

**Implications of Climate Change and  
Sea Level Rise for  
the Cook Islands**

**Report of a Preparatory Mission**

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# Executive Summary

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This report details the findings of a two-person climate change task team mission to the Cook Islands during the period January 14-22 1992. The report outlines the possible impacts of climate change and consequent sea-level rise on the natural, physical, social and economic activities as perceived by the authorities and organisations in the country. Possible response options were difficult to identify because local scientific information about impacts was not available.

The problem of the lack of Cook Islands-specific information made it difficult to secure government support hence specific studies on climate change and sea-level rise were given low priority. However, by supporting and expanding on-going programmes, local knowledge about climate change and consequent sea-level rise could be improved without major changes in current social, economic and environmental priorities. Thus this report suggests the following for further in-depth study and funding;

- Rarotonga foreshore monitoring programme
- Coral reef inventory programme
- Studying seabird ecology
- On-site meteorological forecasting capabilities
- Expansion of climate and weather monitoring capabilities
- Resource accounting in the national accounts system
- Systematic study of Manihiki atoll

Inclusion of the in-depth evaluation of impacts of climate change and sea-level rise will ensure not only accumulation of country-specific information but also provide training and experience for the appropriate local personnel, authorities and organisations.

# The Report

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## 1. Introduction

### 1.1 Background

Through previous studies conducted under the auspices of the South Pacific Regional Environment Programme (SPREP) and supported by the United Nations Environment Programme (UNEP), Pacific Island states have been identified as being under threat of major environmental change due to the expected greenhouse-forced global warming and consequent sea-level rise.

Some of the environmental problems identified in these studies have already been detailed (Pernetta and Hughes 1990), but there is no comprehensive coverage of each country. Based on a measure of impacts which take account of the size of the country, its insularity, relief and the number of atolls and raised coral islands in the country, Pernetta and Hughes identified four categories of countries with varying susceptibilities to changes in sea level. The countries identified in this report as likely to experience profound environmental and social impacts are Tokelau, Marshall Islands, Tuvalu, Line Islands and Kiribati. Countries where severe impacts were anticipated include the Federated States of Micronesia, Palau, Tonga, Pitcairn, Nauru, French Polynesia, Niue and the Cook Islands (ibid:23).

The first of a series of preparatory missions was conducted in Kiribati (Sullivan and Gibson 1990). The general aim of this preparatory mission was to prepare a proposal for an in-depth study of the potential impact of expected climate change on the natural environment and socio-economic structures and activities of Kiribati.

A two person task team supported by SPREP and the Association of South Pacific Environmental Institutions (ASPEI) visited the Cook Islands for the duration of 8 days to undertake a similar preparatory mission in consultation with national counterparts.

### 1.2 Purpose of the mission

The main objective of the mission was to prepare, in close association with national experts, a proposal for a programme of assistance to undertake an in-depth study of the potential impact of expected climatic changes due to global warming and the consequent sea-level rise on the natural environment and the socio-economic structures and activities of the Cook Islands.

The proposal includes identifying response options suitable and available to avoid or mitigate the expected negative impacts of climatic change.

Working closely with the national experts of the Cook Islands the SPREP Task Team on Climate Change had the following terms of reference;

- i) examine and evaluate the available information affecting the physical and biological environment of the islands and atolls comprising the Cook Islands;
- ii) examine and carry out a preliminary assessment of available demographic, social (archaeological and cultural) and economic data of the Cook Islands,
- iii) present the results of relevant studies as to their applicability to the case of the Cook Islands;

- iv) discuss with the national authorities, organisations, institutions and experts their perceptions of the consequences of the potential impacts of climatic change and seek their views on suitable response options;
- v) identify national authorities, organisations, institutions and experts which may participate in the in-depth study to follow the mission, and determine the modalities of cooperation between the legal and administrative structures of the Cook Islands with the team which will assist in the implementation of the in-depth study.

On the basis of the activities above, a report was to be prepared containing,

- i) a general overview of the climatological, oceanological, biological and socio-economic factors which may be relevant to or affected by the potential impact of expected climatic change;
- ii) a preliminary identification of the most vulnerable components and sites of the natural environment, as well as those socio-economic structures and activities which may be most critically affected by expected climatic change;
- iii) an overview of current environmental management problems in the Cook Islands and an assessment of how such problems may be exacerbated by climatic change;
- iv) a detailed proposal for a joint programme of assistance to the Cook Islands for the in-depth evaluation of the potential impacts of expected climatic change on the natural environment and the socio-economic structures and activities of the Cook Islands including the identification of the policy or management options suitable to avoid or mitigate the impact of climatic changes; the proposal should identify the workplan, timetable and financial requirements of the in-depth evaluation as well as the possible institutional arrangements for carrying out the evaluation.
- v) Before leaving the Cook Islands the mission will present to and discuss with the authorities, the outline of the proposed programme as well as the major findings of the mission. The comments and suggestions of the authorities of Cook Islands will be duly taken into account in preparing the final report of the mission.
- vi) the final report of the mission will be transmitted by SPREP to the government of Cook Islands through the Cook Islands Conservation Service within 30 days of the completion of the visit.

