UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

NIUE ISLAND Initial National Communication

NIUE CLIMATE CHANGE PROJECT

Government of Niue
June 2000

WMO UNEP UN GEF SPREP

NIUE CLIMATE CHANGE PROJECT

This is the Logo for the Climate Change Project. It was chosen from a number of entries by local Niuean competitors for the Logo Competition. This Logo was used as a letterhead in all Climate Change correspondence.

The meaning of the Logo is Niue Island amidst the elements that affects Niue's Climate and that is the Sun, Sea, Clouds, Vegetation, Land and Air.

INITIAL NATIONAL COMMUNICATION OF NIUE ISLAND

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

JUNE 18 – 05 - 2000

Foreword by the Premier of Niue Island

The Climate Change phenomenon is becoming increasingly a major concern to Niue, more so than was initially conveyed. It was for this reason that The Government of Niue ratified the Convention on Climate Change.

We are fully committed to the key principles and obligations as outline in the Framework Convention on Climate Change. But readers need to note explicitly that being a small Pacific Island Nation, Niue will endeavour to fulfil its role despite that fact that its economic and industrial activities are so minute and I believe, negligible, in contributing to the climate change scenario.

However, we are concerned with the underlying issues on Climate Change. In this context, the need to understand the subject due to its potential implications in the future has seen the people of Niue establish a great interest in Climate Change. Awareness has grown dramatically through all sectors of the island including private sector and non-government organisations. This enthusiasm is sincere despite our very limited resources to assist in the best possible manner available. It is with this understanding that we are able to contribute to the international and national strategies and efforts in our own unique way.

The "Niue Island National Communication" document, I trust is an excellent and historic reference for those interested in this work. It compliments our desire to continue supporting the international community to combat climate change.

I congratulated those involved directly or indirectly in the final product.

Kia Monuina

Hon Sani Elia Lagigietama Lakatani

PREMIER OF NIUE

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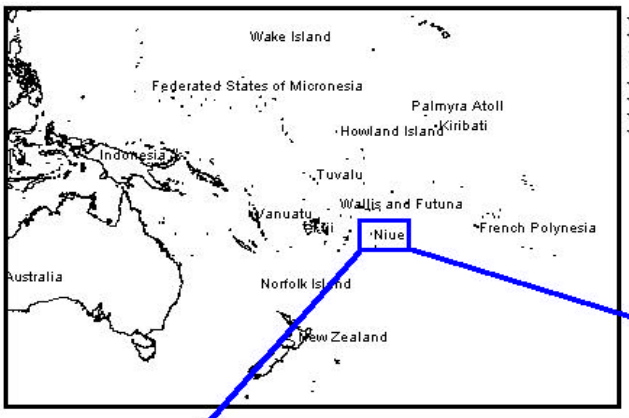
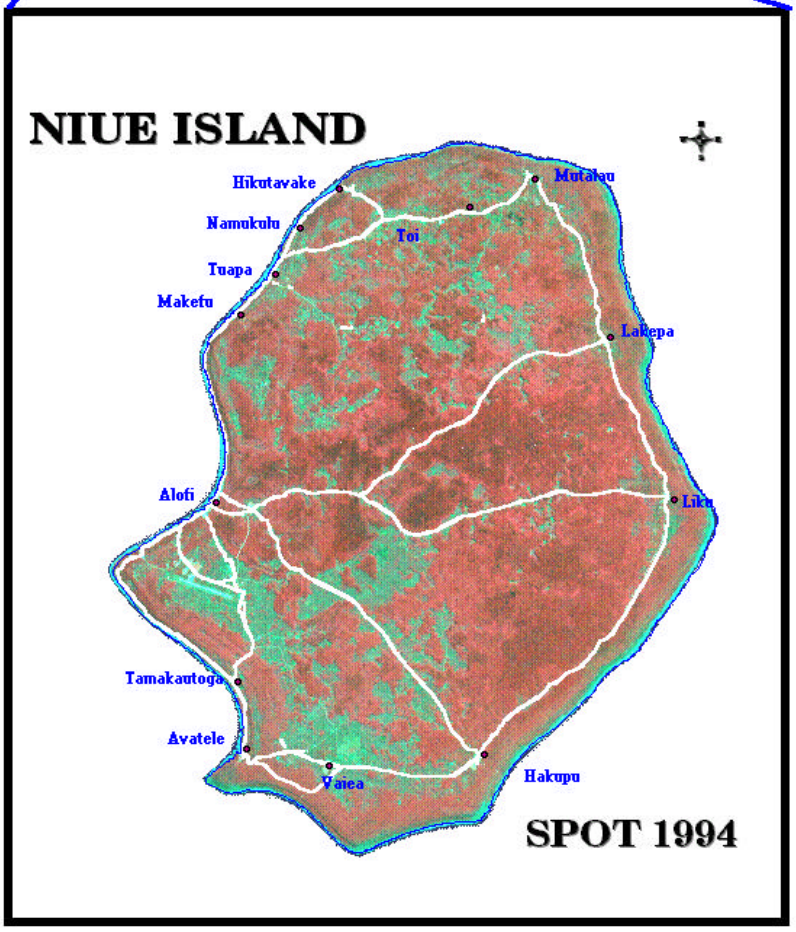


NIUE ISLAND IS SITUATED 169 LONGTITUDE AND 19 LATITUDE IN THE SOUTH PACIFIC OCEANIA GROUP



LIST OF ABBREVIATIONS AND ACRONYMS

GHG	*Greenhouse gas*
IPCC	*Intergovernmental Panel on Climate Change*
CO_2	*Carbon Dioxide*
SO_2	*Sulfur Dioxide*
Gg	*Gigagram*
EEZ	*Exclusive Economic Zone*
NEMS	*National Environmental Management Strategy*
Km	*Kilometer*
NOAA	*National Oceanic and Atmospheric Administration*
GOES-10	*Geo-stationary Observation Earth Satellite*
USP	*University of the South Pacific*
GDP	*Gross Domestic Product*
SOE	*State of the Environment*
kW	*Kilowatt*
UNFCCC	*United Nations Framework on Climate Change*
CFC	*Chloro-fluorocarbon*
HFC	*Hydrofluorocarbons*
PFC	*Perfluorocarbons*
H_2O	*Water*
CH_4	*Methane*
N_2O	*Nitrous Oxide*
O_3	*Ozone*
CO	*Carbon Monoxide*
NMVOC	*Non Methane Volatile Organic Compounds*
ICM	*Integrated Coastal Management*
DAFF	*Department of Agriculture, Forestry and Fisheries*

GLOSSARY

- *Moui Olaola* - *The Niuean Healthy Living Program undertaken by the Health Department where it promotes regular exercise, good diet, power walking, elderly sports activities etc.*
- *Magafaoa* - *Extended family*
- *Ciguatera* - *Fish Poisoning*

1.0 EXECUTIVE SUMMARY

1.1 National Circumstances

Niue consists of a single uplifted coral atoll with a unique rugged coastline. It is situated in the Southwest Pacific Ocean within the Polynesian cultural zone.

The population of Niue was 2,088 at the 1977 population census, and is a declining population due to outward migration. Niue lies on the edge of the southern tropical cyclone belt, and has two distinct seasons, a hot wet season from November to March and a cool dry season from April to November.

The economy is largely dependent on overseas aid, with no realistic prospect of economic self-reliance. However, there is a modest export production mainly comprising of taro and coconuts to New Zealand.

Agriculture, fisheries and forestry are at subsistence levels with current government policy focusing on eco-tourism and private sector development.

The predominant energy source is electricity and is provided by diesel powered generators. Although alternative energy sources have been investigated they are all currently under-utilised mainly due to the initial capital expense involved.

Trade and tourism to Niue is hampered by transport. Currently there is a weekly flight to Auckland via Tonga serviced by Royal Tongan Airlines. There is a small concrete wharf at Alofi, the capital of Niue, however the channel is too small to be navigated by the larger ships. The larger container ship's cargo is transferred by 'lighters' on a monthly basis.

Internal transport is mainly comprised of privately owned ships.

1.2 National Inventory of Greenhouse Gases (GHG'S)

This was the first greenhouse gas inventory for Niue, with 1994 being the base year used. Iterated throughout this chapter, it was felt that the IPCC guidelines and default values were excessive for such a small island nation with a negligible population base. In addition 1994 for Niue, is not a true representation of the actual greenhouse gas emissions due to major construction/development work undertaken on the island in that year.

Greenhouse gas emissions were mainly due from the combustion of secondary fuels, gasoline and diesel. CO_2 emissions from fossil fuels accounted for 99.1% of total GHG emissions of which power generation accounted for 50.5% and transport accounted for 48.1%.

Interestingly SO_2 was also a large contributing source of gas emission's, accounting for 32.1% of the total energy sector, of which the transport sector accounted for 99.4%.

Niue is still largely covered by tropical rainforests, with CO_2 absorption far in excess of CO_2 emissions. In fact 1.2×10^6 Gg of CO_2 is removed by Niue's woody biomass as opposed to the total CO_2 emissions from all sectors.

1.3 Vulnerability and Adaptation

As a small Pacific Island nation, Niue is at the forefront of the proposed climatic changes. It is particularly conscious of the predicted sea level rise and the increased incidence and severity of tropical cyclones. Associated with tropical cyclones is damage to existing infrastructure and the environment.

The predicted sea level rise threatens Niue's fresh water lens which is critical due to the non-existence of running surface water.

Climate change within the natural ecosystem such as the coral reefs and tropical rainforests may eventually lead to a change in species composition. Niueans are dependent on subsistent agriculture and fishing. Proposed climate changes such as increased precipitation, sea and atmospheric temperature rises threaten the nations food security. This may in turn lead to socio-economic problems such as health, increase in the national deficit coupled with diminishing social services eventually leading to outward migration.

Adaptation measures have been identified and are discussed at length in this first national communication. The adaptation measures discussed include the relocation of vulnerable infrastructure to areas of low vulnerability, increased research of marine/terrestrial flora and fauna with respect to climate change, establishment of database and information systems for accurate monitoring and data collation. It has been noted that such measures are costly, time consuming and often difficult to implement.

1.4 Mitigation

Effective mitigation options for Niue will have to be largely focussed on the transport and energy sectors, the major contributors of GHG emissions. The majority of the mitigation options identified are readily and easily implemented such as the encouraged use of low energy rated appliances, use of compact fluorescent light bulbs, enforcement of maximum speed limits and the encouragement of carpooling. Whilst other mitigation options, waste management and exploration of renewable energy resources will be timely and may involve significant establishment costs.

1.5 Capacity Building

Although Niue has a well educated, highly literate population, it is a very small population base and can in itself be identified as the major limiting factor to the capacity building of the nation.

A survey compiling a National Inventory of Skills of Public Servants identified a need for on-going technical training in sector analysis, climate change science, negotiations and policy making.

1.6 Education and Public Awareness

Due to Niue's geographical size, small population base and high literacy rate, Climate Change and its Impact, were easily disseminated and comprehended. Information was disseminated through print, radio, television and competitions. Both the Niue Primary and High Schools were actively involved to such an extent that one day was set aside for "Climate Awareness Day".

A good basis of community awareness and formal education has been established, however it is important to maintain and increase public awareness with issues pertaining to climate change.

1.7 Government Measures and Policies to Limit Emissions and Enhance Sinks

Niue has a very comprehensive energy policy, with the overall objective of energy efficiency with minimal environmental impact. The National Forest Policy for Niue has yet to be passed by Cabinet, in which it provides guidelines on the regulation and implementation over programmes and activities for the use, management and conservation of the forest resources of Niue.

Niue Assembly House

2.0 National Circumstances

2.1 Background

Niue is the world's largest and highest single coral atoll situated in the Southwest Pacific Ocean at latitude 19º south and 169º west.

The land area is comprised of 259 km2.

The Exclusive Economic Zone (EEZ) of Niue is 39,000km2 of the South Pacific Ocean. Within its EEZ Niue has two atoll reefs, Antiope and Beveridge, visible only at low tide. Commercial fishing is banned.

2.2 Geography

Niue lies approximately 480 km east of Tonga, 930 km west of Rarotonga in the Cook Islands and 660 km south east of Western Samoa.

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

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

There is no surface water on Niue, but artesian bores enable a subterranean reservoir of fresh water to be tapped for domestic commercial and agricultural purposes.

2.3 History

Niue is in the Polynesian triangle of the South Pacific. Its culture and language strongly related to that of neighbouring Tonga and Samoa.

It is thought that Niue was probably first settled more than 1000 years ago by successive migrations of Tongans, Samoans, and the Cook Island Maoris of Pukapuka Island. However the recorded history of Niue dates only from the mid-18th century.

The discovery of Niue by Captain Cook in 1774 was received with such ferocious hostility by the natives that he named it "Savage Islands". This reputation, justified or not, provides a possible explanation for the infrequent contact with outsiders during that period.

