and Adaptive Capacity*, Tyndall Centre for Climate Change Research Technical Report 7. University of East Anglia, Norwich.

Anderson, K. and Bows, A. 2008. Reframing the climate change challenge in light of post-2000 emission trends, *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*,366: 3863-3882.

Ayre, D. and Hughes, T. 2004. Climate change, genotypic diversity and gene flow in reef-building corals, *Ecology Letters*, 7: 273– 278.

Barker, J. 1994.Home Alone: The Effects Of Out-Migration On Niuean Elders' Living Arrangements And Social Supports, *Pacific Studies*, 17: 41-81.

Barker, J. 2000. Hurricanes and socio-economic development on Niue Island, *Asia-Pacific Viewpoint*, 41:191-205.

Barnett, J. 2001. Adapting to climate change in Pacific Island Countries: The problem of uncertainty. *World Development*, 29: 977-993.

Barnett, J. 2002. The Challenges of Adapting to Climate Change in Oceania. *Pacific Ecologist*, 1: 25-28.

Barnett, J. 2008. The effect of aid on capacity to adapt to climate change: insights from Niue, *Political Science*, 60: 31-47.

Barnett, J. 2010. Adapting to climate change: three key challenges for research and policy, *Wiley Interdisciplinary Reviews – Climate Change*, 1: 314-317.

Barnett, J. and Campbell, J. 2010. *Climate Change and Small Island States Power, Knowledge and the South Pacific*, Earthscan, London.

Barnett, J. and Campbell, J. 2010. *Climate Change and Small Island States Power, Knowledge and the South Pacific*, Earthscan, London.

Barnett, J., Webber, S., Vaha, K. and Siosikefu, M. 2009.*An Analysis of Household Consumption of Locally Procured Foods in Niue*. The University of Melbourne and Statistics Niue: Unpublished.

Becken S (2005) Harmonising climate change adaptation and mitigation: the case of tourist resorts in Fiji. *Global Environmental Change*, 15: 381 – 393.

Bedford, R., Poot, J. and Ryan, T. 2006. *Niue: Population Policy Scoping Study*. Report for the New Zealand Agency for International Development. Population Studies Centre, University of Waikato, Hamilton.

Bell, J., Kronen, M., Vunisea, A., Nash' W., Keeble, G., Demmke' A., Pontifex' S. and Andréfouët' S. 2009. Planning the use of fish for food security in the Pacific, *Marine Policy*, 33: 64-76.

Bennett, P., Taylor, R., Uili, R. and Zimmet, P. 1984. *Epidemiological Studies of Cardiovascular Disease and Diabetes in Polynesians from Rarotonga (Cook Islands) and Niue*.Technical Paper 185.Secretariat of the Pacific Community, Noumea.

Bertram, G. and Watters, R. 1984.*New Zealand and its Small Island Neighbours.* Institute of Policy Studies, Wellington.

Bradbury, J. and Holloway, W. 1988.*Chemistry of Tropical Root Crops: Significance for Nutrition and Agriculture in the Pacific*. Australian Centre for International Agricultural research monograph, Canberra.

Brown, B., Dunne, R., Goodson, M. and Douglas, A. 2000.Bleaching patterns in coral reefs. *Nature* 404: 142-143.

Burton, I., Huq, S., Lim, B., Pilifosova, O. and Schipper, L. 2002. From impacts assessment to adaptation priorities: the shaping of adaptation policy. *Climate Policy* 2: 145-159.

Bussell, W. and Bonin, M. 1998.Effects of high and low watering levels on growth and development of talo. *New Zealand Journal of Crop and Horticultural Science* 26: 313-317.

Butler, D. 2004. *Assessment of the Impacts of Cyclone Heta on the Terrestrial Biodiversity of Niue*. David Butler and Associates, Nelson, New Zealand.

Campbell, J. 1990. Disasters and development in historical context: Tropical cyclone response in the Banks Islands, northern Vanuatu', *International Journal of Mass Emergencies and Disasters* 8: 401–424.

Carter, T., Parry, M. and Harasawa, H. and Nishioka, S. 1994. *IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations*. Department of Geography, University College London, and the Centre for Global Environmental Research, National Institute for Environmental Studies, Japan.

Chapman, T. 1976. *The Decolonisation of Niue*, Victoria University Press and New Zealand Institute of International Affairs, Wellington.

Churchill, W. 1908. Niue: A Reconnaissance, *Bulletin of the American Geographical Society*, 40: 150-156.

Cohn, P. 2003. *Economic independence through the expansion of private sector enterprise – the 'prescriptive unreality' of Niue's development planning*. Melbourne University Development Studies Working Paper 11, Melbourne.

Connell, J. 2007. At The End Of The World: Holding On To Health Workers In Niue. *Asian And Pacific Migration Journal*, 16: 179-198.

Connell, J. 2008. Niue: Embracing A Culture Of Migration, *Journal Of Ethnic And Migration Studies*, 34: 1021-1040.

Cooley, S. and Doney, S. 2009. Anticipating ocean acidification's economic consequences for commercial fisheries, *Environmental Research Letters* 4: 024007

Cowell, P. and Kench, P. 2001. The morphological response of atoll islands to sea level rise: Part 1: modifications to the modified shoreface translation model. *Journal of Coastal Research*, 34: 633 – 644.

Coyne, T. 2000. *Lifestyle Diseases in Pacific Communities*. Technical paper 219.Secretariat of the Pacific Community, Noumea.

Cutter, S. 1996. Vulnerability to environmental hazards. *Progress in Human Geography*, 20: 529-539.

DAFF. 1997. *Vanilla development project annual report for period ending June 1997*. Submitted to New Zealand Overseas Development Assistance September 1997.Department of Agriculture, Forestry and Fisheries, Alofi.

DAFF. 1998. *Progress report on Niue's vanilla industry for period April – June 1998*. Submitted to NZ High Commission, Tapeu, Niue. Department of Agriculture, Forestry and Fisheries, Alofi.

Dalzell, P., Lindsay, S. and Patiale, H. 1993. *Fisheries resources survey of the island of Niue*, Inshore Fisheries Research Project Technical Document No. 3, South Pacific Commission, Noumea.

Darwin, R. 2004. Effects of Greenhouse Gas Emissions on World Agriculture, Food Consumption, and Economic Welfare, *Climatic Change* 66: 191-238.

Doney, S., Fabry, V., Feely, R. and Kleypas, J. 2009. Ocean acidification: the other CO2 problem. *Annual Review of Marine Science*, 1: 169–192.

Donner, S., Skirving, W., Little, C., Oppenheimer, M. and Hoegh-Guldberg, O. 2005. Global assessment of coral bleaching and required rates of adaptation under climate change, *Global Change Biology*,11: 2251-2265

Douglas, H. 1987. Niue: The Silent Village Green, in Hooper, A. (ed.) *Class and Culture in the South Pacific*, Centre for Pacific Studies, University of Auckland, and Institute for Pacific Studies, University of the South Pacific, Auckland and Suva. 186-193.

Dovers, S. 2009. Normalizing adaptation. *Global Environmental Change* 19: 4-6.

Easterling, W., Aggarwal, P., Batima, P., Brander, K., Erda, L., Howden, M., Kirilenko, A., Morton, J., Soussana, J., Schmidhuber, J. and Tubiello, F. 2007. Food, fibre and forest products, in Parry, M., Canziani, O., Palutikof, J., van der Linden, P. and Hanson, C. (eds.) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge: 273-313.

Ellemor, H. and Barnett, J. 2007. Niue After Cyclone Heta, *Australian Journal of Emergency Management*, 22: 3-4.

Ericksen, P. 2008. What is the vulnerability of a food system to global environmental change?.*Ecology and Society*, 13: 14.

FAO (Food and Agriculture Organization Of The United Nations) (2002) The State of Food Insecurity in the World 2002. FAO, Rome.

Feenstra, J., Burton, I., Smith, J. and Tol, R. (eds). 1998. *Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies*. Institute for Environmental Studies, Free University Amsterdam, Amsterdam.

Fernando, M., Zubair, L., Peiris, T., Ranasinghe, C. and Ratnasiri, J. 2007. *Economic Value of Climate Variability Impacts on Coconut Production in Sri Lanka*. AIACC Working Paper No. 45. Assessments of Impacts and Adaptations to Climate Change Project Office, Washington D.C.

Fleming, E. 1996, *Research Options for High-Value Agricultural Exports in South Pacific Island Nations*, Research Report 10, International Service for National Agricultural Research, The Hague.

Fleming, E. and Blowes, A. 2003.*Export Performances in South Pacific Countries with Inadequate Endowments of Natural Resources: Cook Islands, Kiribati, Niue and Tuvalu, 1960 to 1999*. Working paper series in agricultural and resource economics, University of New England, Armidale.

Glantz, M. (ed.). 1988. *Societal Responses to Regional Climate Change: Forecasting by Analogy*. Westview Press: Boulder.

Government of Niue 2009.*Niue National Strategic Plan.* Government of Niue, Alofi.

Government of Niue, 2003.*Halavakake he Monuina. Niue Integrated Strategic Plan – 2003-2008. Niue Ke Monuina – A Prosperous Niue*. Economic, Planning, Development and Statistics Unit, Government of Niue, Alofi

Government of Niue. 2000a. *Niue Island: Initial National Communication to the United Nations Framework Convention on Climate Change*. Government of Niue, Alofi.

Government of Niue. 2000b. *National Food and Nutrition Briefing Paper: Niue Island*. Department of Agriculture, Forestry and Fisheries, and Niue Health Department.FAO Sub-Regional Office for the Pacific Islands, Apia.

Government of Niue. 2004a. *Estimates of Expenditure and Revenue for year 2003/4*. Treasury Department, Alofi.

Government of Niue. 2004b. *National Impact Assessment Report of Cyclone Heta*. Economic, Planning, Development and Statistics Unit, Government of Niue, Alofi.

Government of Niue. 2007. *Estimates of Expenditure and Revenue for year 2006/7*. Treasury Department, Alofi.

GWP . 2006. Groundwater Resources Investigations on Niue Island. Report for the Government of Niue and the South Pacific Applied Geoscience Commission. GWP Consultants, Oxfordshire.

Hales, S., Weinstein, P. and Woodward, A. 1999.Ciguatera (fish poisoning, El Nino, and sea surface temperature. *Ecosystem Health*, *5*: 5-20.

Hellmann, J., Byers, J, Bierwagen, B. and Dukes, J. 2008. Five Potential Consequences of Climate Change for Invasive Species, *Conservation Biology* 22(3): 534-543.

Heyn, J. 2003. *Migration and Development on Niue Island.* Thesis presented in partial fulfilment of the requirements for the degree of Master of Science, The University of Montana, Missoula.