### 1.3 Programme of visit

The preparatory mission to the Cook Islands took place between 14th and 22nd January 1992. Only the island of Rarotonga was visited on this trip but both consultants were familiar with other islands and atolls from previous longer visits to the Cook Islands. The mission was organised by SPREP and was planned by the Cook Islands Conservation Service. The outline of the programme of consultations with relevant organisations in Cook Islands is in Appendix I.

## 2. Cook Islands: Physical Setting

### 2.1 Location

The Cook Islands comprises 15 islands spread over 2,000,000 km<sup>2</sup> of ocean (Figure 1). With a total land area of only 237 km<sup>2</sup>, the island chain extends from 8° to 23° South latitude and 167° to 156° West longitude, and is often divided into two groups of islands: the Southern and the Northern Groups.

The Southern Group consists of the volcanic island of Rarotonga and high islands of Mangaia, Mauke, Mitiaro, Atiu, and Aitutaki. Included in the Southern Group are two small uninhabited raised coral cays, Manuae and Takutea situated north of Atiu island.

The Northern Group includes the inhabited atolls of Pukapuka, Nassau, Manihiki, Palmerston, Rakahanga and Penrhyn and the uninhabited atoll of Suvarrow. The distance between the southernmost island of Mangaia and the northernmost island of Penrhyn is over 1,400 kilometres.

### 2.2 Geology

The Southern Group comprise two parallel volcanic chains of islands extending over 2,600km (Stoddart *et. al.* 1990). The southern chain extends from the Macdonald seamount in the southeast to Rarotonga in the northwest and the northern chain extends from the Austral Islands of Rapa and Marotiri in the southeast to Palmerston atoll in the northwest. It is along this chain that Mauke, Mitiaro, Atiu, Takutea, Manuae and Aitutaki islands are located. Mangaia which lies on the southern chain between Rarotonga and the Macdonald seamount, is the only island that fits the model of "age-distance" correlation from the Macdonald hotspot. The other islands in the Southern Group are considered too young and their age and degree of geomorphic development present a complex geology. Some of these complexities have been outlined by Stoddart, *et. al.* (1990).

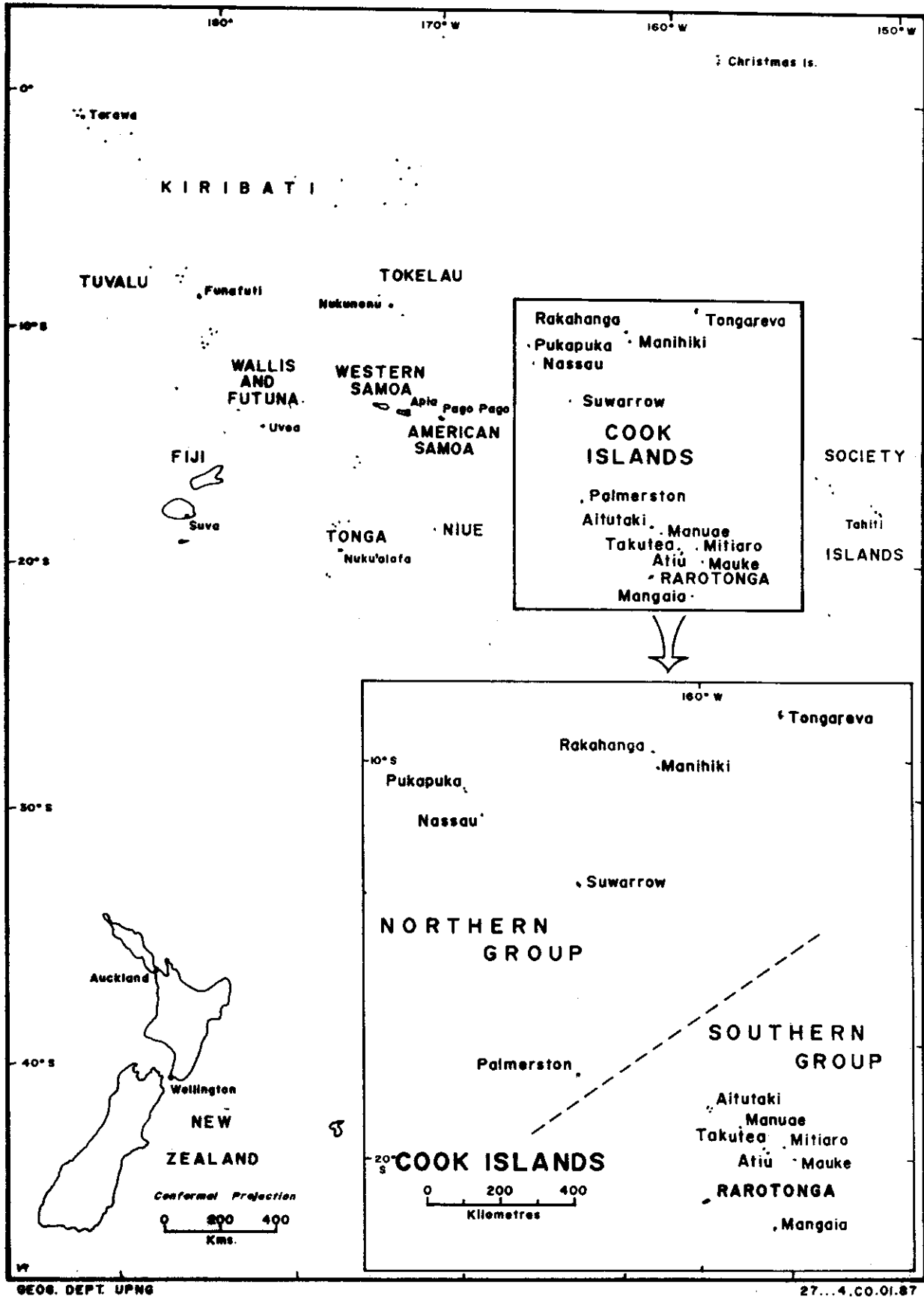
All islands in the Southern Group consist of a series of volcanoes of different ages, some of which are young with narrow fringing reefs and others capped with limestone elevated to form what is locally known as *makatea*. The islands all rise from the sea floor at depths of 4,500-5,000m.