It was not until the mid-18th century that contact with the outside was firmly established. Missionaries figured prominently in the Pacific during this period. Niue was evangelised in 1846 by their own missionary, Peniamina, who was trained in Samoa. The period immediately after this saw the arrival of European missionaries, more notably George and Frank Lawes, who exerted greater influence and therefore made more changes to the Niuean community.

One result of their influence was the petition sent to Queen Victoria requesting British protection for Niue. The Niuean people were successful on their third petition submission, 21 April 1900. Sir Basil Thomson on behalf of Her Majesty signed the Treaty of Cession and hoisted the British flag on Niue.

The following year, 1901, New Zealand annexed Niue as part of the Cook Islands. Niue was governed by a succession of Resident Commissioners until 1974 when Niue chose self government in free association with

New Zealand rather than full independence from or political integration with New Zealand. The Constitution came into force on 19 October 1974. Niue has full control over domestic and external affairs, and legislative power rests in the democratically elected Niue Assembly. [the Fono Ekepule]

As a consequence of the Niue Constitution Act 1974 (NZ) an the citizenship Act 1977 (NZ) persons born in Niue or descendents from persons born in Niue are New Zealand citizens and have a right to New Zealand passports. There is neither a separate Niuean citizenship nor a Niuean passport. The right to New Zealand citizenship with free entry to and from New Zealand is a major factor in the current political arrangement between Niue and New Zealand.

The Premier is a member of the Niue Assembly elected by the Assembly at its first meeting after a general election or whenever the office of the Premier is vacant.

The executive power of Niue is exercised by the Cabinet, which comprises the Premier and three other members of the Niue Assembly, selected by the Premier.

The Niue Assembly, established under the under section 16 of the Constitution consists of fourteen members elected from village constituencies and six common roll members.

Elections are held every three years.

2.4 Climate

Niue lies on the edge of the southern tropical cyclone belt and in the zone of the southeast trade winds, and hence is subject to strong gale force winds. There are two distinct seasons in Niue, the hot wet season from November to March, characterized by high temperatures and humidity, and the cool dry season from April to November, characterized by warm sunny days and cool nights.

The hot wet season also coincides with the tropical cyclone season.

2.4.1 Rainfall

The average rainfall is approximately 2,180mm but can vary from 810 to 3,300mm per annum. The bulk of rainfall is concentrated in the wet season often delivered in torrential downpours which accounting for 68% of the total annual rainfall.

However the annual rainfall pattern is erratic, with very dry or very wet months possible at any time of the year.

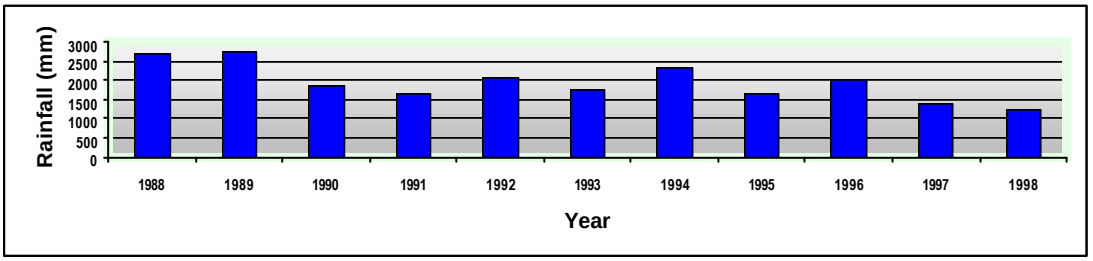


Fig 2.2 Annual Rainfall for Niue

2.4.2 Temperature

Annual average temperature does not vary greatly throughout the year due to the influence of the sea on a small low-lying island.

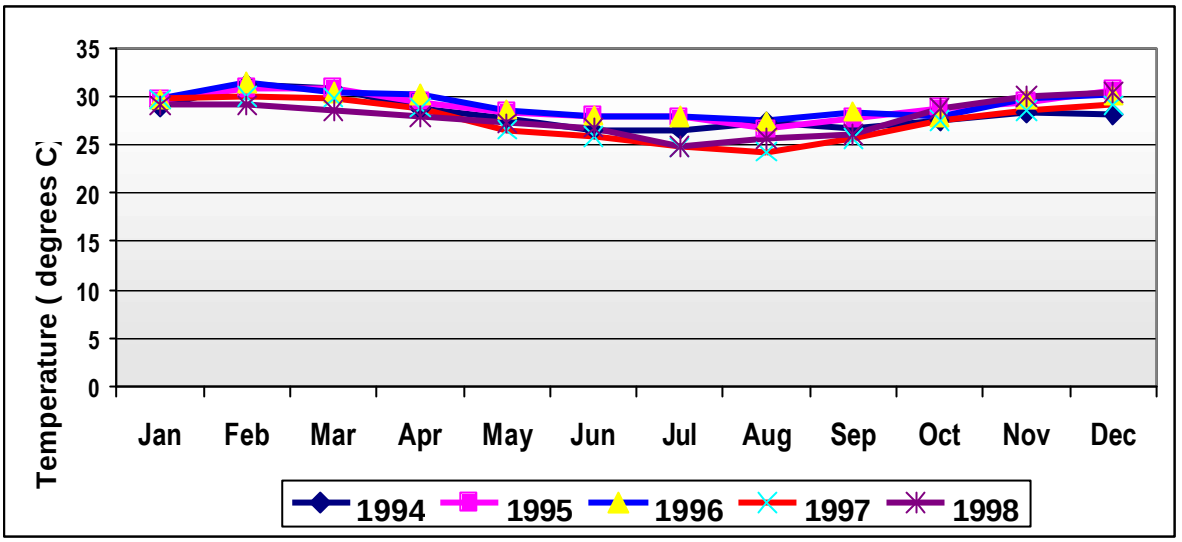


Figure 2.3 Mean Monthly Temperature

At the height of the wet season mean daily maximum temperature is 30ºC (January/February) with a mean daily minimum of 23ºC.

In the dry season the lowest mean daily maximum is 26ºC and a mean daily minimum of 19ºC

2.4.3 Weather Systems Affecting Niue

The tropical cyclone season officially start on the 1 November to 1 March. All tropical cyclones begin as tropic depressions over warm oceanic waters covering an area of 200 – 400 km. A substantial number of tropical depressions do not reach the cyclonic stage. Tropical storms begin with an increase in wind speed (63 – 87 km/hr to 88 – 117 km/hr) and follow a spiraling path towards a distinct centre. The eye measures 5 – 15km across.

Tropical cyclones are evaluated using several objective criteria:-

- *Minimum pressure*
- *Wind speed – measured over five, three or one minute gusts or in a single gust.*
- *Rainfall - quantity and intensity*
- *Area/diameter of widest closed isobar and/or isobar of 1,000 millibars and/or area/diameter of winds greater than 87 – 117km/hr.*
- *Point of origin and characteristics of the track*

Table 2.1 Windspeed Categories

Class	Wind Speed Range (km/hr)
Gale Force	63 – 87
Storm Force	88 – 117
Hurricane Force	118+

Niue lies in the path of the Southern tropical cyclone belt (10° South) and has been subjected to severe cyclones on average of one every ten years.

Niue's prevailing winds blow from the east to the south influenced by the zone of the South East Trade Winds which are at the edge of the tropical cyclone belt. The strongest winds usually occur in the first four months of the year now commonly referred to as the cyclone season. This is, however, not a rigid natural phenomenon as a cyclone threatened Niue in June 1987, well outside of the cyclone season.

2.4.4 Tracking of Tropical Cyclones

Tropical cyclones are tracked via satellite images: the NOAA polar orbiting satellite and the GOES-10 geo-stationary satellite. This information is relayed to Niue Telecommunications Centre from the Regional Meteorological Centre in Nadi, Fiji.

In the event a tropical cyclone occurs within the region, a tropical cyclone tracking map is used, based on an alpha-numeric system.

As a tropical cyclone nears and poses a potential threat to Niue, cyclone warnings are issued to enable inhabitants to take the necessary precautions.

The cyclone warning system is based on a series of colour codes each being determined by the degree of severity of cyclonic conditions and associated dangers.

CODE BLUE:

Linked to Readiness Phase: Issued when the cyclone threat has increased, and gale force winds are expected within the next 24 hours. This is a general warning to the community that a cyclone is in the area and preparedness action should commence.

CODE YELLOW:

Linked to Standby Phase: Issued when the threat has further increased, with storm force winds and destructive winds a distinct possibility within the next 12 hours. The most significant action during this phase is be the closure of schools, the commencement of final preparedness for government buildings and the gradual release of non-essential staff.

CODE RED:

Linked to Activation Stage: Issued when the cyclone impacts and the threat of destructive winds are imminent. When a Red Alert has been issued the cyclone is imminent or has already hit the island.

These cyclone warnings are disseminated through the press (if time permits), radio, television and telephone/fax.

TROPICAL CYCLONES WHICH AFFECTED NIUE FROM 1830-1997

Table 2.2

YEAR	MONTH	SEVERITY
1863	11 January	Unknown
1915	13 March	Severe
1920	18-19 January	Minor
1929	18-28 January	Moderate
1944	30-31 January	Moderate to Severe
1946	16-18 January	Minor
	25-26 December	Minor to Moderate
1948	07-11 December	Moderate to Severe
1955	02-03 January	Minor
1956	01 January	Minor
	17-18 February	Minor
1957	04-06 February	Severe
1959	25-26 February	Severe
1960	17-18 January	Moderate to Severe
1968	09-10 February	Severe
1970	17-23 February	Unknown
1972	18-21 January	Unknown
	31 Jan 05 February	Unknown
1973	07 November	Unknown
1974	25-28 April	Unknown
1979	10-15 December	Severe
1983	29 March – 03 April	Minor
1987	22-26 April	Minor
1988	22-26 April	Minor
1989	02 – 07 January	Minor
	06 – 09 January	Moderate
	07 – 14 February	Severe
1990	30 January – 07 February (OFA)	Very Severe

2.5 Population and Welfare

2.5.1a Population

The Niuean people are of Polynesian descent and are thought to have originated from the neighbouring Polynesian islands of Tonga, Samoa, and Pukapuka Island of The Cook Islands. Christianity is the major religion of Niue. Almost all Niueans are bilingual, with both English and Niuean being the official languages.

The population of Niue was estimated at 2,088 people on 17 August 1997: 1,053 men and 1,035 women, with a population density of 8.1 persons per km2.

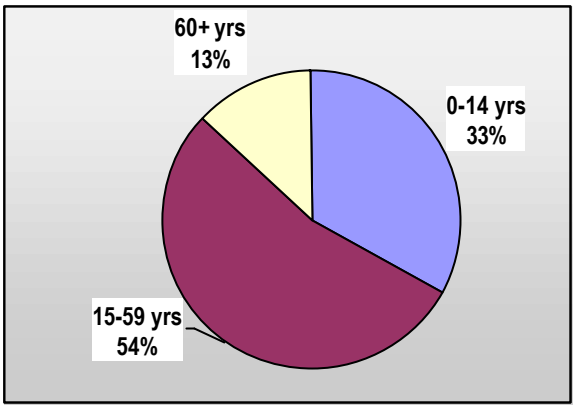


Figure 2.4 Age Distribution of the Population

The average life expectancy for either sex combined is estimated at 69.5 years and Niue's infant mortality rate is estimated at 17.5 deaths per 1000 live births. (1997). Niue's population is too small to compile different life tables for males and females. However only 105 of all males 60+ years were widowed compared to 37% of females of the same age.

Migration has been the major factor in the fluctuation in the island's population. As a result Niue has a negative population growth rate of –1.2% per annum. Without migration, natural increase of the Niuean population would be approximately +1% per annum.

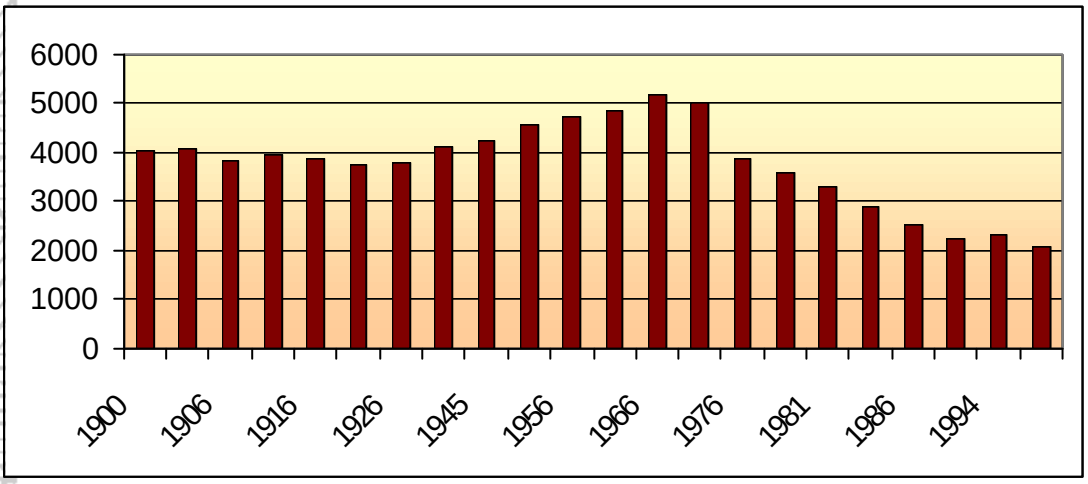


Figure 2.5 Shows Niue's Population Changes From 1900 to 1997.