Horton, D. 1988. *Underground crops: Lon- term trends in production of roots and tubers.* Winrock International Institute for Agricultural Development: http://pdf.usaid.gov/pdf_docs/PNABD277.pdf.

Huang, A., Titchenal, C. and Meilleur, B. 2000.Nutrient composition of talo corms and breadfruit, *Journal of Food Composition and Analysis*, 13: 859 – 864.

Kaluwin, C. and Smith, A. 1997. Coastal vulnerability and integrated coastal zone management in the Pacific Islands Region. Coastal Research, 24: 95–106.

Kennedy, D. and Marsters, H. 2009. Reef and rocky coast development on an uplifting coral atoll, Niue. Paper presented at the Institute of Australian Geographers Conference, Cairns, September 28 – October 1.

Kirono, D., Jones, R. and Bathols, J. 2008. *Climate Change in Niue*. CSIRO, Aspendale.

Laplagne, P., Treadgold, M. and Baldry, J. 2001.A Model of Aid Impact in Some South Pacific Microstates, *World Development*, 29: 365-383.

Leolahi, S. 2007. *Refinement and analysis of coastal fishery problems facing Makefu and Alofi North villages, Niue, with associated recommendations*. IWP-Pacific Technical Report (International Waters Project) no. 55. SPREP, Apia.

Lim, B. and Spanger-Siegfried, E. (eds.) 2004.*Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures*. Cambridge University Press, Cambridge.

Lim, B. and Spanger-Siegfried, E. (eds.) 2004.*Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures*. Cambridge University Press, Cambridge.

Lincoln International. 2002. *Niue Study on the Maintenance of a 'Living Community'*. Lincoln International, Lincoln NZ.

Linnekin, J. 1990. The Politics of Culture in the Pacific, in Linnekin, J. and Poyer, L. (eds.) *Cultural Identity and Ethnicity in the Pacific*, University of Hawai'i Press, Honolulu.

Loeb, E. 1926.*History and Traditions of Niue*. Bishop Museum Bulletin 32, Honolulu.

Marler, T. and Clemente, H. 2006. Papaya seedling growth response to wind and water deficit is additive, *HortScience* 41: 96-98.

Matheson, T. 1986. *Aid in an Island Microstate: The Case of Niue*. A thesis submitted for the degree of Doctor of Philosophy. The Australian National University, Canberra.

Meehl, G., Stocker, T., Collins, W., Friedlingstein, P., Gaye, A., Gregory, J., Kitoh, A., Knutti, R., Murphy, J., Noda, A., Raper, S., Watterson, I., Weaver, A. and Zhao, Z.. 2007. Global climate projections, in Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K., Tignor, M. and Miller, H. (eds.). *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge: 747-846.

Meinshausen, M., Meinshausen, N., Hare, W., Raper, S., Frieler, K., Knutti, R., Frame, D. and Allen, M. 2009. Greenhouse-gas emission targets for limiting global warming to 2 °C, *Nature*,458: 1158-1162

Mimura, N., Nurse, L., McLean, R., Agard, J., Briguglio, L., Lefale, P., Payet, R. and Sem, G. 2007. Small Islands, in Parry, M., Canziani, O., Palutikof, J., van der Linden, P. and Hanson C. (eds.). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge: 687-716.

Mitchell, G. 1977. *Village Agriculture in Niue: An Examination of Factors Influencing Participation and Productivity*Ph.D Thesis, University of Canterbury, Christchurch.

Mitikulena, M., Mitikulena, A., Talagi, S., Badcock, J., Bach, J., Dignan, C. and Terrell-Perica, S. 1993. *The 1987 National Nutrition and Dietary Survey of Niue*.Technical Paper No. 202. The South Pacific Commission, Noumea.

Murray, W. 2000.Sustaining agro-exports in Niue: the failure of free market restructuring.*The Journal of Pacific Studies* 24: 211-228.

Nakićenović, N. and Swart, R. (eds.). 2000. *IPCC Special Report on Emissions Scenarios*. Cambridge University Press, Cambridge.

Nishina, M., Zee, F., Ebesu, R., Arakaki, A., Hamasaki, R., Fukuda, S., Nagata, N., Leng Chia, C., Nishijima, W., Mau, R. and Uchida, R. 2000.Papaya production in Hawaii, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa, Honolulu.

Nosa, V. 2009. The Impact of Transnationalism on Niue, in Lee, H. and Francis, S. (eds.), Migration and transnationalism : Pacific perspectives. The Australian National University E-Press, Canberra.

Nunn, P. 2004. Myths and the formation of Niue Island, central South Pacific.*The Journal of Pacific History*, 39: 99-108.

Nunn, P. and Britton, J. 2004. The long-term evolution of Niue Island, in Terry, J. and Murray, W. (eds.). *Niue Island: Geographical Perspectives on the Rock of Polynesia*. Insula: International Scientific Council for Island Development, Paris.

NZAid, 2005.*NZAid Annual Review 2004/2005*, NZAid, Wellington.

O'Brien, K. and Leichenko, R. 2000.Double exposure: assessing the impacts of climate change within the context of economic globalization, *Global Environmental Change*, 10: 221-232.

Orr, J., Fabry, V., Aumon, O. and 24 others. 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. *Nature* 437: 681-686.

Parry, M., Canziani, O., Palutikof, J.P., van der Linden P.J., and Hanson, C.E. (eds.). 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

Paulson, DD (1993) 'Hurricane hazard in Western Samoa', *Geographical Review* 83(1): 43–53.

Pollock, N. 1979. Work, Wages and Shifting Cultivation on Niue.,*Pacific Studies* 2: 132–143.

Popkin B, Horton S, Kim S (2001) The nutrition transition and prevention of diet-related diseases in Asia and the Pacific. *Food and Nutrition Bulletin* 22 (Special Supplement). United Nations University, Tokyo.

Rahmstorf, S. 2007. A Semi-Empirical Approach to Projecting Future Sea-Level Rise, *Science˚,* 315: 368-370.

Rajagopal, V., KasturiBai, K. and Kumar, N. 2005. Breeding for drought tolerance in coconut: status and potentials, in Batugal, P., Rao, V. and Oliver, J. (eds.), *Coconut Genetic Resources*. International Plant Genetic Resources Institute, Selangor.

Rao, A. 1989.Water requirements of young coconut palms in a humid tropical climate, *Irrigation Science* 10: 245-249.

Rao, R. and Ravishankar, G. 2000. Vanilla flavour: production by conventional and biotechnological routes. *Journal of the Science of Food and Agriculture*, 80: 289-304.

Reaser, J., Pomerance, R. Thomas, P. 2000. Coral bleaching and global climate change: scientific findings and policy recommendations. *Conservation Biology*, 14: 1500-1511.

Rhodes, R. 1996. The new governance: governing without government. *Political Studies* 44: 652-667.

Ruosteenoja, K., Carter, T., Jylha, K. and Tuomenvirta, H. 2003.*Future Climate In World Regions: An Intercomparison Of Model-Based Projections For The NewIPCC Emissions Scenarios.* Finnish Environment Institute: Helsinki.

Ryan, T. 1981. Fishing in Transition on Niue.*Journal de la Société des océanistes*37(72-72): 193-203.

Sampson, T. 2005. *Aid to the Pacific: Past, Present and Future*, Towards a New Pacific Regionalism Working Paper No. 18. Asian Development Bank, Manilla.

Silverman, J., Lazar, B., Cao, L., Caldeira, K. and Erez, J. 2009. Coral reefs may start dissolving when atmospheric $CO_2$ doubles, *Geophysical Research Letters* 36: doi:10.1029/2008GL036282.

Siosikefu, M. and Haberkorn, G. 2008.*Niue Population Profile: Based on 2006 Census of Population and Housing*, Niue Economics, Planning, Development & Statistics Unit, and the SPC Statistics and Demography Programme, Noumea.

Smit, B. and Wandel, J. 2006. Adaptation, adaptive capacity and vulnerability.*Global Environmental Change*. 16(3): 282-292.

Spanger-Siegfried, E. and Dougherty, B. with Downing, T., Hellmuth, M., Hoeggel, U., Klaey, A. and Lonsdale, K. 2004.'User's Guidebook', in Lim, B. and Spanger-Siegfried, E. (eds.) 2002.*Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures*. Cambridge University Press, Cambridge: 9-28.

SPC (Secretariat of the Pacific Community). 2006. Climate and tuna fisheries. Oceanic Fisheries Programme. SPC, Noumea: http://www.spc.int/oceanfish

Statistics Niue, 2005.*Niue Merchandise Trade January 1996 – December 2004*. Economic, Planning, Development and Statistics Unit, Government of Niue, Alofi.

Statistics Niue. 2009a. *Gross Domestic Product of Niue for 2004 to 2006*. Economic, Planning, Development and Statistics Unit, Government of Niue, Alofi.

Statistics Niue. 2009b. *Niue Merchandise Trade 2005 – 2009*. Economic, Planning, Development and Statistics Unit, Government of Niue, Alofi.

Statistics Niue. 2009c. *Statistical Release: Travelling Residents and Visitors of Niue for 2009*. Economic, Planning, Development and Statistics Unit, Government of Niue, Alofi.

Stoker, G. 1998. Governance as theory: five propositions. *International Social Science Journal* 50: 17-28.

Sutherland, K., Smit, B., Wulf, V. and Nakalevu, T. 2005.Vulnerability in Samoa.*Tiempo* 54: 11-15.

Sutherland, K., Smit, B., Wulf, V. and Nakalevu, T. 2005.Vulnerability in Samoa.*Tiempo* 54: 11-15.

Swim, J., Clayton, S., Doherty, T., Gifford, R., Howard, G., Reser, J., Stern, P., Weber, E. 2009. *Psychology and Global Climate Change: Addressing a Multifaceted Phenomenon and Set of Challenges*. American Psychological Association: Washington D.C.

Tauevihi, N. 2009a. *Tau Tala Niue*, #4. Niue Public Relations Office, Alofi.

Tauevihi, N. 2009b. *Tau Tala Niue*, #29. Niue Public Relations Office, Alofi.

Tauevihi, N. 2010. *Tau Tala Niue*, #21. Niue Public Relations Office, Alofi.

*Taylor, R., Whitmore, J., Shirley, R. an others. 1983.* Niue Women's Health Survey *1983. Technical Paper 187.Secretariat of the Pacific Community, Noumea.*

Terry, J. 2004. Climatic Hazards Facing Niue, in Terry, J. and Murray, W. (eds.). *Niue Island: Geographical Perspectives on the Rock of Polynesia*. Insula: International Scientific Council for Island Development, Paris.