Following a period of stability up until the 1930's Niue's population increased to an all-time high of 5,194 people in 1966. After which it decreased dramatically until the late 1980's (as a result of the opening of Niue's Hanan International Airport in 1970, when many people took the opportunity to migrate to New Zealand).

Since 1991 the population of Niue has been reasonably stable. Its first population increase for 30 years in 1994 (1994 Mini Census) was followed by a further decrease to reach its lowest level ever in 1997.
Niueans are New Zealand citizens, and as such are permitted to travel to and from New Zealand freely. Almost nine times as many Niueans live in New Zealand as Niue itself. The 1996 New Zealand Census counted 18,474 Niueans in New Zealand, the majority of which live in urban Auckland (77%).

2.5.1b Welfare

Niueans in comparison to a lot of other Pacific Island countries have a high standard of living, indicative of their life expectancy, literacy and infant mortality rates. In addition the majority of residential dwellings have access to electricity, safe running water and sanitation.

There are 13 villages situated around the coast of the island. Alofi is the capital and is divided into two sub-villages, Alofi North and Alofi South. Alofi on the whole has the largest population of 732 people. All major medical, educational, financial institutions, communication, entertainment facilities and most importantly employment opportunities are located in Alofi.

The small size of Niue generally allows people living in other villages to reach Alofi in a relatively short time subject to availability of transport.

Within each village there is a mix of income groups, and strong mutual support amongst extended families.

There is no welfare benefit for the unemployed, with benefit payments restricted to school age children up to 16 years, old age pensions and in extenuating circumstances a widow/widowers and a disability allowance may be available.

2.5.2 Education and Training

The education system is based on the New Zealand model, and contains similar achievement objectives.

Education is compulsory between the ages of 5 to 14 years. Educational development is a high priority for the Government of Niue, with a 99% literacy rate. Since 1989, primary schools have been centralised in Alofi, due to the declining number of pupils in the outer villages. There is only one secondary school also situated on the outskirts of Alofi. The Government wishes to introduce compulsory, free education, while incorporating Niue's traditional arts and crafts and promoting bi-lingualism.

The University of the South Pacific (USP) extension centre is located next to the Niue High School, and is the only post secondary education facility on the island. The USP offers extension courses at the diploma and degree level in addition to vocational and community level education programs.

Other students pursuing tertiary qualifications travel abroad, often on scholarships awarded (through bilateral aid programmes from New Zealand, Australia and World Health Organization) to attend institutions in Fiji, New Zealand and Australia.

2.5.3 The Economy

Niueans are highly dependent on cash income generated from the public sector, which is subsidized by budgetary support from New Zealand.

There are no formal regular estimates made of GDP, national accounts or sector accounts. It is expected that a system of real GDP indicators will be established in the near future to provide an indication of real activity. Surveys of household or business activity are limited to a five yearly census, with a mini-census held in the intervening two and half years. Other measures of activity are confined to visitor data, accommodation survey, prices and a five yearly agricultural survey.

The last estimate of the GDP was made for the 1990/1991 June Year. Since then there has been considerable structural change in the economy. Government has downsized by more than 50% and this includes Government activities being corporatised or privatised. Furthermore there has been some growth in tourism and exports of taro in over recent years.

Rough estimates for 1994 indicated that the overall real GDP has declined by 2.5% to 3.5% per annum for the previous three years. The rise in inflation during the same period will not have been sufficient to offset this, so that GDP for 1995/1996 is likely to be in the order of NZD$11.0 million.

New Taro Plantation

Huvalu Forest Corridor

Table 2.3 Economic Indicators of Niue

Economic Indicators	
GDP	US $8 million (1994 estimate)
GDP/Capita	US $3447 (1994 estimate)
Imports	US $3.8 million (1994 estimate)
Exports	US $0.3 million (1994 estimate)
Currency	New Zealand Dollar

Source: South Pacific Trade Directory 1998/1999

The labour force is comprised of some 50% of the population (between the age of 15 and 59 years), of which 51% of the labour force is within the public sector, and 4% are unemployed. Many people are engaged in subsistence farming and therefore are not recorded in the official statistics for paid employment.

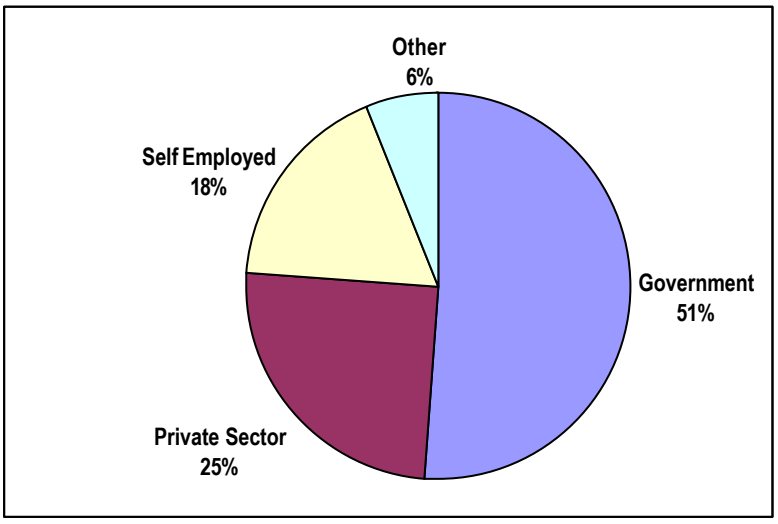


Figure 2.6 Employment Status of the Formally Employed Population
Source: Niue 1997 Census

The Government of Niue accepts that there is no realistic prospect of economic self-sufficiency. However current development policy focuses on tourism and private sector development through increased employment opportunities and agriculture production as mechanisms to reduce aid dependency.

2.5.4 Agricultural Sector

The coral atoll origins of Niue have left it with a scenic coast line but with limited soil depth and fertility. Throughout the island, the soils are of marginal fertility for intensive agriculture and long-term mono-culture. Much of the land is covered with fern growth, which again indicates the poor structure and nutrient content of the soils (NEMS 1997).

Thirty to forty percent of Niue's land is unsuitable for agriculture while those areas under cultivation are only at the subsistence level. Farming is centered on bush gardens, which are cleared by bulldozers with taro as the predominant crop. Taro production evolved as a modest export product to New Zealand and has increased of late. Other crops grown include cassava, sweet potatoes and yam. Small quantities of coconut, lime, banana, fruit and vegetables are also cultivated mainly for domestic use. Ongoing research is currently being undertaken to develop other cash crops such as vanilla for export or for processing. Livestock raised include chickens, pigs, and a small number of cattle.

Fishing activities are also at a subsistence level due to the limited inshore fishing resources. Niue's fishing grounds are not particularly fertile as there is little surface runoff to provide nutrients. The island is also situated on a relatively barren seamount, with limited access to deep-sea resources.

Fishing activities are further hampered by difficult access to the sea via the rugged and steep coastline. The exposure of unprotected nature of the coastline to the open and sometimes very rough seas, the absence of natural harbours or lagoon systems are added obstacles.

Current exports of fish are solely on the basis of Niueans exporting cooked or frozen fish for friends and relatives in New Zealand (NEMS 1997).

2.5.5 Tourism Sector

Although Niue's tourism is still in its infancy, it is the key element in Niue's development strategy. In 1993 there were 3,358 visitors, the majority of which were in the holiday and vacation category. Subsequent loss of airline services saw visitor numbers fall dramatically, to 1,522 in 1996. New services were instituted from late 1995 by Royal Tongan Airlines, which now provides a weekly service from Auckland, New Zealand, and another service from Tonga to Niue.

Tourism facilities are limited, with accommodation dominated by the government owned, but privately operated, Niue Hotel and the Matavai Resort. Other activities comprise of four rental agencies, four tour operators, one dive operator and four handicraft shops.

Table 2.4 Tourist Arrivals to Niue

Year	Number of Tourists Arriving in Niue
1989	481
1990	649
1991	993
1992	1668
1993	3358
1994	2802
1995	2161
1996	1522
1997	1820
1998	1399

Source: Niue Statistics Department

2.5.6 External Trade

Niue is dependent on imports for all consumer and capital goods apart from food staples and basic timber construction materials. New Zealand is by far Niue's largest trading partner, though Australia and neighbouring Pacific Islands also provide a source of imports and export destinations to a small degree. Of these, Fiji is the largest, being the only source of bulk petroleum fuels.

Exports are largely comprise of taros sold in New Zealand, and more recently to American Samoa. Small quantities of honey, dry coconuts and bananas, vanilla and yams are also exported to New Zealand. Significant volumes of taro, green coconut and coconut crab (an estimated two tonnes/year) are also carried by passengers to New Zealand, as gifts for relatives or for informal resale.

A major component of "consumer goods" production are handicrafts . These are exported on a small scale to New Zealand, Australia and Hawaii.

2.5.7 Energy

Natural Energy Resources are limited, with no traditional mineral or hydro-based resources available. Niue imports all its petroleum products; the main ones are diesel, gas and petrol. Diesel is mainly consumed in the electricity and transport sector. Bottled gas is the most common energy source for domestic cooking and has replaced the earlier charcoal and kerosene burners to a large extent.

The predominant energy source is electricity, provided by diesel-powered generators. Four of these are located in a central powerhouse with a total installed capacity of 1,684kW, with 45% of the power produced being consumed by the Government sector.

Opportunities for alternative energy sources have been investigated and include wind generation, solar power and sea and tide movements, both marine and through the water lens. Are all currently not yet developed, due to lack of funds.

2.5.8 Water

There is no surface water on Niue. Rainwater seeps down to an underground lens that is pumped from fifteen bores into header tanks or reservoirs and then reticulated untreated to houses in each village.

Periodic water quality testing by the Health Inspector indicates that there has been little change in quality over time in terms of pH, temperature, sulphate, iron, chloride and nitrate content.

The water is generally of good drinking quality but has high levels of iron content present. However, a number of agricultural practices, in particular the use of chemicals (biocides and fertilizers) and the keeping of livestock pens close to where water is extracted, are a threat to quality. (NEMS 1997, SOE 1994).

2.5.9 Transport

Transport is a great barrier to both trade and tourism for Niue, as with many other small Pacific Island Countries.

A 64km coastal circuit road passes through 13 villages. There are also two major cross-island roads both of which are sealed, with a total of distance of 230 km. The majority of the roads are sealed and are maintained to a high standard.

There is no natural sheltered harbour. However a small concrete wharf has been built at Alofi. A channel has been constructed through the narrow, fringing coral reef surrounding the island to service the wharf but is not navigable by larger ships. Smaller vessels are able to approach the Alofi wharf, with the larger monthly container ships' cargo being transferred to the wharf by lighters.

Niue's Hannan International Airport was built in 1970, and was later extended in 1994 to accommodate the 737's, to a 2,335m runway in asphalt concrete. Currently there are twice weekly flights serviced by Royal Tongan Airlines to Niue from Auckland and Tonga.

Internal domestic transport is mainly comprised of privately owned vehicles, with no formal public transport system in operation. The exception being the transportation of High School and Primary School students to and from school on buses.

Table 2.5 Distribution of Vehicles on Niue (1999)

Type of Vehicle	Number of Vehicles
Light and Heavy Trucks	239
Buses	13
Cars	386
Motorcycles	214
Vans	225
Tractors and Trailers	9
Government Vehicles	51
TOTAL	1137

Source: Niue Police Station

2.6 Land Use Change and Forestry

Niue was originally covered in dense tropical rainforest. Extensive areas of fern dominated shrub land and regenerating forest have now replaced much of this forest.

Niue is still largely covered by tropical forests, 18,200 ha or 64% of the island (this includes both primary and secondary re-growth). Thus at 8.7 ha of forest per capita, Niue has one of the highest forest areas per inhabitant amongst island countries of the Pacific Region.

The expansion of agriculture is one of the chief causes of deforestation, and this is prevalent in Niue. The key agricultural activity in Niue is the growing of taro for export, resulting in large areas being cleared.

There is a growing concern at the progressive decrease of indigenous forest area. Over the last 30 years, the people of Niue have cleared an additional 22% of the indigenous forests, a reduction in the overall forest cover from 86% to 64% of the island. This is equivalent to a rate of deforestation of 0.9% of the 1966 forest cover each year. This deforestation occurred when Niue was undergoing its most rapid depopulation and coincided with a need to increase cash income. Improved technologies for land clearing, (such as the use of bulldozers), and more intensive agricultural practices, such as mono-cropping of taro for export as well as increased use of agricultural chemicals have also contributed to this process.

Table 2.6 Niue Vegetation Types by Area

Vegetation Type	*1966 (ha)*	*1981 (ha)*	*1999 (ha)*
Open areas	3,200	7,800	
Coastal Forest	2,500	3,000	
Light Forest	14,000	12,000	
Merchantable Forest	5,500	3,200	

Source: State of the Environment Report 1994

2.7 Environmental Unit

There is a local timber industry that has an annual harvesting of 230m^3, and is well within the sustainable level of the indigenous forest of Niue. The local timber industry is small in nature but is supportive of the sustainable concepts and methods of harvesting.

A National Forest Policy is currently being implemented for Niue enabling guidelines for the conservation and sustainable development of the forest on the island.

2.8 Biodiversity

Due to its isolation and distance from the other islands in the Pacific, Niue has limited naturally occurring fauna and flora. These factors also contributed to the relatively small number of foreign species introduced into Niue in the past several years.

2.8.1 Flora

Niuean plant species have been researched and documented, however there has been no recent work done on the relative abundance and distribution of species.
In the 1943 Survey of plants, T.G.Yunker identified 456 species of vascular plants excluding cultivars in the flora of Niue Island publication; it was assumed by later studies in 1965 by W. R. Sykes that the records were fraught with errors of identification. An updated account lists 629 types of a variety of vascular species, which consists of an estimated 175 indigenous species and a few cultivars.

2.8.2 Forests

2.8.2a Inland Rainforest

This forest is composed of both original primary forest and modified mature growth. Closed canopy high stature forest is found throughout and is largely dominated by two tree species, *Syzgium inophylloides* (kafika) and *Syzgium richii* (kolivao). Other common species include *Dysozylum forsteri* (moota), *Planchonella torricellensis* (kanumea), *Pomentia pinnata* (tava), *Macaranga seemanii* (le) and *Fiscus prolixa* (ovava). Major understorey trees include *Polyscias multijuga* (tanetane vao), *Streblus anthropophagourm* (atatu), *Merremia peltate* (fue vao) and epiphytic and ground ferns (kapihi, luku and mohuku tane).

2.8.2b Coastal Forest

Coastal forest is dominated by species similar to inland forest however they tend to be stunted as they are exposed to salty winds. Seaward, there is more open scrub and include species *Barringtonia asiatica* (futu), *Capparis cordifolia* (pamoko), *Timonius polygamu* (kavetutu), *Ochrosia oppositifolia* (pao), *Pandanus tectorus* (fa fi), *Scaveola taccada* (pao) and *Messerchmidia argentea* (taihune). Within 50 metres of the coast there is only *Pemphis acidula* (gigie).

Scattered areas and agricultural clearings are dominated by pioneering species such as *Hibiscus tiliaceous* (fou), *Morinda citriflora* (nonu) and *Macaranga harveyana* (le hau). Ferns are also present, the dominant species being *Nephrolepis hirsutala* (mohuku).

2.8.3 Fauna

2.8.3a Aves

The bird species presently breeding on Niue are of western Polynesian origin, and most are thought to have originated from Tonga or Samoa and comprises of 32 species that have been sighted or are known. The Polynesian triller (*Lalage maculosa*) and Polynesian starling (*Aplonis tabuensis*) have evolved into distinctive subspecies on Niue but all other birds are found elsewhere in the Indo-Pacific Region.

Two species are classed as endangered/ rare are the Spotless crake (*Porzana tabuensis*) as there have been no confirmed sightings since 1970. The Blue-crowned lory (*Vini australis*) is also rare.

The Pacific pigeon “lupe” (*Ducula pacifica*) is hunted from December to February and concerns have been raised with regard to the hunting pressure placed on this species.

2.8.3b Mammals

Indigenous species is the fruit bat/flying fox “peka” (*Pteropustonganus*) and the Polynesian rat (kuma). The ship rat was later introduced between 1900 and 1950.

Other mammal species include the humpback whale and spinnaker dolphin, in addition to the usual introduction of domestic mammals, cats, dogs, pigs, feral pigs, cattle and goats.

Of concern are the dwindling number of fruit bats, estimated at 2000 – 4000. The fruit bats are also subjected to hunting pressure from December to February.

2.8.4 Marine Resources

There are 243 marine fish species known. In addition to inshore resources, there are potential marine reef resources offshore within the EEZ including Antiope, Harran’s and Beveridge reefs.

2.8.5 Reptiles

There are 5 species of lizards, green and hawksbill turtles and recent records show sea snakes, skinks and geckos, as some of the commonest.

2.8.6 Invertebrates

A total of 376 species of insects belonging to 15 orders were identified. There are 6 crab species including the endangered coconut crab, giant clams and crayfish are plentiful and 2 species of sea cucumbers are among the biodiversity of Niue's ecosystem.

Vaiea Coconut Farm

2.9 List of Rare and Significant Species

Coconut Crab	"uga"	(*Birgus Latro*)
Fruit bat/ Flying Fox	"peka"	(*Pteropustongamus*)
Pacific Pigeon	"lupe"	(*Ducula Pacifica*)
Spotless Crake/ Sooty Rake	"moho"	(*Porzana Tabuensis*)
Blue Crowned Lory	"hega"	(*Vini Australis*)
Polynesian Starling	"miti"	(*Aplonis Tabuensis*)
Polynesian Triller	"heahea"	(*Lalage Maculosa*)
Kafika		(*Syzgium Inophylloides*)
Kanumea		(*Planchonella Torricellensis*)
Le		(*Macaranga Seemanii*)
Kolivao		(*Syzgium Richii*)

Huvalu Forest

3.0 NATIONAL INVENTORY OF GREENHOUSE GASES

3.1 INTRODUCTION

The United Nations Framework Convention on Climate Change (UNFCCC) requires that all members of the Convention are to update and report periodically on their national inventory of anthropogenic emissions and removals of green house gases (Article 4.1 a).

As with many of other Pacific Island Countries, this is the first greenhouse gas inventory for Niue. The base year used for this inventory is 1994 as per the recommendation of the revised edition of the Intergovernmental Panel on Climate Change (IPCC) guidelines. This ensures that the emission inventory is consistent and comparable across sectors and between Parties.

3.1.1 Greenhouse Gases

The Greenhouse effect is essentially the trapping of heat in the lower levels of the atmosphere. Next to H_20, CO_2 is the most important gas in this process. There are other trace gases which in concentrated forms in the atmosphere can create a strong green house effect. Notable amongst these is methane (CH_4), which is produced by insects, humans and other animals and Nitrous oxide (NO_2), which is also on the increase due to the rapid growth in the use of nitrogen fertilizers. It has been speculated that humankind, in satisfying its energy and agricultural needs, has increased the amount of CO_2 in the atmosphere by 20 – 30% since the Industrial Revolution.

Naturally Occurring Gases

Water vapour (H_2O)
Carbon dioxide (CO_2)
Methane (CH_4)
Nitrous oxide (N_2O)
Ozone (O_3)

Man Made Compounds

Chloroflurocarbons (CFC's)
Hydroflurocarbons (HFC's)
Perflurorinated carbons (PFC's)

Gases such as carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC) contribute indirectly to the greenhouse gas effect. whereas SO_2 contributes negatively.

Niue is heavily dependent on imported fossil fuel to meet the majority of its energy requirements. The main source of greenhouse gas emission for Niue is the imported fossil fuels, which are used mainly in the transport sector and in the generation of electricity.

3.2 INVENTORY PROCESS

3.2.1 Methodology and Data

The emissions calculated in the National Inventory for Niue adhere strictly to the 1996 guidelines specified by the IPCC. As there are no existing values for Niue for the emission of greenhouse gases, the IPCC guidelines on default methods and precursors were adopted.

Table 3.1 Niue Initial National Greenhouse Gas Inventories of Anthropogenic Emissions by Sources and Removal by Sinks.

Greenhouse Gas Source and Sink Categories	CO_2	$C0_2$	CH_4	N_20	NOx	CO	NMVOC	$S0_2$(Note1)
	Emissions	*Removals*						
Total (Nett) National Emissions (Gigagrams	4395.87		0.68155	0.0399				
Total (Nett) National Removals (Gigagrams)		995.679						
1. Energy	4395.87	Nil	0.58771	0.0369	26.297	184.29	34.7375	2211.18
Fuel Combustion								
Energy Industries	2922.06	0	0.09109	0.0182	6.0729	0.4555	0.15182	
Transport	1406.19	0	0.48142	0.0184	20.173	183.75	34.5639	
Residential	67.18	0	0.01519	0.0003	0.0508	0.0787	0.02179	
Solid Fuels	0.42624	0	0	0	0	0	0	
2.Industrial Processes	0	0	0	0	0	0	0.00637	0
4. Agriculture	nr	nr	0.0417	0.0007	0	0	0	
A. Enteric Fermentation	0	0	0.0069	0	0	0	0	
B. Manure Management	0	0	0.03501	0	0	0	0	
D. Agricultural Soils	nr	nr	0	0.0007	0	0	0	
F. Field burning of Agricultural residues	nr	nr	0	0	0	0	0	
5. Land Use Change & Forestry	204.321	120 x 10^6	0.01549	0.0001	0.0038	0.1355	0	
A.Changes in Forest & other woody biomass stock	0	120 x 10^6	0	0	0	0	0	
B.Forest and Grassland Conversion	204.321	0	0.01549	0.0001	0.0038	0.1355	0	
C.Abandonment of Managed Lands	0	119.329	0	0	0	0	0	
6. Waste	nr	nr	0.03666	0.0021	0	0	0	
A. Solid Waste Disposal on Land	0	0	0.02616	0	0	0	0	
B Wastewater Handling	0	0	0.0105	0	0	0	0	
D. Human Sewage	0	0	0	0.0002	0	0	0	
Memo Items								
International Bunkers			0.00594	0.0238				
Aviation			0.00594	0.0238				
CO_2 Emission from Biomass								

nr: Not Recorded

3.2.2 Sources of Data

The data used to complete the initial communication of Niue's Greenhouse Gas Inventory for the base year 1994 were obtained from organizations and government departments listed in Table 3.2

As there are no actual publications, the bulk of the information sourced was based on departmental quarterly/annual reports

Tuila Power Generator.

Table 3.2 Sources of Data and Type of Data Collected

Source of Data	Type of Data Collected
Niue Bulk Fuel Department	Imported Fuel Types and Usage
Electrical Power Supply	Power Generation
Niue Statistics Department	Statistical data
Privately Owned Service Stations	Fuel distribution for transport
Police Department	Registered Vehicles
Public Works Department	Energy Activities/Transport Sector
Customs Department	Confirmation of Imports
Department of Agriculture, Forestry and Fisheries	Land Use, Forestry and Livestock
Privately Owned Businesses	Industrial Waste
Niue's Growers Association	Importation of Fertilizers
Department of Lands and Survey	Land Use and Forestry Estimates
Health Department	Solid Waste

3.2.3 Organization

The National Inventory has been organised into five parts, which correspond with the five major source categories, as described in the IPCC 1966 Guidelines.

No emission estimates were made from solvents and other product use as there was no default values provided by the IPCC guidelines.

I Energy Activities

Fuel Combustion Activities

- Energy Industries
- Transport
- Residential

Memo Items

- International Bunkers

II. Industrial Processes

III. Agriculture

- Enteric Fermentation
- Agricultural Soil

IV. Land Use Change and Forestry

- Managed Lands
- Grassland Conversion
- Managed Forests
- Cleared Forests

V. Waste

- Solid Waste Disposal on Land
- Liquid Waste

The uncertainty and limitations, as per the IPCC guidelines are reflected throughout this chapter.

3.3 EMISSIONS

3.3.1 Energy

Greenhouse gas (GHG) emissions were mainly from the combustion of secondary fuels namely gasoline and diesel.