Thaman, R., Tukiuha, C., Tukiuha, V., Kulatea, M. and Aue, S. 2004. Niue's Biodiversity: A Foundation for Ecological, Cultural and Economic Survival of a Small Island Nation, in Terry, J. and Murray, W. (eds.). *Niue Island: Geographical Perspectives on the Rock of Polynesia*. Insula: International Scientific Council for Island Development, Paris.

TRADESTAT. 2010. *FAO Statistical Databases*. Food and Agriculture Organisation of the United Nations: http://faostat.fao.org last accessed August 10 2010.

Trenberth, K., Jones, P., Ambenje, P., Bojariu, R., Easterling, D., Klein Tank, A., Parker, D., Renwick, J., Rahimzadeh, F., Rusticucci, M., Soden, B. and Zhai, P.-M. 2007. Observations: surface and atmospheric climate change,in Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K., Tignor, M. and Miller, H. (eds.). *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge:235-336.

*Tuara, P. 2000.* An Assessment of the Role of Women in Fisheries in Niue. *Community Fisheries Division, Secretariat of the Pacific Community, Noumea.*

*Tuhega, L. 1977. The problem of absentee owners, in Kalauni, S., Crocombe, R., Tuhega, L., Douglas, N., Phigia T., Leonard, G. and Lipitoa, E. (eds.),* Land Tenure in Niue, *Institute of Pacific Studies, University of the South Pacific, Suva: 25-31.*

*UNFCCC (United Nations Framework Convention on Climate Change Secretariat) 2002.*Annotated Guidelines for the Preparation of National Adaptation Programmes of Action. *LDC Expert Group, UNFCCC Secretariat, Bonn: unfccc.int/files/cooperation_and_support/ldc/application/pdf/annguide.pdf*

*UNFCCC (United Nations Framework Convention on Climate Change Secretariat) 2002.*Annotated Guidelines for the Preparation of National Adaptation Programmes of Action. *LDC Expert Group, UNFCCC Secretariat, Bonn: unfccc.int/files/cooperation_and_support/ldc/application/pdf/annguide.pdf*

*UNFCCC (United Nations Framework Convention on Climate Change Secretariat) 2005.*Compendium on Methods and Tools to Evaluate Impacts of, and Vulnerability and Adaptation to, Climate Change.*UNFCCC Secretariat with Stratus Consulting Inc. Bonn: http://unfccc.int/adaptation/methodologies_for/vulnerability_and_adaptation/items/2674.phvan*

*Oldenborgh, G., Philip, S. and Collins, M. 2005. El Nino in a changing climate: a multi-model study.* Ocean Science, *1: 81–95.*

Vassie, J.M., Woodworth, P. and Holt, M. 2004. An example of North Atlantic deep-ocean swell impacting Ascension and St.Helena Islands in the Central South Atlantic. *Journal of Atmospheric and Oceanic Technology*, 21: 1095-1103.

Vunisea, A. 2005.Community-based fisheries management in Niue.*SPC Women in Fisheries Information Bulletin* 15: 30 – 32.

Walsh, A. and Trlin, A. 1973. Niuean Migration: Niuean Socio-economic Background, Characteristics of Migrants, and Settlements in Auckland." *Journal of the Polynesian Society*, 82: 47-85.

Walsh, K. 2004. Tropical cyclones and climate change: unresolved issues. *Climate Research*, 27: 77-83.

Watson. R., Zinyowera, M., Moss, R. and Dokken, D. (eds.) 1995. Climate change 1995 : impacts, adaptations and mitigation of climate change : scientific-technical analyses. Contribution to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.

Yeeting, B. 2003.*A Preliminary Investigation of Ciguatera Fish Poisoning in Niue*.Secretariat of the Pacific Community, Noumea (unpublished).

# 5. Programmes Containing Measures to Mitigate Climate Change

## *I Introduction*

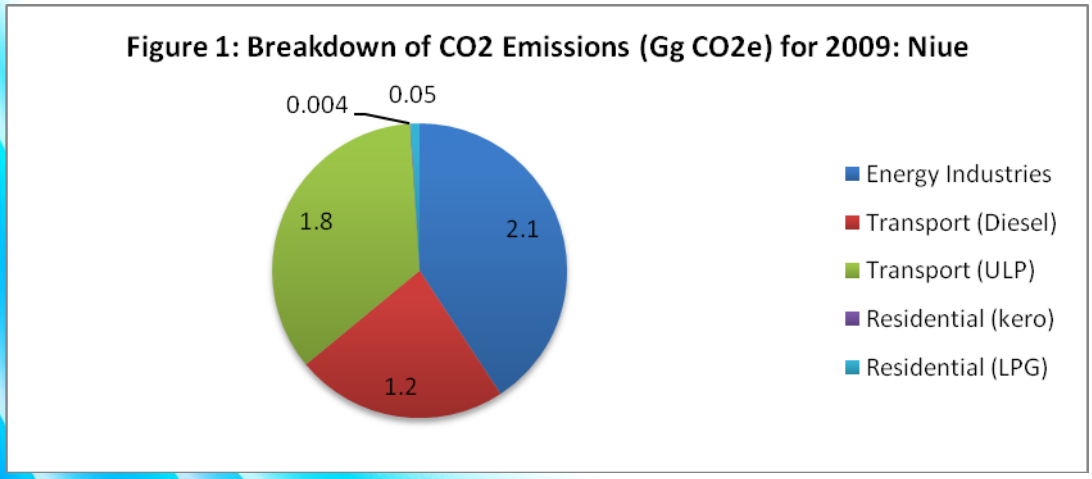
Under Article 4.1 (b) of the United Nations Framework Convention on Climate Change (UNFCCC), all Parties to the Convention are required to "…formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases…", after accounting for their common, but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances.

This chapter will update the progress of Niue in regard to the implementation of programmes to reduce the emissions of greenhouse gases and formulate additional programmes in response to the Island's current emission profile detailed by the 2009 Niue Greenhouse Gas Inventory (NGGI) as published within the Second National Communication of Niue (Government of Niue, 2010). These additional mitigation programmes are expected to form the basis of potential voluntary projects that Niue may wish to put forward for financing under Article 12.4 of the UNFCCC.

The Initial National Communication (INC) of Niue (Government of Niue, 2000) identified a focus of mitigation measures on the Energy and Transport sector and on the activities of 'reducing demand of greenhouse emitting products or by controlling the supply'. In Table 5.1 of the INC, the report identified 16 possible measures across the 5 sectors of: Energy and Industry; Transport; Forestry; Waste management and Water resources. The report noted that these measures "can be viewed as a step in the right direction taken by a small nation with limited economic resources attempting to fulfil its moral global obligation."

The NGGI concluded that the 2009 Greenhouse Inventory of Niue was approximately 5.1 Gg $CO_2e$ (5100 tonnes $CO_2e$). Removals, mainly from cropland conversion to secondary rainforest, were some 144 Gg $CO_2e$, making Niue a net sink of greenhouse gases in 2009.

The breakdown of greenhouse emissions by sector is illustrated in Figure 1.



The vast majority of emissions on Niue arise from the combustion of fossil fuels imported into Niue over the wharf at Alofi. Diesel combustion for electricity generation, general (mainly transport) usage and unleaded petrol for transport emit about one third each of the total emissions. This means that emission reduction measures that reduce electricity and transport fuel consumption, increase electricity generation and transmission efficiency, increase transport fuel use efficiency, increase the grid penetration and/or distributed use of renewable technologies and promote switching of fuels to lower emission sources will all be relevant to mitigation on Niue. The sectors of Waste or Agriculture, Forestry and Other Land Use (AFOLU) do not contribute significantly to overall emissions and are thus a lower priority.

## II Greenhouse Gas Emission Mitigation Action

In the period of 2000 (the SNC inventory baseline year) to 2009 a number of actions for greenhouse gas emission mitigation under the above categories have been implemented on Niue.

### A Reduce Energy and Fuel Consumption (Demand side)

The major activities were the installation of domestic solar hot water heating to 300 kw capacity. This not only reduced the electricity consumption of households, but also reduced imported fuel costs. In addition, public education campaigns encouraging energy saving behaviour and the use of high efficiency (CFL) lighting have been conducted.

### B Increase the Grid Penetration and/or Distributed Use of Renewable Technologies

In 2008, a total of 52.5 kw of grid connected photovoltaic capacity was installed; 30 kw at the Niue Hospital, 20 kw at Niue High School and 2.5 kw at Niue Power Corporation.

### C Promote Switching from Fuels to Lower Emission Sources

In 2008, 300 conversions of electricity to LPG-based energy have been carried out in residential and commercial premises throughout Niue.

Other behaviour change initiatives were identified in Table 5.1 of the INC, including:

- Encourage car-pooling to and from work;
- Promotion of bicycle use and walking;
- Promotion of public awareness of recycling, composting and other alternatives [*to landfill*];
- Enforcement of maximum speed limits, and
- Implement and improve Warrant of Fitness [*roadworthiness*] standards for motor vehicles,

Campaigns to implement these behaviour change initiatives have occurred from time to time. However, the lack of capacity for data collection, monitoring and evaluation on Niue prevent the impact of these initiatives on greenhouse emissions from being collated, reported and improved.

The installation of solar hot water, grid-connected photovoltaic capacity and LPG fuel switching was expected to result in an approximate 10% reduction in greenhouse gas emissions. In fact, greenhouse gas emissions in 2009 declined by 15% when compared with 2008. Although data is not available to fully attribute the greenhouse gas emission decline to the solar and LPG initiatives, the timing and magnitude suggests the measures attained their objectives. The capacity built through the success of these pilot mitigation programmes means that their extension to take in progressively larger

sections of Niue's households, as well as government or commercial establishments, provides a ready opportunity to significantly cut the direct and indirect emissions of greenhouse gases. Any measures beyond this extension would require further development of national capacity.

## III The Way Forward for Greenhouse Gas Mitigation in Niue

There are two key building blocks of this capacity that can assist in the development of further measures to reduce Niue's greenhouse emission profile. The first is the acquisition of base environmental data to support optimal deployment of renewable energy sources, such as wind and/or wave mapping and solar incidence. Being a tropical nation, it is natural that distributed solar technologies would be the first choice on Niue, however a renewable energy portfolio approach may provide better availability and cost-effectiveness and in any case the interactions with the existing electricity grid would have to be evaluated prior to any large scale conversion. This data is not yet available to support decision-making.

The second issue is the lack of capacity to monitor and evaluate energy supply initiatives on Niue. This particularly applies to behaviour change initiatives, but can also apply to household energy efficiency measures. Without this support there is no way to evaluate the cost or emission reduction effectiveness of programmes and take an adaptive management approach.