The total amount of GHG emissions for the energy sector was:

- 4412.13 Gg of which CO_2 emissions accounted for 63.84% of the total GHG emissions
- SO_2 was the other large contributing source accounting for 32.0% (2211.18Gg) of the total GHG emissions for the energy sector

CO_2 emissions from fossil fuels accounted for 99.1% of the total GHG emissions

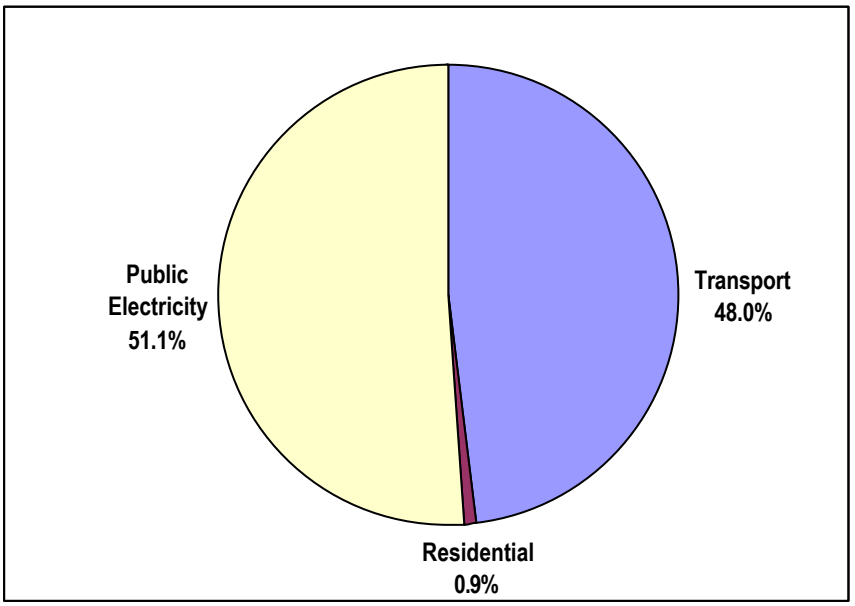


Figure 3.1 CO_2 Emissions from Fossil Fuels

The large percentage of SO_2 emissions contributing to the overall GHG emissions can be attributed to the large-scale extension of Niue's Hannan International Airport runway and the major construction and sealing of roads. (230 km). Both projects took place in 1994. A large contract team from New Zealand was employed to undertake this project, with the necessary heavy machinery also being imported from New Zealand.

1994 is an uncharacteristically high in terms of GHG emissions, particularly with respect to the energy – transport sector due the large-scale construction projects that took place on Niue.

3.3.2 Power Generation

Electricity on Niue is sourced from diesel-powered generators located in a central powerhouse. Power is available throughout the island servicing all sectors (government, private, residential and commercial).

The resulting CO_2 emissions from power generation accounted for:

- 50.46% (2226.54Gg) of the total CO2 emissions

Both the residential and commercial sectors rely heavily on electricity for lighting and running of appliances mainly coolers/fridges/freezers, washing machines and ranges.

Within the residential sector, the bulk of cooking is done using gas, which has largely replaced the kerosene and charcoal stoves. Heating of water is mainly by solar, and to a lesser degree, electricity.

It is important to note that it was difficult to differentiate the residential from the agriculture/forestry/fisheries sector due to a large amount of unrecorded data not recorded and discrepancies within the data available. For this reason, the amount of fuel sold by the retailers for agriculture/forestry and fishery purposes has been included in the residential sector.

Table 3.3 Sectoral CO2 Emissions Based on Fuel Types (Gg)

Fuel Type	Public Electricity	Road Transport	Residential/Commercial
Gasoline	-	1500.23	-
Gas/Diesel Oil	2226.54	646.481	-
Kerosene	-	-	36.04
LPG	-	-	nr

**nr = not recorded*

3.3.3 Non CO2 Emissions From Fossil Fuel Combustion

In addition to CO_2 emissions, fossil fuels combustion produces other greenhouse gases namely, methane (CH_4), nitrous oxide (NO_2), oxides of nitrogen (NO_x), carbon monoxide CO, and non methane volatile organic compound NMVOC, all of which result from incomplete combustion.

Transport accounted for 99.15% of the total non CO_2 emissions (2498.25Gg) from the energy sector

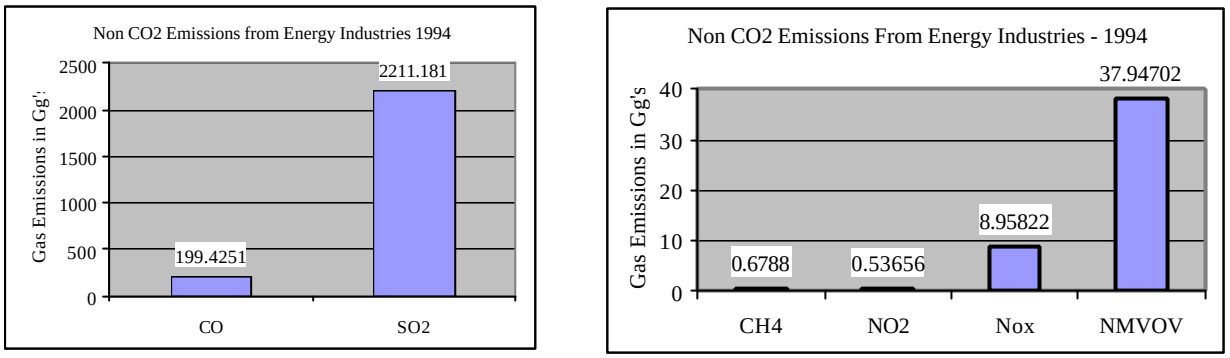


Figure 3.2 Non CO_2 Emissions From Fossil Fuel Combustion

3.3.4 SO_2 Emissions From Fossil Fuel Combustion

Varying amounts of sulphur are found in fossil fuels and during their combustion, SO_2 is emitted.

SO_2 emissions were extraordinarily high for an island with a small population. This wass due to the major developmental work undertaken in 1994 where a team of contractors from New Zealand, sealing 230km of road and extending the Hannan International Airport runway to accommodate 737 aircraft.

Table 3.4 Total of SO_2 Emissions 1994

Energy Sector	SO2 Emissions (Gg)
Public Electricity	*14.02*
Transport	*2197.05*
Residential	*0.01*
TOTAL	***2211.07***

Transport accounted for 99.36% of the total SO_2 emissions

3.4 MEMO ITEMS

3.4.1 International Bunkers

Bunker fuel applied to aviation only, as Niue does not have the facilities for refueling international marine transport.

- ***840.83 Gg CO_2 emissions resulted from this sector***

3.5 INDUSTRIAL PROCESSES

As Niue lacks industries, there was minimal work undertaken for this sector. Industrial sector for Niue is comprised of various small-scale cottage industries such as beer manufacturing, a meat processing plant, and a few bakeries.

- **The emission of 0.0064 Gg of NMOVC resulted from this sector**

3.6 SOLVENTS & OTHER PRODUCT USE

There are no default values provided by the IPCC guidelines therefore this sector was not incorporated in the national inventory.

Power Generator Fuel Storage

3.7 AGRICULTURE

While Niue is largely dependent on imported foodstuffs, subsistence agriculture occurs and is actively encouraged. The majority of households own a "bush garden" where a variety of fresh vegetables and taro, the staple food are grown.

The agriculture sector is very small in contributing to GHG emissions. This is largely due to the small number of livestock present. There is an estimated number of 100 cattle, as well as household chickens and pigs, kept mainly for subsistence purposes and various cultural functions. The bulk of the meat consumed on the island is imported.

Emissions from agricultural soils are low due to Niue's small landmass. Only an estimated 40% of the land is suitable for agricultural purposes.

Table 3.5 Emissions from Agriculture Activities

Type of Emission (Gg)	Enteric Fermentation	Manure Management	Agriculture Soils
CH_4	0.0417	-	-
N_20	0.0000	-	0.001

3.7.1 Land Use Change and Forestry

Changes in the biosphere through land use changes and forestry activity, has resulted in modifying the natural balance of uptake and emission of the carbon and nitrogen trace elements.

On a global scale, deforestation of tropical forests has had the greatest effect on the biosphere.

The default values which were used were very general in light of the tropical forest concept. It was felt that there should have been a further breakdown of the tropical forest into smaller categories.

3.7.2 Abandonment of Managed Lands

Land area per capita is high. In addition poor soil fertility, the main reason for land abandonment is the need for a fallow period to allow for soil rejuvenation.

Abandonment of managed lands contributed to:

- **119.33 Gg CO_2 removal from the atmosphere**

3.7.3 Grassland Conversion

Despite the decline in population, advances in agricultural methods such as clearing with the aid of bulldozers, application of fertilizers and pesticides coupled with good prices for Niue's export taro have contributed to larger plantation areas per capita being cleared.

This growing need for arable land has also been compounded by the gradual reduction of aid from New Zealand over the previous 10 years. This has forced the people to turn to the land as a source of income.

- 204.32 Gg of CO_2 emissions have resulted from the conversion of tropical forests

These issues have been identified within the local community, Government Departments and in particular, the Department of Agriculture Forestry and Fisheries. A Forest Policy document is currently in place, yet to be submitted to Cabinet for approval. This policy aims to promote integrated land use practices in order to reduce the need to encroach on the high canopy forest. It should also optimize returns from subsistence and commercial plantations, and as far as is possible, improve the productive capacity of the island's soils.

3.7.4 Managed Forests

Much of Niue was once covered in tropical forests and there are still large areas of such forests. (18,200 ha in total)

The plantation areas established under the New Zealand Government funded forestry scheme is scattered in 50 small wood lots covering 290 hectares. The plantations were established with two main exotic species but are generally characterised by variable and poor tree growth rates.

These results have reinforced the need to change to planting indigenous forest species.

Harvesting of forest timber on a commercial basis is a recent venture by a private business which aims at self-sufficiency in timber production for housing and construction. Logging of indigenous forests is well within the sustainable capacity, with the current annual harvesting for timber representing only 5% of the allowable cut. (Niue's National Forestry Policy Statement – Final Draft 1998).

The Government does not collect any revenue from forestry. The industry is very small with virtually no log or timber exports.

Table 3.6 Carbon Uptake by Forests

Plantations	Area (kha)	Annual Growth Rate (tdm/ha)	Annual Biomass Increment (ktdm)	C Fraction Of Dry matter	Total C Uptake Increment (ktC)
Tropical					
Dry Forest	*18.457*	*6.8*	*125.510*	*0.5*	*62.755*
Mixed Hardwoods	*0.310*	*6.8*	*2.105*	*0.5*	*1.053*
Eucalyptus spp	*0.000015*	*14.5*	*0.00021*	*0.5*	*0.00011*

Table 3.7 Carbon uptake by Non Forest trees

Non Forest Trees	No. of Trees (1000s)	Annual Growth Rate (ktdm/100trees)	Annual Biomass Increment (ktdm)	C Fraction Of Dry matter	Total C Uptake Increment (ktC)
	9592.47	*6800*	*6522762*	*0.5*	*32614381*
				TOTAL	***32614445***

1.2 x 10^6 Gg of CO_2 is removed by the woody biomass as opposed to the total emissions from all other sectors.

3.8 WASTE

Methane, second only to CO_2 as a source of greenhouse gases, also contributes to global warming. Sources of methane emission include anaerobic decomposition of organic wastes in solid waste disposal sites, sludge and residual solid by products.

3.8.1 Solid Waste

In this sector, the data was collected by the group, involved with the inventory, over a two month period, as no previous data was available on the amount of solid waste being produced or amounts disposed of by the certain sectors of the community. The values obtained were calculated on the population figures of 1994.

There is one open disposal site, with no data on the quantity of waste being disposed. Much waste burning and bulldozing also takes place at the site

A private contractor transports household solid waste from all villages to the open disposal site at least twice weekly.

The bulk of biodegradable wastes are recycled via mulching/composting in an effort to return valuable nutrients to the soil, in order to enhance soil fertility and structure. Food scraps however are fed to the pigs or domestic pets, kept by most households.

Niue has a very effective aluminium can recycling scheme, organised by the Catholic Mission, which compacts and ship's the aluminium cans back to New Zealand. The price per can return is 5 cents and this actively encourages the recycling concept, especially amongst the children.

A main issue of concern is the lack of control measures with regard to which products can safely be disposed of, as there is a potential risk of toxic wastes entering the underground water lens. Currently the Government of Niue is in the process of negotiating for a waste management specialist to provide and implement a practical solution to this problem.

- **5.45% (0.037 Gg) of the total CH_4 emissions resulted from the waste sector: - solid waste disposal emitting 0.026 Gg of CH4**

3.8.2 Liquid Waste

Sewerage waste is contained/disposed of by septic tanks and includes domestic "grey water". The Health Department is responsible for the collection of the septage sludge, which is disposed of into open holes near the Hannan International Airport. There are no septage treatment facilities. However disposal of the septage complies with the recommended distance form the water bores, thereby minimizing potential health risks are minimized.

Actual liquid waste data was from the Industrial sector, namely a beer manufacturing plant and a meat processing plant.

- ***0.011 Gg of CH4 emissions resulted from waste water handling***

3.8.3 Indirect N_2O Emission

Liquid waste produces N_2O emission from human sewerage, and was calculated using a population base of 2,302

- ***Total annual emission of N_2O was 0.054 Gg, human waste contributing to 3.94% of the total annual emission.***

3.9 CONCLUSION

Despite the large gaps in the data collation, which was raised throughout this chapter, it was also felt that the IPPC default values are too high for such a small island nation with a negligible population base.

An interesting fact which emerged was the amount of CO_2 removed by the biomass (approximately 120 million Gg) as opposed to the total sum of emissions from all sectors. It is important to note that this is only for CO_2 removal and does not take into account the other greenhouse gases.

It can be further concluded that any adaptive or mitigation measures will be of benefit in the area of transportation, and electricity production. Improved efficiency of electricity production will result in beneficial savings – monetary and environmental. This would include measures such as the use of low energy rated appliances and the increased use of renewable energy resources i.e. solar and wind power generation schemes.

The transport sector is of concern, as despite the population decline, the number of vehicles imported onto the island continues to increase.

A nationwide fitness and health campaign is currently in place with the "Moui Olaola" or the healthy island project. The fitness component actively encourages the population to walk or bike instead of using automotive transport. Car pooling to and from work could also be encouraged to reduce the amount of emissions produced from the transport sector.

Wharf Buildings and Fuel Depot

4.0 VULNERABILITY AND ADAPTATION

4.1 VULNERABILITY

A country's vulnerability refers to the severity of potential impacts of climate changes on the natural environment, main sector of the economy, human health and social activities.

In Niue, the key sectors likely to be affected by the climate change and sea level rise are:

- *Coastal zone and reefs*
- *Agriculture*
- *Land Use Change and Forestry*
- *Water Resources*
- *Health*
- *Biodiversity*
- *Socio Economic Impacts*

4.1.1 Climate Change Scenario's

Climate Change, although of universal concern may have different impacts on national and regional exposure units depending on their vulnerability and adaptation.

4.1.2 Sea Level Rise Scenario's

There are three types of islands within the Pacific region, volcanic, atolls and high coral islands. Niue is classified as a high coral atoll and therefore may not be as susceptible to sea level rise as would the low lying atolls of the Pacific Region. Nonetheless, the increase in frequency and severity of tropical storms and cyclones are of particular concern to Niue.

Mid-range estimates of sea level rise project an approximate rise of 20cm by the year 2050 and 40cm by the year 2100. High range estimates project a rise of 40cm by 2050 and 95cm by 2100.

Table 4.1 Estimated Projections of Sea Level Rise for the Future

Year	2050	2100
Mid-Range Projections	20 cm	50cm
High Projections	40cm	95 cm

It is very unlikely that a prediction of a sea level rise of 30-50cm by the year 2100 will prove a very serious threat to Niue.

However, increasing temperatures of 3-5^{o}C over the next 100 years resulting in increased levels of greenhouse gases may result in increased frequency and severity of tropical storms and cyclones.

Climate research has shown that in the South Pacific, as a general prediction, there will be a warming effect in the long-term. The records on climatic changes are alarming with predictions of catastrophic consequences. The scenario is analyzed and evaluated against the background that climate warming occurred throughout most of the Central South Pacific during the1980's, and in the New Zealand (Niue) region of the South Pacific since the 1940's. According to Dr Jim Sallinger, a senior Climate Scientist with the National Institute of Water and Atmospheric Research Ltd (NIWA), only the neighbouring island countries of Kiribati, Samoa and Northern Cook Islands have shown dry temperature decline up to 1970, followed by a rapid increase in mean temperatures. However the record states that the 1980's have been the warmest years on record.

The "El Nino" phenomenon has created the worst scenario for high warming trends in the entire Southern Hemisphere since the mid 1970's. Niue will experience the strongest impact per capita due to its vulnerability and lack of resistance. Meteorologists believe that "El Nino," the Pacific current responsible for a large-scale shift in rainfall patterns, is causing disturbed weather patterns.

The "El Nino" phenomenon results when the combined actions of southerly winds along the South American coast and the rotation of the earth causes cool waters to rise from the ocean depths. Trade Winds blow the warmer surface waters furthest west and the cook waters take their place. The movement of cool water across the Pacific upsets rainfall patterns. When the cool waters meet the warm waters on the West Pacific, cyclones are likely to occur.

"El Nino" is a phenomenon that repeats itself every few years. Scientists know precisely what causes the phenomenon but are unable to predict when and how strongly it will occur and how strong its impact will be.

The impact of climate changes and its associated sea level rise will affect Niue's water supply, biodiversity, agriculture, forest biomes and the unprotected coasts.

4.1.3 Coastal Zones and Reefs

Niue's coastal landform is unique and does not follow the global pattern of coastal formation. The coastline was formed by a combination of factors, namely reduced sediment yield, combined with severe storms and wave erosion. Reef formation is flat and only fringes the island.

The Alofi landing site has revealed that even in the wet season, the minimum low waters are 0.4m high and the maximum wave height in the absence of gusts and cyclones is 1.2m.

To date Niue has no Sea-Frame gauges and ancillary sensors. Therefore there is no available data on sea level rise.

As Niue is at the edge of the tropical cyclone belt and in the zone of the southeast trade winds, it has been subjected to severe cyclones on average once every ten years with cyclones hitting the island every four years.

Niue was hit by two cyclones, (the first in 1979 and second in 1990) both named Ofa by the Niue weather Bureau Fiji. At the peak of both cyclones extremely high waves rose 60-80 meters in height causing massive damage on the coastal environment and the infrastructure to the western side of the island.

The Alofi wharf, which was extended by 20m in 1999, collapsed three months after its completion under the impact of Cyclone Cora. This cyclone caused widespread destruction on 25/26 December 1998 in neighbouring island of Tonga.

The immediate effect to the cyclones on the coastal zone is wave damage to the coral reef, fauna, erosion of sands and destruction of properties by wind, waves and huge boulders washed inland by the waves.

Anaana Big Sea Spray

The action of waves near the shoreline is the most fundamental factor in coastal erosion. An increase in sea level rise and associated temperature rise will result in increased frequency and intensity of storms, which in turn actively contribute to increased coastal erosion.

In the absence of an appropriate adaptive response, Niue may lose its coral reefs, which is a habitat for its fish resources, coconut crabs which spawn in the sea and other marine resources. Unlike many other Pacific Islands, coastal erosion in Niue is largely attributed to wave action whereas on other islands and surface water runoff is also a contributing factor.

4.1.4 Agriculture

Agriculture is carried out mainly on a subsistence level with a small number of commercial growers. It is generally accepted that an increase in CO_2 concentrations within the atmosphere with subsequent warmer temperatures will result in rapid growth of green matter, rather than good crop production. This could adversely affect nutritive value, storage life and taste of the crop. In addition it has been speculated the crop growth season will change, with an overall shorter cropping length, resulting in increase of crop rotation per annum.

Variations in rainfall patterns can also affect the yield and sustainability of the crop. Increased periods of intense rainfall, combined with high humidity levels will result in a higher incidence of diseases caused by fungi and bacteria. The number of insect/pest generations per year may increase along with their geographic location.

Intense rainfall periods within the planting season may cause seedling damage, leaching of essential nutrients into the water lens and increased intensity of competition of weeds with establishing crops, thus leading to an increased level and dependence of fertilizer and pesticide/herbicide usage.

Conversely, more pronounced dry seasons could result in warmer temperature, increased evapotranspiration causing plants to become stressed with an overall reduction in crop yield. As a result more land may be required to be cleared to maintain crop production.

A decline in agricultural production will result on a greater reliance on the importation of fresh vegetables/fruits that may not be readily affordable across all socio economic groups.

Cyclone Ofa in 1990 destroyed the majority of village and bush gardens, thereby seriously affecting the export of copra, bananas and limes seriously affected. The people who depended on their produce as a source of cash, were without income and without plantation food until new subsistence crops were grown.

A report compiled by the Police Department and the Executive Committee revealed that, except for a few taro plantations near the coast, nearly all the taro was undamaged. However cassava and papaw (papaya) were scarce for the first 6 months, there were no bananas for 15 months, and minimal coconuts and breadfruit for about 2 years.

The passionfruit export industry was totally destroyed and never recovered due to the large capital cost involved in the establishment of passionfruit.

The worst recorded drought was from 1940-44, when the annual rainfall was 23.6% below the mean for a five-year period. In two other droughts, 1925-6 and 1976-77, the annual rainfall was more than 32% below the mean for a two-year period.

The most recent recorded drought was a period of 18 months from July 1982 – December 1983. During the height of the drought, growers stopped exporting taros to New Zealand and had to import produce from Samoa to alleviate the shortage of planting material.

The Department of Agriculture had to slaughter over half of its cattle due to feed shortages. Following that, an intensive-breeding programme was implemented to build the herd up to pre-drought number of approximately 600. This was unsuccessful and to date there is a negligible number of cattle on the island.

Coconut trees were also seriously affected by the drought and it was predicted that it would take at least 18 months to recover.

Drought conditions are ideal for the invasion of leafhoppers and aphids into taro plantations. The aphids and leafhopper quench their water requirements from the sap of the taro, which retards crop growth and results in a lower yield.

4.1.5 Land Use Change and Forestry

While extended periods of drought may be a threat in terms of forest fires, there is more likely to be an increase in rainfall and temperature as a resultant of the climate change scenario. Due to a decrease in crop rotation time, fallow periods will also be shorter resulting in more land being cleared to maintain the same level of production.

Currently Niue has the largest remaining lowland forest in the Pacific, it is now established as the Huvalu Forest Conservation Area and the only protected area under proper management. Over a considerable period of time, increased rainfall and temperatures may affect the distribution and survival of plant and animal species resulting in a changing rainforest ecosystem, some species increasing at the cost of others.

In addition devastating cyclonic effects may result in the regeneration of certain species becoming more troublesome, potentially changing the biodivesity of the biome.

4.1.6 Water Resources

There is no surface or running fresh water. And as there is no surface runoff on Niue, the water balance can be determined by the measurement of evaporation and ground water recharge, the sum of which determines the amount of rainfall.

Rainwater seeps down to an underground lens that is pumped from 15 bores, eventually to be reticulated to houses in each village.

Resistivity data has indicated that the fresh water lens thickness is 40 – 80m in the centre of Niue, 50 – 170 m below the former atoll rim and 0 m at the coast. The model of the freshwater layer on Niue is based on a depth of 50 m below sea level. Rainwater infiltrating over the entire island recharges the groundwater. Previous research has shown that the freshwater layer of porous rock is thicker than the less permeable limestone near the coast, thereby restricting the lateral flow of groundwater into the ocean.

Allowing for the effects of drought and based on the assumption that the freshwater is initially 50 m thick at the baseline, their figures indicate that there will be a safe yield of approximately 4,000m^3/ha/year. In any drought situation the freshwater/saltwater could be maintained at 25m below sea level with 222mm rainfall as an effective recharge.
With the information currently available coupled with the results of scientific investigation, predictions are that the effect of drought and its impact on Niue will be severe in the long term. However, in the in the event of climatic disturbances, this would be offset by the heavy rainfall which accompanies gales and thunderstorms.

Cyclones, intensive rainfall and coastal erosion cause pollution of the water lens due to infiltration of salt and land based pollutants. Sea level rise may also impact on the fresh water lens, through salt-water infiltration into the fresh water lens, thereby reducing the overall lens thickness.

4.1.7 Health

Climate change affects human health and survival indirectly via the effects on the ecosystem, agricultural crops and disease agents such as vectors. Natural disasters which affect Niue and in turn the health of its peoples: include cyclones, droughts, prolonged periods of rain and changes in weather patterns.

Mosquito-born diseases such as dengue fever and filiarisis are a constant threat to Niue, although the level of incidence is lower compared to other Pacific Island countries. There was a recorded epidemic of dengue fever in February 1980 with 57 diagnosed and resulting in 4 deaths. The epidemic outbreak was attributed to a cyclone in December 1979.

The impact of droughts on health is not as drastic if compared to the effects of past cyclones. Increased temperatures and prolonged rainy seasons could lead to an increased incidence of mosquito borne diseases, due to the prolonged breeding season of the mosquitoes. In addition, a very mobile population and adaptation of mosquitoes to conditions associated with climate changes could increase the range of diseases on Niue.

Prolonged rainfall of greater intensity could result in greater incidences of diarrhoea due to the deterioration in water quality. This in turn may necessitate the implementation of a expensive water treatment programme.

Fluctuations in weather and temperatures affects the general health, of the population making them more susceptible to influenza and respiratory tract infections, which can be fatal amongst the elderly and

infants. There is a high incidence of asthma, bronchitis and pneumonia dehydration amongst the elderly population generally associated with periods of temperature/weather fluctuations.