In respect of the removals of greenhouse gases by AFOLU, it is important that this capacity be maintained, if not enhanced. Currently, forestry activity is low and population decline has resulted in significant conversion of cropland to secondary rainforest. Removals can be assumed to be highly sensitive to future population increases, residential infrastructure replacement after cyclones or commercial forestry resumption. The Government of Niue is concluding a National Forest Policy to provide strategic direction for the island's forest areas, including climate change, and there are government programmes being implemented to increase tree plantation areas. As highlighted in the NGGI, removals and emissions from the AFOLU sector need to be better characterised through the acquisition of recent, multi-spectral satellite imagery and relevant processing and verification to track land use change.

Niue currently has a small greenhouse gas emission inventory with a low *per capita* emission of greenhouse gases. However, there appears to be considerable scope through technological and behavioural means to lower this further, congruent with Niue's ambition to be a globally responsible citizen. In achieving this, mitigating greenhouse gas emissions may also have substantial collateral benefits including: decreased national expenditure associated with the escalating costs of importing fossil fuels; improved energy security; improved local air quality; support for Niue as an eco-tourism destination and encouraging sustainable development in the Pacific region.

***Sunset at lowtide beyond one of the many sandy coves around Niue***

# 6. Development and Transfer of Environmentally Sound Technologies

## *I Introduction*

Articles 4.5 and 4.7 of the United Nations Framework Convention on Climate Change (UNFCCC), require developed country Parties to take steps to promote, facilitate and finance the transfer of, and access to, environmentally sound technologies(EST) and know-how to other Parties, and in particular developing country Parties.

As a developing country Party, Niue requires the assistance of developed country Parties in order to fulfil its commitments under the UNFCCC. The Niue Initial National Communication did not indicate the challenges and opportunities relating to ETSs in Niue and interest and awareness of ETSs were limited at that time. In 2003, a national workshop was held. At the workshop, a technology needs assessment process was suggested. This would provide a basis for technology transfer development. The focus was to build consensus on priority technologies and strategies to acquire them. These issues were revisited in 2007.

The workshop identified the Electricity, Transport and Environmental sectors to be the sectors where the greatest EST opportunities existed. The following is an analysis of the legislation relating to these sectors.

## *II Legislation*

### A Electricity Power Supply Act 1960

The Act provides for the control of electrical installations, wiring and appliances. While the Act is dated, it is the primary avenue for current and future developments in electrical energy supply. Regulations and control over renewable energy technologies and supply would build upon this existing framework.

### B Environment Act 2003

The Act provides for the establishment of an Environment Department for the purposes of design and implementation of environment planning, natural resources management, environmental impact assessment, waste management and pollution control, and nature conservation. This Act has broad provisions that can allow for specific developments in future.

### C Transport Act 1965

The Act provides rules for the control of vehicles, roads and road traffic. Rules on annual registration of vehicles and licensing are set out. Data on the Transport sector is kept with the Police Department. Data on vehicle imports are kept with boarder control being the Customs Department.

Information and planning for developments in the Transport sector is vague because of limited data. For this reason, capacity building to improve the collection and storage of data is necessary. Improved data systems will provide the requisite information that determines how this sector may improve.

## *III Development*

While the existing legislation is useful, there is no specific mention for technologies or technology transfer processes. Furthermore, each sector has developed independently of one another and independently of any EST intentions. There is a need to develop the sectors in a way which allows for ESTs to be implemented. Current policies do not take into account scientific and technological considerations. This needs to change and a link between science, technology and policy making needs to be made.

At operational level, constraints in human and financial resources have made access, financing and development of ESTs difficult. Cost of procurement and maintenance is a major barrier to technology transfer. Most of Niue's existing technologies are basic and require updating for better efficiency and performance. For example, the Telecommunications sector maintains its land line telephone services since it first started and has had limited expansion to a mobile phone systems service. Reliable telephone service is available at Alofi and on the north, west and south-west side of the island. Reception becomes susceptible to poor weather conditions on the eastern side of the island. For the paying customers, the cost is high. Another example is the Water sector. Bore pumps which were once powered by windmills are now powered by electricity. It is estimated that 10% of the power generated in Niue is absorbed by pumping water bores. The cost is increased as leakages in the bores result in water wastage which results in power wastage.

Niue's major emission source is fossil fuel combustion for electricity generation and transport usage. It is therefore justifiable that Niue selects these areas as areas which require ETSs to allow for adaptation and mitigation of climate change. Low efficiency appliances and vehicles could be prohibited and efficient alternatives provided. Promotion of alternative transport systems such as car pooling, walking and cycling may reduce demand in transport usage.

Recent developments in renewable energy technologies have been through European Union project funding. Although the government budget may not be able to support technology transfers, it can provide for better decision-making processes that facilitate technology transfers. Renewable energy sources, such as solar for water heating and gas stoves for cooking, are current efforts to reduce reliance on electrical energy.

Future developments in Niue should include country driven activities that promote mitigation and adaptation activities. Identification of the barriers for ESTs and areas for capacity building should feature in any future development. All technology dependent sectors such as energy, water, communication, information and networking, and transport should prioritise activities that align with mitigation and adaptation. It is expected that lessons learnt from the second national communication will provide the basis to encourage movement in EST development at the next phase. This can be done simultaneously when climate change concerns integrate with the national development process.

***Regular maintenance is crucial to keeping Niue connected***

# 7. Research and Systematic Observation

## *I Introduction*

In the interest of Article 4.1 (g) and (h) and Article 5 of the United Nations Framework Convention on Climate Change the promotion of Research, Systematic Observation (RSO) was necessary for furthering understanding and reducing the remaining uncertainties regarding the causes, effects, magnitude and timing of climate change. The Niue Meteorological Service (NMS) serves this purpose to the extent of its resources.

## *II Niue Meteorological Service*

### A Organisational Structure

Meteorological operations have been managed under the Telecom Department since its first climate records in 1905. Two climate stations and two rainfall stations were installed during this period with minor site changes since. NMS was established in 1996 and became operational in 1997. Currently, based at Hanan Airport the Department is the reference station undertaking all weather and climate observations and services. There is no upper air observations carried out in Niue.

The Department's mission is to provide efficient weather and climate information. Its core business includes the issuing of reliable weather and marine forecasts and warnings; reporting meteorology and climatological observations; advising on threat of tropical cyclones and other natural disasters; and fulfilling commitments and obligations with inter-governmental organisations.

The organisation of the Department consists of seven personnel being the director, meteorology supervisor, scientific officer, meteorology communications officer, meteorology officer, meteorology trainee and the Niue Climate Change Project coordinator.

### B Observation and Forecasting

Basic observation programmes carried out by the Department includes manual synoptic observations (3-hourly) and METAR reports (hourly) undertaken during normal working hours from 8am to 4pm on Monday to Friday. Synoptic observations during after hours are transmitted through an automated system the Synoptic Automatic Weather Station (SAWS). Climate observations recorded after hours are done on a voluntary basis and limited to 2 working hours, which are used as Time Off In Lieu (TOIL). The same treatment applies with longer working hours during severe weather conditions.

The forecasting services are provided by the Regional Specialized Meteorological Centre (RSMC), Nadi, Fiji. Forecasting services for severe weather warnings, public, aviation and marine forecasts are received regularly. The Department provides value to the weather forecast by adding a three-day forecast for the local community. Routine dissemination of weather and climate information for the general public is through the Broadcasting Corporation of Niue (BCN).

## C Data Collection and Analysis

Climatological information is recorded on a daily basis and digitalised into the climate databases, Climate Computer (CLICOM), Climsoft, and basic Excel Spreadsheet. Through recent developments of the data management systems, the NMS has upgraded to using a climate database called CLIDE (Climate Database for the Environment), that holds all digitized and updated climate data. All data and information are archived on the government server, hard copies and basic hard drive storage system.

Analysis of meteorological data by local expertise has been possible through the Pacific Island Climate Prediction Project (PICPP), Pacific Climate Change Science Programme (PCCSP) and through regional and international training workshops. Local knowledge can now adequately offer basic interpretation and analysis of weather and climatic information.

Web-based tools provided through collaboration of the NMS and regional projects such as the Pacific-Australia Climate Science and Adaptation Program (PACCSAP) and now Climate and Oceans Climate and Oceans Support Program in the Pacific (COSPPAC) builds the basis for access to tropical cyclone portal, climate data portal, sea level data and other climate related products and education and awareness materials.

A Niue Climate Outlook (NCO) newsletter is issued monthly to all stakeholders using a program called the Seasonal Climate Outlook for Pacific Island Countries (SCOPIC). Niue's rainfall of 64 years is matched against the sea surface temperatures in the NINO 3.4 region.

NMS is also undergoing a process where traditional knowledge information is being recorded and entered into a Traditional Knowledge database through the COSPPAC program. The intention is to have a system in place to record the information and communicate it to all stakeholders with an outlook and intention of incorporating it into weather and possibly climate forecasting.

The Chairperson and Niue National Disaster Council (NNDC) affirm action upon any natural disaster event. The colour coded system of Blue Alert ("approaching"), Yellow Alert ("near"), and Red Alert ("hit") is executed accordingly to the strength of the Tropical Cyclone. All fundamental utilities such as water, power, and communications are to be ceased at the Red Alert phase.

The Department has implemented a Quality Management System (QMS) plan that would assist and comply with the reporting requirements of aviation services under the International Civil Aviation Organisation (ICAO).

## D Future Development

The Department has developed a Meteorology Bill and passed by the *Fono Ekepule* (Parliament) that encompasses all issues relating to meteorology and therefore grant protection for the Department. The long term goal of the Department is to maintain adequate human and institutional capacity for climate data monitoring. It is essential for meeting the minimum standards of research, and systematic observations. Ongoing capacity building, in-country and long term training for current or new staff could help reinforce the Department. Collaboration and coordination with regional and international counterparts is desirable to sustain, improve and strengthen resources and services of the Niue Meteorology and Climate Change Department.

# 8. Public Awareness, Education and Training

### *Introduction*

Article 6 of the United Nations Framework Convention on Climate Change requires parties to the convention to:

**(I) Promote and facilitate at the national and, as appropriate, sub regional levels, and in accordance with national laws and regulations, and within their respective capacities:**

(i) The development of implementation of educational and public awareness programmes on climate change and its effect;

(ii) Public access to information on climate change and its effects,

(iii) Public participation in addressing climate change and its effects and developing adequate responses; and

(iv) Training of scientific, technical and managerial personnel.

**(II) Cooperate in and promote, at the international level, and, where appropriate, using existing bodies:**

(i) the development and exchange of educational and public awareness material on climate change and its effects; and

(ii) the development and implementation of education and training programmes, including the strengthening of national institutions and the exchange or secondment of personnel to train experts in this field, in particular for developing countries.