4.1.8 Fisheries

Fishing is on a subsistence level, and as Niue's inshore fishing grounds are not particularly fertile due to the limited sediment and nutrient run off, the deployment of fish aggregating devices on the western side of the island is of significant importance in assisting the fishermen who supply the local market with fresh pelagic fish.

Changes in sea temperature could lead to changes in wind, ocean currents and patterns which may affect the distribution and availability of nutrients, thereby changing patterns of migratory and non-migratory fish stocks.

Increase in rainfall intensity and cyclones/storms may also reduce fishing opportunities as the rugged coastline already restricts boat and foot access to only a few places which are accessible in calm conditions.

In addition, disturbances to the reef environment are thought to be a trigger to ciguatera populations. This then builds up in the food chain, eventually leading to food poisoning when fish that contain a large number of these organisms are eaten. Although rare on Niue, symptoms, especially in mild form could easily be misdiagnosed as some other illness.

Ciguatera outbreaks can also be a result of natural changes to the reef, such as storm damage.

4.1.9 Biodiversity

Wildlife species are amongst the most vulnerable group to weather fluctuations and climate change scenarios. One such species was the local parakeet 'hega' (*Vini australis*) now rarely seen after Cyclone Ofa (1990). Some bird species are beneficial as they combat insect plagues such as the Butter Moth (*Cleora Samoana*) which attack the leaves. Such species reduces the need for chemical application.

Fruit bats (*Ateropus tonganus*), pigeon (*Ducula pacifica*), hega (*Vini australis*), heahea (*Lalage maculosa whitmeei*), misi (*Apolonis tabuensis brunnescens*), kalue (*Eurodynamis taitensis*), tuaki (*Phaethon lepturus*), taketake (*Gygis alba*), kiu (*Pluvialis dominica fulva*) gogo (*Anous stolidus*), kalagi (*Puffinus pacificus*), kulukulu (*Ptilinopus prophyraceus porphyraceus*), motuku (*Numenius tahitiensis*), lulu (*Tyto alba lulu*) are all very vulnerable to strong winds as they all perch on trees.

The fruit bat and pigeon play an important role in the regeneration of the tropical rainforest through seed dispersal, thereby ensuring the survival of the rainforest.

Increased water temperatures may be associated with a high incidence of coral bleaching, with certain species of coral becoming more susceptible than others, changing the overall coral biodiversity of the reef.

Increased frequency and incidence of storm surges may result in increased damage to the coral reef fringing the island, which in turn could lead to a reduction in marine diversity. One such species is the larvae of the coconut crab 'uga', which migrates to the sea to lay it's eggs.

4.1.10 Socio-Economic Impacts

Niue's social and economic development, has been hampered by natural disasters such as tropical storms, cyclones and droughts.

It must be acknowledged that Niue's ability to deal with the impacts associated with natural disasters has been cushioned by external assistance from New Zealand and Australia.

Natural disasters impact on a country's GDP, employment, trade, Government finance, inflation and the overall level of economic growth of the economy.

The main economic impacts resulting from climate change would be:-

I. Food Security

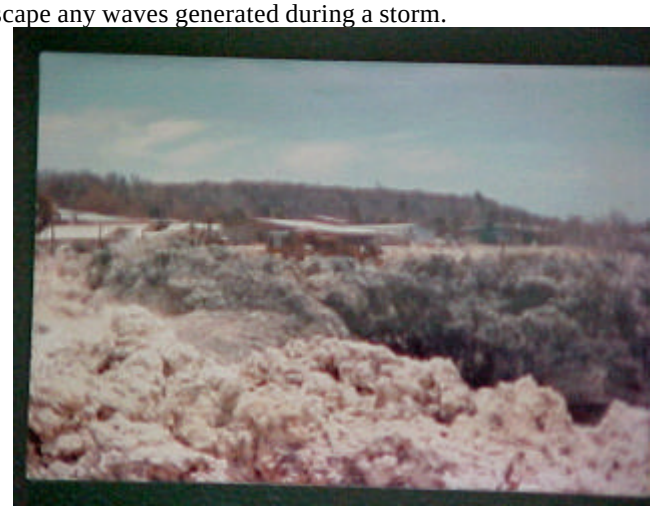
Climate change and rainfall patterns may lead to a decrease in the quantity and quality of domestic food for local consumption which in turn could result in an increase in demand for imports.

II. Damage to Public Infrastructure

Most of the public infrastructure on Niue is situated on the western coast of the island, where it is very susceptible to cyclone damage.

Cyclone Ofa 1990 highlighted the vulnerability of this infrastructure as there was extensive damage to the Lord Liverpool Hospital, the Niue Hotel, Alofi wharf, and a number of private homes situated on the western coast.

Prior to Cyclone Ofa, it had been thought that infrastructure situated on the western coastline of the island was high enough to escape any waves generated during a storm.



Niue Hotel and Cliff Top after Cyclone Ofa

III. Cultural Impact / Traditions

The introduction of a cash based economy within Niue has brought about many changes to the social system. Niue's customs and traditions are strongly centred on the extended family, family lands and strong traditional practices such as the sharing of family resources.

Undoubtedly Climate Change and the consequential impacts on the island's economy could affect the life style of the people, their value systems and behaviour patterns. Disturbances to the existing balance could result in disruptions to family life styles resulting in many social problems such as a breakdown in the community support systems.

IV. Negative economic impacts

Effects of climate change on agriculture production, tourism sector and human health will in turn, have an effect on the national economy exerting pressure on Niue's reserves and exacerbating the trade deficit. This could lead to an increased dependency on foreign aid and social services.

In addition this could lead to a further increase in outward migration in order to secure better job prospects and higher standard of living. The majority of those leaving are the youth and those with young families, groups which are both considered the more active agents of food production both on a national and a community level. They leave behind the aging and the young, a population more dependent on social services.

4.2 ADAPTATION MEASURES

There are two main methods of classifying adaptation activities. One method is to distinguish those which are anticipatory and planned and the second is those which are reactionary and forced. Anticipatory adaptations are those which are undertaken before the effects of climate change, become obvious. They can be planned carefully with the luxury of time, enabling economically efficient, socially appropriate and environmentally sound activities. By comparison, reactive adaptations are those which take place once climate change effects are experienced in such cases the range of options is likely to be limited and adaptation will be expensive, socially disruptive and environmentally unsustainable. The use of anticipatory approaches will greatly reduce the potential cost of forced and ad hoc adaptation responses at a later date when loss of resources, poorly planned development and delayed implementation of plans are the result.

4.2 1 Coastal Zones and Reefs:

- Measures need to be undertaken to protect Niue's vulnerable low lying areas by establishing a standard code for coastal management i.e. an integrated coastal management plan (ICM).
- ICM with National Resource and Development Planning should integrate all aspects of conservation and environmental protection and legislation.
- Land and marine use planning need to be incorporated with economic planning and other sectors for preparing management plans for infra-structural development.
- Other adaptive measures include creation of artificial coasts such as the Alofi wharf and Avatele jetty.

Big Wave on Wharf

4.2.2 Agriculture

- Adaptation of agricultural methods by cultivating crops that are drought resistant and/or tolerant.
- Introduction of sustainable agricultural practices such as mixed cropping, utilization of composting and mulching techniques to minimize the need for chemical fertilizers and herbicides.
- Development of alternative agricultural practices i.e. hydroponic systems which has the ability to produce high quality crops utilizing minimal land area and which can be constructed on land deemed unsuitable for other uses.
- Reinforce research institutes to ensure the development of plant/crop species which are more resistant to future adverse climatic conditions.
- Department of Agriculture, Forestry and Fisheries to undertake more research and development.

I Forestry And Land Use Change

- Government to extend the forest assets through plantation forestry in a manner which is technically feasible and cost effective to act as a sink, absorbing CO_2 from atmosphere.
- Reduce the clearing of land in mature forest areas as well as limiting further infra-structural development in the Huvalu Conservation area.
- Protection of native tree species by replanting, where possible, in place of exotic species to provide food and flowers, and encouraging seed dispersal by fruit bats and pigeons.

II. Biodiversity

- Adaptation of the precautionary principle of minimizing pollution.
- Increase public knowledge of bird, flora and fauna and the effects of external influences on these species and their interactions.
- Increase knowledge of marine flora and fauna interactions and the effects of external influences on these species and their interactions.
- Increase knowledge of pelagic fish migration.
- Conservation of the forests of Niue and the continued support for the community-driven Huvalu Forest Conservation Area and Niue's Conservation of the Biodiversity project.
- Establishment of protected area system in areas other than the Huvalu Forest Conservation Area.
- Land and marine use planning should be incorporated with economic planning and other sectors for preparing management plans for infrastructure development.
- Priority to be given to environmental protection through institutional strengthening and programme implementation of action strategies.

4.2.3 Health

- Health education and promotion programmes to incorporate health impacts of climate change on infectious diseases.
- Future health services delivered on Niue to acknowledge emerging infectious diseases with an adaptive perspective on human health impacts.
- Preventative health programmes and projects within the Public Health division to be strengthened and supported, with emphasis on community involvement in the projects.
- Policies for disaster preparedness with adaptive strategies to be formulated and implemented.
- Database and information system to be established for accurate monitoring and data collation.
- Further studies required to explore in detail the impacts of climate change on the health of the people.

4.2.4 Socio-economic Resources

Some of the strategies to reduce certain of the socio-economic impacts of climate change have been covered previously in the section on adaptive measures and include cultivation of drought resistant and/or tolerant crop varieties, introduction of sustainable agriculture, mixed cropping, and alternative agricultural practices.

- Relocation of vulnerable infrastructure such as Government flats, Niue Hotel, Lord Liverpool Hospital, private homes and guest houses to areas of lower vulnerability.
- The Alofi wharf is classified as a high risk area and any future planned development within the wharf proximity must take into account the vulnerability of the wharf to turbulent wave action throughout the cyclone season.
- The Bulk Fuel depot, situated at the top of the Alofi Wharf is another high risk area and its relocation is treated as top priority.
- Almost 10 years after Cyclone Ofa 1990, it appears little effort has been given to minimising the devastating impact of cyclones on hospital properties. The Government, due to financial constraints cannot afford the relocation of the hospital to higher ground.
- Diversification of export products is arranged by moving into value added products using local materials. Small-scale industries should also be encouraged to help stimulate domestic economic activity via better utilisation of local materials, employment creation and increased income through injection into the economy of foreign exchange.
- Import substitution where possible.
- Export promotion: Establishment of formal reciprocal trade ties with other countries in the region, creating an avenue for Niue's exports while allowing Niue continuous access to affordable goods.
- Development of alternative income creation initiatives.
- It is economically feasible for Niue to diversify it's investment portfolio's

Fresh Water Storage Tanks

5.0 MITIGATION OPTIONS

The mitigation options, to be effective in the reduction of GHG emissions, will have to be focussed largely on the energy and transport sector. Mitigation measures can focus either on reducing people's demand for GHG emitting products or by controlling the supply.

Mitigation options identified for Niue are summarised in the table below.

Table 5.1 Identified Mitigation Options for Niue

SECTOR	OPTIONS
Energy and Industry	• Increased efficiency and maintenance of diesel generators. • Encourage use of solar heating and other renewable energy options. • Encourage use of low energy rate appliances. • Encourage use of compact fluorescent light bulbs (energy saving light bulbs).
Transport	• Encourage carpooling to and from work. • Enforcement of maximum speed limits. • Implement and improve standards for warrant of fitness for vehicles. • Promotion of bicycle use and walking. • Importation of more fuel-efficient vehicles.
Forestry	• Preservation and conservation of forest areas, other than Huvalu Conservation Area. • Initiation of an indigenous tree planting programme. • Government Legislation for a National Forest Policy for Niue, based on 1998 National Forest Policy Statement.
Waste Management	• Implementation of a "waste recycling" mind frame rather than 'waste management' mind frame e.g. bacteria from septic sludge when mixed with oil will break down oil. • Promote public awareness of recycling, composting and other alternatives to reduce amount of solid waste.
Waster Resources	• Encourage use of village rain catchment systems and household backup rain catchment tanks. • Encourage use of "gray water" for secondary household uses.

CONCLUSION

On a global scale, Niue, the smallest self- governing nation, is also a very minor producer of GHG emission's per capita. The identified mitigation measures via financial incentives, modified taxes and charges and government legislation will further reduce the national GHG emissions through active participation of the community.

Some of the mitigation options will easily and readily be implemented whist others may require additional training of personnel and involve significant establishment costs.

However the initiation of some of the more readily implemented mitigation options 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.

Huvalu Forest Conservation Area

6.0 CAPACITY BUILDING

6.1 CAPACITY TO RESPOND TO CLIMATE CHANGE

The objective of this activity specifies that "there is a need to build or strengthen the national capacity to integrate climate change into medium to long term planning". This may include education and training of climate change issues for national development planners as well as for policy and decision-makers.