In order to fulfil these obligations the Niue Climate Change Project formed the Education, Training and Public Awareness Group (EPTA). The EPTA, in conjunction with government departments and non-governmental organisations, has developed and implemented a number of projects to increase the public's awareness and knowledge of climate change issues.

Findings of the Education Training and Public Awareness Group ("the Group") suggested a different view regarding the general knowledge and interest of the Niuean public regarding climate change issues. Planned activities that involved all levels of the Niuean public which included village meetings, radio and television programmes, logo, talent and poster competitions opened up the interest and minds of the public to climate change issues. Participation under each of the activities was high resulting in increased public interest. Questions raised throughout the various activities indicated sufficient understanding and skill regarding climate change issues. Due to the direct connection between the Niuean lifestyle and the environment, it was inevitable that the Niuean public would wish to understand climate change issues. Furthermore, climate change related events such as sea level rise in Tuvalu required relocation of some Tuvaluan families to Niue. An arrangement entered between the Governments of Niue and Tuvalu in the mid-1990s was indicative of the Niue Government's commitment to addressing climate change issues impacting on other Pacific island countries. Loss of momentum and lack of human resources may have resulted in miscommunication by the time of the Initial National Communication.

The Group recommended three main areas for training for dissemination of information on climate change issues and technology transfer. These were (i) general training for awareness raising,

(ii) specialized training for technology transfer and (iii) scholarships for tertiary education for outstanding candidates. Although the Initial National Communication made recommendations outside of this structure, the same recommendations should exist for the present and future of Niue.

## *II Projects*

### A Poster and Billboard Competition

The poster competition encouraged competitors to communicate climate change impacts and effects in a simple understandable form. Competitors were asked to present their artworks in both the Niuean and English languages, and a huge amount of creativity, humour and originality was shown by the competitors. The winning poster was transformed into a billboard and erected at the entrance of the Niue Meteorological Service.

### B Niue Youth Hip Hop Competition

The main goal of the Hip Hop competition was to encourage the youth of Niue to promote Climate Change awareness. By using the popular dance style, the youth were given a platform to portray meaningful messages on climate change issues.

The competition enjoyed the support of the National Youth Council and was held at Niue High School. All performances were entertaining, effective and well presented. The youth were able to highlight many aspects of Climate Change using their own knowledge.

After the success of the Hip Hop competition the ETPA group has recommended that more climate change awareness activities targeting the youth should be held.

### C Niue Youth Power Point Presentations

The Power Point Presentations allowed the youth of Niue to display a more in-depth knowledge of Climate Change issues. Questions such as 'Why do we care about climate change?" provoked a high standard of presentation which showed the level of awareness that the young people have regarding the environmental, social and economic issues that climate change presents for Niue.

The presentations also included measures which could help Niue slow the effects of climate change. These included calls for the use of renewable energy and more responsible waste disposal.

### D Women Talent Quest

The women of Niue were given this opportunity to express the problems of climate change. The messages expressed through the acts were meaningful and stressed the importance of preparation for natural disasters such as tropical cyclones and tsunamis. Some groups used props to support and add impact to their songs and others wore costumes to reflect some of the jobs that contribute towards the problems of climate change.

### E Men Song Quest

This competition looked to increase the involvement of the Men of Niue in the promotion of Climate Change Awareness. The acts were well presented and the men showed that it is important for all of the Niue people to be aware of the dangers of Climate Change.

### F Women Short Story Writing

There were 24 women on Niue that submitted their stories either in English or Niuean. The stories were based on the author's real life experiences in natural disasters, and a huge amount of courage was shown by the women of Niue to tell their personal struggles through earthquakes, tropical cyclones and droughts. The importance of the Mothers of Niue in a natural disaster was highlighted through this competition.

**G Climate Change Touch Rugby Tournament**

The Niue Climate Change Project worked with the Niue Island Touch Association to run this highly popular competition. The importance of the competition was made clear when the Premier of Niue, Hon. Young Vivian opened the event.

The competition was enjoyed by all, and provided an opportunity for a wide audience to be made aware of climate change issues. As well as the touch games, the event included a banner competition, a climate change quiz, and a team name competition.

The Tournament also provided the National Touch Teams, Kyoto9 and Oceans13, a great build up to the South Pacific Games.

**H Niue Primary School and Niue High School**

The Niue Primary School Education and Awareness package included a number of programmes to increase the awareness of climate change issues. These included visits to government departments such as Niue Meteorology and Climate Change, composing climate change based songs and poems and the creation of posters focussing on climate change.

The Niue High School carried out climate change based poem writing and speech competitions.

The Niue Climate Change Project visited both the Primary School and the High School to explain the purpose of the Project and to inform the students of the numerous education and awareness activities.

**I Climate Change Showcase**

Niue hosted the 39th Pacific Island Forum in August 2008. During the forum, a Climate Change Showcase was displayed by government departments, the private sector, Niue communities and overseas institutions to show the different ways in which Niue was dealing with climate change.

The showcase included displays, a national float parade and a global warming walk which attracted various Pacific Island leaders as well as the people of Niue.

**J Climate Change Newsletters**

The Niue Climate Change Project disseminated monthly newsletters to keep the general public up to date on climate change issues.

**K Climate Change Website**

The Climate Change Website was established in order to provide promotional activities at the national, regional and international level.

**L School Holiday Educational Program**

During each school term break, the Met Office allowed students to visit the Department and gave them an insight into weather forecasts and climate issues. The majority of students who attended were from Niue Primary School.

**M Community Involvement**

The Niue Climate Change Project has worked with various village groups to promote climate change issues at village show days, Miss Niue pageants, and other community events. This collaboration has successfully promoted climate change issues in communities around Niue.

**N Climate Change Episodes**

Working with Kilocutz Productions, the Niue Climate Change Project produced and broadcast 10 episodes presented by the Department of Meteorology and Climate Change staff. The episodes covered topics such as Meteorology, Climate Change, Greenhouse Gases, Mitigation, Vulnerability, Adaptation and Education systems.

**O Training and Group Workshops**

A number of high level workshops have been held by climate change experts in order to determine the methods of dealing with climate change and ways forward for Niue. The workshops included: the Inception Workshop, the Greenhouse Gas Inventory Workshop, the Vulnerability and Adaptation Workshop, the Environmentally Sound Technologies Workshop, the Education, Training and Public Awareness Workshop, and the Meteorology and Climate Change Workshop.

**P 350.Org Campaign**

This is a global initiative to combat climate change, in which Niue is participating. So far 350Niue has undertaken 3 successful events:

- Grab that Jandal: to clean up Togo;
- Tremendous Tree Planting; and
- 350Niue Cocktail.

With the help of the Niue Broadcasting Corporation, all of the events were filmed, and images were provided to 350.org, which displayed them as part of their global campaign in New York's Time Square. This organisation has allowed Niue to promote climate change issues locally while being involved in a global movement.

**Q Climate Change Theme Song**

The Climate Change Theme Song was composed by John Talagi. The lyrics focussed on the national and international efforts to minimise the impacts affecting the climate to protect humans and the environment.

# 9. Integration of Climate Change Concerns into Sustainable Development Programmes

## *I Integration of Climate Change Concerns into Sustainable Development Plans*

In the context of this chapter, the term "integration" refers to the process of considering climate change impacts in decision-making processes such as planning or budgeting and involves incorporation of policies and measures in ongoing sectoral and development planning processes. It thus involves the incorporation of climate risk strategies or capacity enhancement initiatives into real decision making regarding disaster preparedness, water management, food security, health, livelihoods, etc. Effective integration therefore requires the active engagement of decision makers and relevant stakeholders to assess climate change vulnerabilities in the context of prevailing conditions and existing management strategies and/ or policies, or those that are being developed to deal with broader issues of livelihoods, disaster management, or sustainable development. Involvement of stakeholders at different levels induces the development and transfer of information in appropriate forms. Unfortunately, information on climate change vulnerability has tended to concentrate within scientific community and lack the socio-economic dimensions. This deterred the engagement of the public, particularly the local communities.

The integration of climate change concerns into sustainable development plans is currently limited to the Meteorology Service and the Environment Department. Its relevance may increase in the Tāoga Niue sector as the Department increases its focus on cultural preservation. At national and community levels, consideration for climate change issues during general planning and decision making process is predominantly regarded a peripheral matter. This could change in future as the work undertaken by the relevant departments expands.

The most relevant have been selected, from an array of plans and policies, for the purpose of this section.

### A Forest Policy 2004

A forest policy statement was developed and subsequently implemented in 2004 to guide development of Niue's forest resources. The underlying guiding principles include sustainable resource use, conservation and protection, individual and collective responsibility for control, and management of forests and provision of economic opportunities.

Climate change issues are not directly addressed in the policy but are stated through sustainable management, conservation and protection principles. Forestry development has been small and is inactive to date; hence, application of the policy may become more relevant according to future activities in forestry development.

### B Niue National Energy Policy 2005

The purpose of the Energy policy is to minimize Niue's dependence on petroleum products by actively encouraging fuel conservation and efficiency. Key principles underlying the policy include economic efficiency, energy efficiency and environmental protection. Sub-sectors within the Energy policy include:

(a) Planning, coordination and management;

(b) Petroleum;

(c)Transport;

(d) Electricity;

(e) New and renewable sources of energy;

(f) Environmental aspects; and

(g) Energy conservation and efficiency.

Implementation of the policy requires coordination with other social sectors at both operational and policy levels. Updating of work programmes is to coincide with the annual budgeting process.

**C Niue National Integrated Strategic Plan (NNISP) 2009-2013**

There are two areas that convey climate change concerns. The first is economic development through the development and maintenance of quality meteorological services. The other falls within environment development where the objective is sustainable utilization and management of Niue's natural resource for present and future generations. Through this sector, all other relevant sectors are encouraged to incorporate climate change concerns into corporate plans by 2013.

**D Climate Change Policy 2010**

The climate change policy came into effect in March 2010 with a vision to achieve sustainable livelihoods and safety from climate change. It supplements climate change developments raised in the NNISP. The policy focuses on the following six objectives;

(i) To raise public awareness on causes and effects of climate change, climate variability, adaptation and mitigation responses;

(ii) To improve management of data collection, storage, sharing and application;

(iii) To develop appropriate adaptation responses and to protect livelihoods, natural resources, assets and areas vulnerable to climate change;

(iv) To mitigate the causes of climate change through effective implementation of measures to reduce greenhouse gas emissions;

(v) To mainstream climate change issues into national development and establish an effective regulatory and institutional framework for the development and implementation of national responses to climate change; and

(vi) To meet its regional and international commitments regarding climate change.