Capacity building for Niue is deemed essential to develop, strengthen and expand activities relating to climate change. Human resource and institutional development will enable further development of:

- *National climate change scenarios and research into emissions*
- *Preparation of future GHG source and sink inventories*
- *Assessment studies in vulnerable areas such as coastal zones, land use change and forestry*
- *Other vulnerable sectors*

and the ability to identify and prioritize cost effective measures which will assist policy makers and the Government to take appropriate action.

Currently the government has a Disaster Management Plan in place with the Niue Police Department as its principal implementing authority. Each village council also has an Emergency Disaster Plan which is integrated with the Government's Disaster Management Plan. Villagers are reminded, prior to and during an emergency situation of the appropriate responses to be followed to ensure maximum protection to life and property.

The Government can fund only the running costs of the committee. The actual protection of the personal property is the responsibility of individual families, which often results in ineffective protective measures and great financial cost to families being the consequence. The lack of funds to develop appropriate protective measures is the main obstacle.

6.2 SPECIFIC CAPACITY BUILDING NEEDS

A survey on a "National Inventory of Skills of Public Servants" was conducted to determine the extent of the level of skills of local people and to determine their capacity to tackle issues relating to climate change. A detailed report outlining the Capacity Building Activity was tabulated as an output of this exercise. It is available at the Niue Meteorological Service along with other reports completed on Vulnerability & Adaptation, GHG Inventory, Education Training and Awareness, and Mitigation Options.

The survey identified an urgent need for ongoing training of Niueans in the area of the science of climate change and policy-making necessary for effective impact for the future.

Training initiatives identified includes:

- *Participation of at least three senior level delegates in regional/international forums allowing for an improved continuation of information dissemination*

- *Scholarships in Climate Change Science to be offered*

- *Training in sector analysis of Niue's vulnerability to adverse effects of Climate Change. These sectors are: Coastal Zone, i.e tidal movements/sea level measurements, Waste Management, Forestry, Agriculture, Marine resources and Coral Reefs*

- *Build Capacity to analyse and recommend sound, appropriate and user friendly technology for data collection, collation, interpretation*
- *Build capacity to recommend sound anticipatory adaptive measures to adverse effects of climate change as opposed to reactive adaptive measures which are quite often ineffective and very costly*
- *Training of relevant personnel such as legal officers, in policy-making for climate change which would benefit the country and the global climate effort*
- *Training of Niueans to improve their capacity to negotiate for better consideration of Niue's special needs and conditions as a least developed country*
- *Build Capacity to recommend sound and effective polices which would ensure the protection of our climate and promote sustainable development*
- *Build Capacity to conduct in depth studies into very vulnerable areas to effects of Adverse Climate Change and to recommend appropriate actions*
- *Build Capacity to consolidate all efforts to avoid duplication of activities on the National, Regional and International scene*
- *Build Capacity to promote effective awareness campaigns to ensure maximum exposure to all sectors of the community and stakeholders to continue long after this project is completed*

In order to address the science and politics of climate change, Niue's people need to be trained at appropriate institutions, to assist in building the capacity of a small nation to deal with the impacts of adverse climate change.

6.3 CONCLUSION

Climate change science and its language is difficult for the wider community to understand. It is also more difficult for the community to respond with appropriate solutions.

Niue High School Students

7.0 PUBLIC EDUCATION AND AWARENESS

Niue's association with New Zealand has resulted in the island's high levels of social support especially with regard to infrastructure, health and education.

Owing to the high level of education of the population and Niue's small size, public awareness of issues pertaining to climate change and the associated cyclonic impacts have been relatively easy to disseminate and comprehend across all sectors of the community.

Print, radio and television, telecommunication facilities and email, have provided the country and its population with comparative advantages over others when dealing with issues of dissemination and comprehension of information on climate change.

7.1 FORMAL EDUCATION

Teaching and training in 'Climate Change and it's Impacts throughout the world is mainly offered at the university level. The introduction and strengthening of climate change science at the primary and secondary levels, at the post-secondary level for non atmospheric and non-marine science students and through non-formal public education, is a necessity for the Pacific region in general and for Niue in particular.

Niue was successfully able to introduce basic climate change science into their existing courses and curriculum at different levels, due to the great efforts of principals and teachers alike.

The most appropriate resource materials were the curriculum models for the Pacific schools namely "Climate Change and Sea Level, Part One: Physical Science and Part Two: Social Science produced under the South Pacific Sea Level and Climate Change Monitoring Project".

Additional activities undertaken at the Niue Primary and High School with regard to climate change awareness included:

- *Art and mural competition*
- *Caption writing*
- *Song writing*
- *Songs and dances*
- *Poem writing*
- *Poster competition*
- *Excursion to the Niue meteorological science*

One day was set aside as a 'Climate Change Awareness Day'. Parents were invited to the two schools to watch their children's performance in drama, songs and dances based on climate change. All the classes in the schools took part and the quality of performance was commendable.

7.2 INFORMAL EDUCATION

Informal education activities were also found to be very effective in stimulating an awareness and interest in climate change activities.
The informal education activities included:

- *Village meetings*
- *Radio programmes*
- *Television coverage*
- *A National logo competition*
- *A Talent quest*
- *Use of Bill boards*
- *National show day float with the theme: "what can we do to minimise climate change"*
- *Climate change newsletter published by Niue Meteorological Service and fully supported by the local newspaper, the Niue Star.*

The importance of educating the local community is vital to develop their understanding of the phenomenon of climate change and it's effects.

7.3 CONCLUSION

To date, a good basis for community awareness and formal education of climate change issues has been established. However, it is important that complacency is avoided and every effort must be made to maintain and increase public awareness of the critical issues pertaining to climate change which includes:

- Expansion and strengthening of USP activities to cater for the continuing education needs of the community.
- Translation of the information into the Niuean language to ensure maximum awareness of issues relating to climate change.
- Continued participation of selected individuals from government offices and non-government organisations to workshops and training courses relating to climate change issues.

8.0 GOVERNMENTAL MEASURES AND POLICIES TO LIMIT EMISSIONS AND ENHANCE SINKS

8.1 INTRODUCTION

Niue's communities and government officials recognize the increasing emergence of environmental problems related to land and forest use. One of the 1994 Niue's Strategic Developmental Plan's main national objective is ***"To promote the conservation and sustainable utilization of our unique environment."***

By becoming a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto protocol, and the Montreal protocol, which is currently in the process of being ratified, Niue has demonstrated commitment. Niue has also signed the Convention on Biological Diversity (CBD) and the Convention to Combat Desertification.

The following Sectoral policies and legislation have implications regarding potential climate change scenarios and greenhouse gas emissions. The National Energy and the National Forestry policies are more detailed, as they are the major contributors to greenhouse gas emissions and emission sinks, respectively.

I. NATIONAL ENERGY POLICY

The overall national energy policy is "to minimize Niue's dependence on petroleum products by actively encouraging fuel conservation and efficient end use."

The national energy policy is further broken down into the following sectors, each with their individual policies contributing to the national energy policy goal.

Petroleum Sector

- Secure a reliable supply of petroleum products at minimum landed cost and conformation to agreed product standards and specifications.
- Secure reliable supply of petroleum products, actively encourage fuel conservation and efficient end use and by utilizing cost-effective alternatives.
- Ensure safe handling and storage of petroleum products, and to minimize the impact of petroleum handling, storage and waste disposal.

Transport Sector

- Maximization of fuel conservation and efficiency in the transport sector.
- Minimize detrimental impacts of petroleum product consumption in the transport sector, on the land, air and marine environment.

Electricity Sector

- Establishment and maintenance of an efficient, semi autonomous and commercially orientated power corporation that is able to provide ongoing cost-effective and reliable electricity to meet the developing demand for electricity in its areas of service.

- To minimize the detrimental impact of the power generation and distribution system on the environment and the community.

New and Renewable Sources of Energy

- To ensure Niue's limited biomass energy resource is used efficiently and in an economically sustainable manner.

- To maximize the contribution of appropriate, proven and cost-effective renewable technologies utilizing indigenous energy resources to help meet Niue's energy needs.

Environmental Aspects

- To minimize the impact of energy production, distribution, and consumption on the environment, and to ensure that energy resources are consumed in an equitable and environmentally sustainable manner.
- To ensure close co-operation and co-ordination of organisations in the energy sector within the framework of the "Niue National Environmental Management Strategy"

Energy Conservation and Efficiency

- To minimize Niue's energy demands without adversely affecting Niue's economic and social programmes and to maximize the efficiency with which energy is used.

II. NATIONAL FORESTRY POLICY

A National Forest Policy draft has been compiled and has yet to be aproved by Cabinet. However the following sets of guiding principles have been identified as structural guidelines for the National Forestry Policy. They include:

Sustainable Resource Use

- To maintain and develop the ecological, cultural and economic values of Niue's forests and ensure that any development of the forest respects the livelihood of the present generation without impacting on the needs of future generations.

Forest Conservation and Protection

- To protect forests, to safeguard the plants, animals and genetic resources of Niue and to maintain endangered habitats, historic and sacred sites.

Basic Human Needs

- To ensure opportunities for essential subsistence needs from the forests for food, water, fuel, building material, medicines, cultural materials, and recreation.

Individual and Collective Responsibilities

- To foster nationwide consensus of the values of forests through individual and collective responsibilities in the control and management of forests while respecting the "magafaoa" ownership of the land and resources.

Economic Development

- To enable opportunities for development of a range of sustainable forest based industries subject to the resource capability, to contribute to Niue's economic development

III. AGRICULTURE

The national goal of the Department of Agriculture, Forestry and Fisheries is "To promote and protect the development of an environmentally sustainable and viable Agriculture, Fishing and Forestry base."

The main objectives required to achieve these are:

- To increase and improve the level of research for sustainable agricultural farming systems.
- To actively promote integrated pest management as an alternative to the sole use of chemical pesticides.
- To create and establish an Indigenous Forest working group to promote conservation and sustainable use of the existing indigenous forest resources.
- To promote sustainable Forest Management.

IV. HEALTH

Emphasis is placed on prevention rather than cure and is of national importance, with a healthy lifestyle and clean environment being actively promoted by the Health Department through the ***Moui Ola Ola*** (Healthy Island) programme which was until recently sponsored by Australian Aid. The Health Department regularly monitors water quality and also conducts public health inspections within each village on a regular basis. The following Legislation has been passed for these areas:

- ***Mosquito Control Act 1980***, which is used to prevent litter, which creates potential breeding, places for mosquitoes.
- ***Niue Public Health Ordinance 1965*** which provides for the sanitation of buildings and dwellings.
- ***Niue Village Council(s) Ordinance 1967,*** which contains, provisions relating to village cleanliness in addition to dealing with health, sanitation and public nuisance issues.
- ***Niue Public Health Ordinance 1965*** and the ***Niue Act 1966 (NZ)*** have provisions for the quality of the water supply.

In addition the ***Agriculture Quarantine Act (1984)*** provides regulations to ensure proper management of rubbish tips and to minimize animal access to these.

V. INTERNATIONAL TREATIES

Additional environmental treaties to which Niue is a party include:

- *Convention on International Trade in Endangered Species of Wild Fauna and Flora,* 1973, Washington (CITES);
- *Convention on Conservation of Nature in the South Pacific,* 1976, Apia (Apia Convention);
- *United Nations Convention on the Law of the Sea*,1982, Montego Bay;
- *South Pacific Nuclear Free Zone Treaty,* 1985, Rarotonga;
- *Convention for the Protection of the Natural Resources and Environment of the South Pacific Region,* 1986, Noumea (SPREP Convention);
- *Treaty on Fisheries Between the Governments of Certain Pacific Island States and the Government of the United States of America,* 1987, Port Moresby;
- *Convention for the Prohibition of fishing with Long Driftnets in the South Pacific,* 1989, Wellington (Wellington Convention);
- *UNCCD (United Nations Convention to Combat Desertfication)*

CONCLUSION

As the smallest self-governing nation in the world, Niue has taken its commitment to ensuring the protection of its unique environment seriously. Although Niue has a small population, there is a consensus amongst its people of the need to protect the tropical forests and the reefs, and the biodiversity within these environments.

Ironically it is the underdeveloped nations of the Pacific region, that on a global scale produces minimal greenhouse gas emissions. However they will be most affected by adverse climatic conditions imposed by the excessive emissions of the larger developed nations.

It is in the signing of these Conventions and their implementation that the predicted changes associated with climate change such as the associated health problems, loss of flora and fauna species, threats to food security, disaster relief, and migration may be alleviated to some extent.

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NIUE CLIMATE CHANGE PROJECT

The meaning of the Logo is Niue Island amidst the elements that affects Niue's Climate and that is the Sun, Sea, Clouds, Vegetation, Land and Air.

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