A national action plan will be developed to drive the implementation of the policy. It is envisaged managing the implementation of the policy will require an appropriately staffed and resourced national climate change office or unit. It would appear that this suggestion may need modification and that this requirement be built into the work of the existing Environment Department and/or Niue Climate Change Project Unit. Advantages of this approach would include avoiding teething problems associated with a new unit, or duplication. The experience and knowledge of the existing bodies can assist with implementation of the policy.

The policy further suggests establishment of a steering committee consisting of representatives from the Environment Department, Niue Meteorological Services, Economic Planning, Treasury, Health, Agriculture, Community Affairs, External Affairs, the private sector, and Non-Governmental Organizations. The proposed committee may either function parallel to or under the National Climate Change Coordinating Committee. Monitoring the progress of activities under the policy will be undertaken annually in conjunction with the budget review process.

At community level, climate change concerns also benefit from activities initiated from other programmes. Examples include the Niue Organic Farming Association where organic farming practices are encouraged. Organic farming practices discourage use of herbicides and artificial fertilizers which consequently curb strain on the biodiversity and water lens.

In Niuean performing arts, various dance and community groups convey the climate change message through song and dance. This cultural medium enables the natural blending of climate change

awareness to the community level. Tourists are similarly exposed to the message during performances at shows held at different locations and at different times throughout each year.

## E The Ecosystems Approach to Fisheries Management 2010

The Ecosystems Approach to Fisheries Management (EAFM) Plan is a step towards redevelopment of the National Tuna Management and Development Plan. The proposed management strategies provide an opportunity to consider issues of economic benefit and community well-being while protecting the fisheries resource through sustainable management of its ecosystem.

The management approach involves a four step process. The objective is to minimize the impact of each factor on the resource. One of the factors that feature strongly is the risk posed by the conditions of the general environment on the fisheries. The first is the occurrence of cyclones and oceanography and the SOI impact. Cyclones and extreme weather conditions are rated very high risk because of the high occurrence possibility and the damage it can cause to infrastructure and coral and fish habitat. The other issue is the impact of water quality on the fishery. The process will provide a report on each of the priority areas which can be addressed in the pending management and development plan.

***Native fish species - Achilles tang (Acanthurusachilles)***

**Table 1: Climate Change Issues Addressed in Corporate Plans 2009-2010**

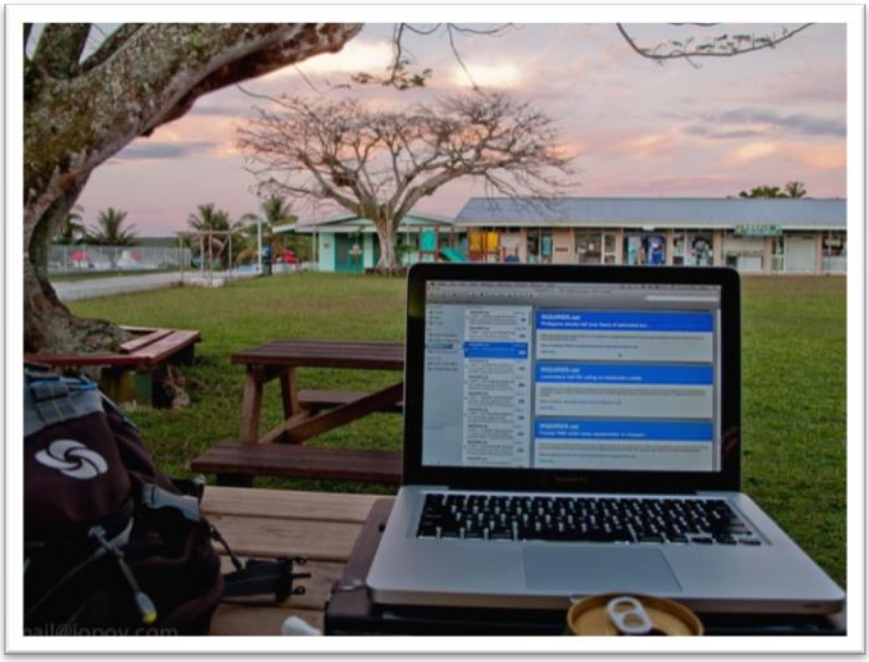
| Department | Yes | No | Action and Expected Outcomes |
|---|---|---|---|
| Police Department | √ | | • Address mitigation adaptation to climate change in regard to disaster and risk reduction management.<br>• Greater public awareness on climate change issues. |
| Health Department | | √ | |
| Education Department | | √ | |
| Community Affairs Department | | √ | |
| Broadcasting Corporation Niue | | √ | |
| Tourism Authority | | √ | |
| Bulk Fuel | √ | | • Commit to safety, health and environment policies.<br>• Support the development and implementation of a Niue Solid and Hazardous Waste Management Pollution Plan.<br>• Eliminate ground water spills |
| | | | • Protection of the Environment from Hazardous Waste.<br>• Protection of the Environment from petroleum products. |
| Power | √ | | • Increase use of renewable energy and other forms alternative forms of energy.<br>• Plan and implement renewable energy projects particularly solar panels. |
| | | | • Cyclone risk reduction (convert pole power line reticulation to underground cable system). |
| Telecoms | | √ | |
| Public Works Department | √ | | • Reduce cost in importing fuel to generate energy.<br>• Water management – minimize leakage and reduce water wastage that will reduce power usage for generating energy.<br>• Strengthen response to national disaster through coordinated plans, policies and capabilities. |
| Treasury Department | | √ | |
| Administrative Services Department | | √ | • Adopt e-government information and improve access to government information.<br>• Reduction in lost or misplaced information and improved communication between government sectors. |
| Premier's Department (Civil Aviation, Economic Planning, Development & Statistics, External Affairs, Niue High Commission, Cabinet Services) | | √ | • Strengthen relationships with bilateral and multilateral partners.<br>• Increased international relations with reciprocal benefits to Niue. |
| Environment Department | √ | | • Develop mitigation and adaptation projects to address climate change. Implement at least three mitigation projects by the end of 2010. |
| Meteorology Service | √ | | • Fulfil Niue's commitment to the United Nations Framework Convention to Climate Change (UNFCC). Submit Climate Change Convention Second National Communication Report. |
| Taoga Niue Department | √ | | • Promote conservation and strengthening of cultural heritage, language, values and identity. Revive customary practices and traditions for future generations. |

# 10. Information and Networking

## *I Introduction*

The following sectors are responsible for providing access to information, communication, and technology (ICT) services for Niue.

- Government Department: Telecom Department, Information Systems Office
- Private Sector: Internet Users Society of Niue (IUSN)



***Keeping Niue connected - one of several wifi hot spots around the island***

## *II Information Systems*

The Government first implemented an internet dial up system in 1997 and sometime in 2006 WiFi was introduced. The WiFi operations ceased due to security reasons. Government network system migrated to public WiFi in 2006. From 2005 to 2008 government departments were networked and known as government Local Area Network (gLAN). There are 14 gLAN sites to form government Wide Area Network (gWAN).

Niue's only current WiFi is managed and controlled by the IUSN. The WiFi systems are installed with full coverage in the villages of Alofi, Hakupu and Liku, while Tamakautoga, Avatele, Lakepa, Makefu, Mutalau and Tuapa with partial coverage. The remaining villages of Toi, Hikutavake and Namukulu are yet to implement a WiFi System.

The Information Systems Office (ISO) shifted in 2010 from being under the care of the Administrations Office to being under the Technical Operations Unit of the Telecom Department.ISO

attends to call outs that require attention on rectifying internet and technological problems of departments.

Newly developed infrastructure includes mobile telephone and the government Internet Service Provider (ISP). The Government ISP will be managed by the Niue Telecom Department. The first phase for installation is expected to commence within a few years from now. This phase will upgrade the government network and roll out of the mobile systems.

Private sector businesses such as Okakoa and Rocket Systems provides internet related services at a cost including ordering new software and hardware and repair of faulty computers for all government and public needs.

Information sharing of weather, climate and climate change issues exists within the department through the gLAN system. Information is also available through the Intranet for a wider audience from other government departments.

A website was also developed to promote awareness and educational programmes of the Niue Climate change Project (NCCP) at all scales, from national, regional, and international.

Information communication technologies exist through the email and internet, radio, VHF radio, facsimile, telephone and television.

Niue has a robust knowledge in the use of email and internet and it is one of the effective mediums utilized for transfer of data and information. The human, scientific, technical and institutional capacity in information and networking has strengthened over time in Niue. This is an advantage to build on active preparation and survival towards natural hazards such as Tropical Cyclones.

There is potential to improve effectiveness and efficiency and achieve full utilization and realization in ICT. This could also improve modes of information, communication and technology for climate change.

***Wi-fi infrastructure maintenance by RockET systems***

# Chapter 11: Capacity-building

## *I Initial National Communication Findings*

The Initial National Communication reported that there is difficulty in the Niuean community regarding climate change issues due to lack of knowledge. This may have coincided with the fact that climate change was not yet a well-known concept in the Pacific region. However, this conclusion made no reference to the education and awareness raising efforts undertaken during this period (1998-1999). There was neither distinction made between the various levels of understanding required whether general, scientific or technical.

## *II Education, Training and Public Awareness Group Findings*

## *III Development*

### A Climate Change Project

Despite the perceived loss of momentum in climate change work, the transition from the initial to the second phase of the Climate Change Project provided opportunity to strengthen the Climate Change Unit (the unit) for the Climate Change Project within the Niue Meteorology Service (Niue Met Service). The continuation of the unit provided the foundation for developments in the area of climate change. Such developments afforded opportunity for the Niuean population to understand the opportunities, challenges and issues pertaining to climate change.

Knowledge of climate change issues continued to spread from the Niue Met Service officials; to politicians through regular meeting attendance at regional and international climate change forums; to youth through the school system where the science of climate change is taught at certain levels; to public officials from other government departments through membership in various climate change working groups; to senior public officials of partner departments that have interest in preservation of the environment and Niuean culture; the general population through participation at workshops, song quests, talent shows and competitions , organised by the Climate Change Unit.

### B Cyclone Heta

The onset of Cyclone Heta in 2004 accelerated interest and understanding of the risks and hardships associated with climate change. Village Councils island-wide have direct roles in the national disaster management plan. All village council designated evacuation centres for sheltering their respective village communities during a cyclone, established cyclone warning systems, how to read and interpret cyclone maps and preparation of emergency kits and other necessary safety measures. Changes in the weather patterns inevitably include climate change issues.

### C National Workshop

During the period of 19 November – 07 December 2009, the Niue Met Service conducted a national workshop held specifically for each village for the purposes of educating and increasing knowledge of lay persons regarding weather, climate observations and climate change. There was particular interest in the discussions around the issue of climate variability and climate change. Overall, the discussions and feedback from the workshops indicated greater understanding of the issues and challenges associated with weather and climate change. There was consensus requesting more and regular workshops of a similar nature in future.

### D Community Opportunities

Other opportunities where communities and individuals have increased understanding of climate change have been through the variety of song quests and cultural performance competitions held over the years. Music, song and dance is an integral part of Niuean culture. The opportunity for individuals, groups and communities to create and convey cultural performances related to climate change naturally injected new meaning and interest regarding climate change.

## *IV Niue Meteorological Service*

Within the Niue Meteorological Service and the unit, officers undertake several roles and responsibilities. Resource constraints and the temporary nature of the climate change project make it difficult to recruit employees from a small population. There is general preference for permanent employment opportunities. Expansion and support for the unit is limited in the choice of candidates for work and employment. This may change depending on the remuneration offer.

Multitasking and the smallness of the office have been both an advantage and a disadvantage. The smallness has afforded greater opportunities for officers to undertake basic training across the board. Consequently, there is a high proportion of officers who have already undertaken short term training offered by regional institutions in this area. The difficulty is time constraints and coordinating different roles for officers to undertake training. The other disadvantage is keeping the balance and ensuring that officers are not over saturated or stressed with too much training and too much work over a variety of issues at any one time.

Capacity building at scientific and technical level is subject to availability of personnel within the Niue Meteorological Service. To date, the capacity of the Niue Met Service and of the Climate Change Unit is such that scientific and technical capacity is sought, on an as needed basis, from colleagues and institutions from the region.

There are officers within Niue Meteorological Service who have undertaken tertiary studies through the service and have returned and continued employment. During the June school holidays for 2010, senior Niue High School students assisted the unit with the national survey on Transport Systems for GHG Inventory. Students were offered training on basic principles in climate change and weather science prior to conducting, collecting and collating data. The Climate Change Project envisions increased interest by students to undertake tertiary level education in the area.

Work with other partner departments such as the Environment, Taoga Niue, Agriculture Forestry and Fisheries, Niue Health and Education is ongoing and requires careful coordination and planning. Contact and progress between other departments is coordinated under the National Integrated Strategic Plan 2009-2013. There is a need for improved communication between departments in order to understand the issues, operational matters and priorities of each area.

At the law and policy level, there has been considerable effort to involve politicians, senior officials and legal officers in climate change work. Politicians, senior officials and legal officers have been included in regional conferences and workshops in the last few years. This has provided the foundation for interest in climate change issues to transmit to law and policy level. At the start of 2010, the unit established an ongoing relationship with a legal officer to assist with climate change work. The purpose is to assist with reporting as well as to assist with legislative drafting and consultation for a Meteorology Bill.

## *V Recommendations*

In future, the Niue Met Service and Climate Change Unit together with the National Training Development Council under its Strategic Human Resource Development Plan will encourage

scholarships and training opportunities in this area. Identification of the immediate and long term needs will be assessed in order to assist with planning.

Areas that will continue to need capacity building and support are:

- General training on education and awareness for the general public;
- Scholarship on tertiary study in climate science for students;
- Specialized training for technology transfer among existing officers; and
- Short term training on policy type issues for decision-makers.

**References**

Education Training and Awareness Group *Final Report 1998-1999,* Government of Niue.

Climate Change Project *Initial National Communication 2000,*Government of Niue.

Niue Meteorology and Climate Change *Niue Island National Workshop Report "Weather, Climate Observations and Climate Change"* Government of Niue.

# Chapter 12:Constraints and Gaps, and Related Financial, Technical and Capacity Needs

## *I Overview*

Challenges and constraints experienced throughout the Niue Climate Change Project (NCCP) are attributed mainly to human resources. NCCP's challenges are primarily because of unavailable technical expertise. This is further challenged by low commitment of committee members.

At regional and international level, there is inadequate assistance for small country members. There is need for regular visits, support and training in project management, and sector expertise.

Relevant government sectors work independently of each other and work under goals and policies that either do not align with one another or are not adequately aligned with climate change purposes. Government sectors have low response rates to requests for data and information. This is due to insufficient data gathering, record keeping and or database systems. This is further hindered by minimal documentation and a lack of analysis of existing data. The sectors involved lacked human and financial resources for maintaining information systems.

Long and uncertain decision making processes, negatively affect the time for completion of proposed activities. Changes in the government of the day also impacts on the progress and reporting by the project. In the absence of legal instruments that describes the functions and rules of the project, pertinent issues are decided upon by the responsible Minister. Preferences of the Minister sometimes conflict with the advice of the NCCP.

Other climate change related work and interest has recently emerged in other departments. For example, climate change projects in the adaptation and water sectors are currently housed and managed by the Department of Environment (DOE), Water Division of the Public Works Department (PWD), Niue Power Corporation (NPC) and Economic, Planning and Statistics Unit (EPDSU). Considerable amount of time and resources is directed at reporting to regional and external agencies leaving insufficient time for appropriate planning with local counterparts. The NCCP in its current form does not have the size and resources to link closely with its sister departments.

In light of these general constraints, Niue's timing for meeting its UNFCC's commitments and obligations correlates with its small public sector.

## *II Other Gaps*

Other gaps are listed below per sector;

### A GHG Inventory

- Lack of human and technical knowledge to gather and analyse data. The local expert is employed on a part time basis. Competing interests and responsibilities has meant the local expert is mostly unavailable.
- Lack of interest for training opportunities in this area.
- Lack of trained experts. There is currently one local expert.
- Scattered data from various sectors. Most sectors do not have robust record keeping systems or a collective data keeping system.
- Records stored in databases are either subject to technical faults or its users are unfamiliar with its uses. There is inconsistent recording of long term data sets.
- Sectors do not keep information for Climate Change purposes.

- Gaps between data information from the time of the initial national communication and the present phase.

**B Vulnerability and Adaptation Assessment of key socio-economic sectors**

- Lack of local human and technical knowledge.
- Absent country-specific guidelines.
- Lack of coordination between climate change related projects.

**C Programmes containing measures to mitigate climate change**

- Insufficient local knowledge.
- Financing programmes is dependent on external funding
- Programmes are not integrated into national development process.

**D Development of transfer of environmentally sound technologies**

- Insufficient local knowledge
- Technical Needs Assessment yet to be undertaken
- High cost of technologies and limited finances for procuring ESTs
- Limited technical knowledge on ESTs that are compatible with local conditions.

**E Research and Systematic Observation**

- Need for ongoing training and capacity building in weather and climate research.
- Is dependent upon a small department
- Expensive equipments
- High maintenance costs

**F Public Awareness, Education and Training**

- Is subject to availability of personnel.
- Awareness needs to move on from general knowledge of climate change concerns and issues. The level of awareness needs to expand in key sectors such as adaptation and mitigation.
- Lack of collaboration of information and linkages of climate change issues between sectors.
- Lack of documentation on links between climate change and local knowledge.
- Lack of premises to arrange and carry out climate change activities for the public. A Climate Change Centre would be appropriate to undertake, store, report and conduct all climate change work.

**G Integration of Climate Change work into sustainable development programmes**

- Limited climate change knowledge at policy level
- Climate change goals are still considered a peripheral issue.
- Climate change concerns do not feature in all departments corporate plans.
- National priorities either depend upon the government of the day or issues that would attract external funding support.
- Financial constraints prevent other sectors from implementing climate change activities in their development programmes.

**H Information and Networking**

- Susceptible to power outages
- Is reliant on a small team that exists to service all government departments
- High maintenance cost
- Lacks policy or legal protection.

**I Capacity building**

- Limited human resources in climate change to train local experts
- High staff turnover and limited tertiary education opportunities for prospective students

# Chapter 13:Conclusions and Recommendations

The Niue National Strategic Plan 2009-2013 stated that its objective is "to build a sustainable future that meets our economic and social needs while preserving environmental integrity, social stability, and the Niue culture."

This Second National Communication reflects a substantial effort by Niue to provide the basis for the achievement of that objective by looking to current circumstances and future needs.

The Niue National Workshop of April 2007 established a ranked list of actions necessary to adapt to climate change in Niue that list is reproduced as Table 4 in Chapter 4 of this Communication. The list is extensive and indicative but not exclusive. The list contains both general and specific actions. The following list of recommendations is more general in nature but reflects the general goals of the conclusion of the National Workshop.

### *Recommendations*

It is recommended that:

1. continued and urgent steps be taken to protect the marine environment and marine resources of Niue, including total or partial closure of marine areas, protections for selected species of marine flora and fauna and tightened controls on fishing activities;
2. strategies for population retention and growth be developed and maintained;
3. there be continued efforts for and government promotion of healthy lifestyles;
4. Niue health resources be improved with a review to reduction of health referrals to New Zealand;
5. all legislation be reviewed, reformed and updated as necessary to fully support the endeavours to protect the environment for the benefit of present and future generations, including early enactment of the Tāoga Niue and the Vagahau Niue Bills, the Meteorology Bill, the new water resource law and the Forest Bill;
6. new endeavours be made in respect of land registration and the identification of land use with a view to better utilisation of the land resource;
7. steps be taken to use the most recent satellite imagery for a comprehensive forensic reclassification of land use;
8. spatial data regarding agriculture be fully characterised for the purpose of defining soil emissions;
9. the government continue its measures to increase the penetration of use of renewable and low-emission energies;
10. the data on harvesting practices in relation to locally sourced food and material for handicrafts be updated as a matter of urgency;
11. the asbestos sheeting and associated contamination be contained and removed at the earliest possible time;
12. appropriate data be collected to support decision-making about the cost effectiveness of renewable energy technologies and interaction with the existing electricity grid;
13. education programmes and studies be undertaken to encourage and support household energy efficiency;

14. the government cooperate closely with developed and developing countries to access information and support on environmentally sound technologies;
15. all environmental initiative be closely integrated into the annual budgeting process of the government;
16. appropriate arrangements be made for the continued management of Niue's environmental policy through an appropriately staffed and resourced National Climate Change Office;
17. the ICT capacity of Niue be fully developed;
18. study scholarships be made available for specialised training in climate science.

# Annex

# List of Projects for Bilateral and Multilateral Funding

Below is a list of project activities suitable for bilateral or multilateral funding. Detail information can be provided by request to the NCCP.

**Part 1: General Project Activities**

1. A centre for Tāoga Niue Resources and Cultural Activities
    - Improved knowledge will strengthen national identity and improve national planning processes.
    - Construction of a Museum, Archives and Cultural Centre previously destroyed by Cyclone Heta 2004. Keep and maintain local knowledge and encourage cooperation between sectors.
    - Cultural Centre to educate and increase awareness in Niuean heritage and how it may link or address climate change issues.
    - Leadership opportunities and empowerment of youth, women and minority populations.

2. Climate proof meteorology department.
    - Secure building
    - Facility for maintenance of equipment
    - Network rainfall stations island wide
    - Solar powered backup systems

3. Disaster insurance scheme
    - To assist in recovery from disasters, to reduce risk to investors
    - Regional mechanism under consideration

4. Maintain, where necessary improve, and test cyclone tracking, warning, planning, response and recovery systems
    - Including a full-time disaster management officer

5. Strengthening structures on west coast
    - Wharf, derricks, roads, sea tracks, buildings
        - Need to design for stronger cyclones
        - Need careful engineering assessments to ensure structures can withstand cyclones

6. Relocation of vulnerable infrastructure from coast
    - Bulk fuel
    - FaleFono-Niue Legislative Assembly Building
    - Commercial Centre
    - Relocation of the Niue Primary School
    - Upgrade of the Niue High School

7. Improve transport and road system
    - Technical knowledge and equipment for road repair
    - Include cycling lane on main roads to encourage cycling
    - Seal inland roads and bike tracks to allow for closer travel between destinations

8. Review and enforce building codes
    - Additional costs of stronger buildings is minimal, costs of poorly constructed buildings is high.
    - Establishment of a building and construction training institution to be conducted by local expertise
    - Local construction expertise and companies to undertake construction projects
    - Improve plumbing standards to avoid water wastage
    - Financing opportunities for new home owners and home relocation
    - Lower shipping costs for building materials to increase access to building materials

9. Relocation of villages and infrastructure on lower terrace, western side, to top terrace
    - This will be expensive and hard to plan and manage successfully. Analogue in move of Fatiau to Vaiea
    - Town Planning – separate residences from public facilities and vice versa.
    - Land valuation
    -

10. Dedicated evacuation centres and emergency supplies
    - Need for proper facilities

11. Procurement and Maintenance Facility for the maintenance and keep of all government structures.
12. Centralised database system for national data and information.
13. National Education and Awareness Facility for all sectors to access financing for activities.
14. Support for private sector and community involvement in climate change awareness concerns.

**Part 2: Project and activities to improve the agriculture sector are as follows;**

1. Drought resistant cultivars
    - Especially of taro
    - Maintain plantings of drought tolerant crops such as cassava and yams
    - new taro cultivars may have export value, little additional cost to maintain plantings of drought resistant crops

2. Sustainable agricultural practices such as mixed cropping, mulching, composting
    - Especially in house gardens, and for vanilla
    - Already happens to some extent
    - costs are minimal, leads to sustainable yields, and reduces need for fertiliser and pesticides

3. Water bores for sustained plots
    - For example, co-location of vanilla plots supported by bores and drip irrigation in times of drought
    - Risk is if vanilla industry fails to sustain returns

4. Soil moisture monitoring and warning system
    - costs minimal, drought is already a problem, and information dissemination is easy

5. Value adding to proven crops
    - Especially taro, e.g. taro chips, vanilla, e.g. essence
    - Increase value from natural resource, alleviate constraints of perishability on supply, more value per transport cost, increase employment
    - Stranded assets if market fails

6. Tree planting

- Support for existing nurseries and improve local knowledge on fruit bearing trees such as mangoes, lychees, avocado etc.

**Food Security:**

7. Maintain nutritional awareness programs

- Encourage consumption of diverse local foods
- Emphasise local chicken, and drought resistant root crops such as cassava and yams
- Niueans are prone to micronutrient deficiencies and obesity, reduce consumption of imported foods

8. Consumption taxes on unhealthy foods

- Should help switch consumption to cheaper and healthier local foods, if not then increase tax revenue

9. Promote household gardening and install household rainwater tanks

- Improve food security, nutrition, and decrease household spending on food
- Improve household water security, decrease water pumping costs in times of high rainfall

10. Emergency food pricing system

- Policy of ceilings on food prices, especially staples such as rice and fish, in times of shortages
- Government may need a right to be sole purchaser and distributor of taro, fish, and other staples in times of crisis
- Additional income support for vulnerable groups - e.g. elderly and low-income groups - in times of rising prices and/or short-term job losses

**Coasts and Fisheries:**

11. Protected reef and near-shore areas

- Permanent or seasonal 'no harvesting' areas
- To maintain biodiversity of coral and reef and artisanal species
- Needs to be balanced with tourist use (e.g. Limu)
- Balance of costs to fishers and gleaners with benefits to species resilience (hard to get this right)

12. Adaptive management of fisheries

- A learning-based approach to policy,
- Management as experiment
- Monitor stocks and seasonal adjustments in management practices
- Risky if data is not accurate, management responses depleting resources
- Monitoring and enforcement a problem

13. Value adding to marine resources

- Risk of stranded assets if markets fail

14. Integrated Coastal Zone Management

- A 'whole of coast' approach
- Coordinated decision making on coastal resource planning, development and management, including:
  - Reef and artisanal fisheries
  - Land use planning

- Water resource planning (especially waste water)

Requires inter-agency cooperation: DAFF, ED+P, Environment, Tourism, Public Works and Water can help address existing problems with bleaching and ciguatera

15. Monitoring systems:
    - Coral surveys
    - Fish surveys
    - Temperature and salinity observations
    - To improve understanding of system properties and feedbacks
    - Can reduce uncertainty for the purposes of management now

**Forests and Biodiversity:**

16. Protect primary forest with a no clearing buffer zone
    - To maintain biodiversity pool
    - Depends on demand for land use within magafoa lands surrounding the forest

17. Total fire bans
    - All burning prohibited on days of extreme heat and in dry spells

18. Fire truck and Huvalu fire volunteer service
    - Moderate cost to avoid potentially large damage

19. Individual Transferable Quota schemes for *uga* (coconut crab), *peka* (bat) and *lupe* (pigeon)
    - Determine annual sustainable catch and allocate quotas to registered households
    - Households can trade quotas
    - Catches above quotas cannot be sold
    - Risky if sustainable yields miscalculated
    - Monitoring and enforcement a problem

**Public Health:**

20. Disease monitoring system
    - Especially for climate-related illnesses such as filiarisis, diarrhea, ciguatera poisoning, heat stress; and watch for malaria and dengue
    - Disease monitoring systems are integral to effective health care systems

21. Develop and test a mosquito borne disease response plan
    - In the event of discovery of malaria or dengue

22. Maintain mosquito eradication programs at village level
    - Maintains tidy villages and mosquito bites are annoying!

23. Quarantine vigilance for mosquitoes
    - Impact of malaria and dengue may be very high

**Import substitution to alleviate trade gaps:**

24. Renewable energy to offset costs of diesel
    - 25% savings through solar p.v./wind water pumps
    - Wind turbines
    - Solar hot water

- Efficiency gains and energy savings (e.g. light bulbs, regular tuning of vehicles, shut down computers, building design)
- Potential to reduce diesel use by 60%

• Can save money for households and Government, many options are cost-effective, and diesel costs will only increase in the future

**Water Quality:**

25. National septic tank assessment and upgrade scheme
    - Already a source of contamination of water and may be linked to declining health of reefs and ciguatera

26. Comprehensive water quality monitoring program
    - Water division has a few test bores, but more necessary
    - Water pollution is a key risk to population and reproductive health in Niue

27. Detailed testing to map groundwater flows
    - Need to know where water and wastes travel

28. Solar powered water pumps
    - Reduce reliance on diesel powered electricity.

**Planning:**

29. Environmental Impact Assessment on all new developments
    - Simple screening and if necessary and more detailed study

30. The 'climate test'
    - Is the development climate proof?
    - Will it increase people's vulnerability to climate change?

31. Wave damage risk maps
    - Establish wave risk zones and disallow further building in these areas
    - Ban on building in areas known to have been affected by wave damage

32. Restrictions on activities based on groundwater flow maps
    - Site potentially contaminating sites (e.g. rubbish dumps) on sites where water does not flow to bores

**Tourism:**

33. Tourism development plan
    - Decisions about location of new accommodation and services to consider:
      - risk of cyclone damage
      - water contamination risks
      - pressure on coastal resources
      - duplication of services
      - distribution of returns'
    - Marketing and supply more important than climate

**Population:**

34. Population debate and policy
    - Niue needs more people, and climate change may increase demand for people to move to Niue.

- Need a national debate about: how many people? Who? Where will they live? What will they do? What will they need to settle in? What can attract people? What is needed to keep people? What are the benefits and costs of various options?
- Need a plan, with costs attached, that takes account of climate change impacts and opportunities.

**Information management:**

35. National library and archives

- Lots of information, everywhere, but identifying it and accessing it is piecemeal and very inefficient, and leads to duplication of information collection tasks
- A need to collect, catalogue, and safely store information (including electronically)
- Procedures for collecting and cataloguing consultants' reports, departmental reports, UN agency studies, academic studies, etc.

***Evening falls over Namukulu ramp***

# NIUE SECOND NATIONAL COMMUNICATION PHOTO DESCRIPTIONS

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COVER PAGE:

Chapter1: Introduction

- ***Double Rainbow over Niue skies***

Chapter 2: National Circumstances

- ***Vanilla flower, Tahitian variety (Vanilla tahitiensis) - One of Niue's agricultural export products***
- ***Sunset in Alofi harbour, with visiting yachts in the bay***
- ***Niue flora - A traditional indicator of a seasonal fish - Kaloama***

Chapter 3: GHG Inventory

- ***Communications infrastructure - Seikena tower***
- ***Scrap metal waste, awaiting shipment overseas***
- ***Clear skies at night***

Chapter 4: Programmes containing measures to facilitate adequate adaptation to climate change (i.e., Vulnerability and Adaptation Assessment for key socio-economic sectors)

- ***Spinner dolphins off the reef***
- ***Fuel Depot in Alofi damaged by Tropical Cyclone Heta 2004***
- ***Young athlete throwing a 'Tika' -a traditional niuean artform/sport***
- ***Generations combine, MP Va'ainga Tukuitonga and a young admirer***

Chapter 5: Programmes containing measures to mitigate climate change (i.e., mitigation options analysis for key socio-economic sectors)

- ***Sunset at lowtide beyond one of the sandy coves around Niue***

Chapter 6: Development and transfer of environmentally sound technologies

Chapter 7: Research and Systematic Observation

Chapter 8: Public Awareness, Education and Training

Chapter 9: Integration of climate change concerns into sustainable development Programmes

- ***Native fish species - Achilles tang (Acanthurusachilles)***

Chapter 10: Information and Networking

Chapter 11: Capacity-Building

- ***Keeping Niue connected - one of several wifi hot spots around the island***
- ***Wi-fi infrastructure maintenance by RockET systems***

Chapter 12: Constraints and Gaps, and Related Financial, Technical and Capacity Needs

Chapter 13: Conclusions and Recommendations

- ***Evening falls over Namukulu ramp***