There is no comprehensive account of the geology of the atolls in the Northern Group. Accounts of the physical environment have been dealt with sporadically on a island by island basis (see for example Bullivant 1974a and 1974b).

The process of atoll development in the Northern Group has been attributed to Darwinian subsidence (Stoddart 1975). There is no direct evidence of the depth to volcanic basement but seismic data from Manihiki suggests a dome-shaped basement with volcanic rocks at 500m beneath the peripheral reef but only 50m depth at the centre of the lagoon. The most recent work on the geological history has been given by Gray (1991) who suggested that Manihiki, Penrhyn, Pukapuka, Suvarrow, Nassau and Rakahanga lie on a submarine plateau.

The northern volcanic island chain of Mauke-Palmerston is considered to be of early Tertiary where the volcanics are heavily eroded and capped with limestone. Rarotonga, with a stronger relief, is estimated to be about 2.3 million years old while Mangaia is much older (Marshall 1927). The maximum age for the Southern Group of the Cook Islands is about 22.5-65 million years as indicated by evidence from a deep-sea drilling programme (Winterer 1973).

Figure 1. Location map of the Cook Islands.





## 2.3 Climate

The climate of Cook Islands is influenced by its oceanic setting. A large-scale zonal (E-W) circulation which operates over the equatorial Pacific known as "Walker circulation" influences local weather conditions in the Cook Islands, bringing moist air, and weakens from November to March. With the positioning of the Inter-Tropical Convergence Zone (ITCZ) south of the equator, maximum convective activity results in lowering of surface pressure and high temperatures, causing tropical depressions, storms and cyclones which are experienced in the Cook Islands during the same period.

Average annual rainfall is approximately 2,000mm, with an average maximum temperature of 27°C and a minimum of 20°C and the sunshine hours of 5.8 hours (Gray 1991). Mean temperatures in the zone southwest of the South Pacific Convergence Zone (SPCZ) (subantarctic islands in the Tasman sea to Rarotonga in the southern Cooks) show an increase of 0.5-0.7°C from the 1940s (Salinger 1992). Annual rainfall totals show that Penrhyn (northernmost island of the Cooks) has become wetter while Palmerston atoll in the southern Cooks has become drier since the 1940s. This variability in rainfall is attributed to the influence of El Nino-Southern Oscillation (ENSO) system (Salinger 1992). Rainfall and temperature records for the Cook Islands have been summarised by the New Zealand Meteorological Service and are published in a monthly bulletin, *South Pacific Climate Monitor* (Basher 1992).

The climatic cycles resulting from oceanographic phenomena affecting the Cook Islands (i.e., Cook Island specific) are scanty. Only recently have parameters such as tide levels been recorded. A tide gauge at Avarua, Rarotonga was installed in 1977 and all tide data have been sent to Hawaii branch of the United States National Oceanic and Atmospheric Administration (NOAA).

## 3. Economic Structure of the Cook Islands and Effects of Expected Climate Change

### 3.1 Population and Settlement

The demographic history of the Cook Islands since 1900 can be divided into four periods: a) a period of gradual recovery from the decline of the nineteenth century lasting to the late 1920's, b) a period of slow but increasing growth leading to the peak population of 21,323 in 1971, c) a period of rapid but decelerating decline from 1971 to 1981 (ESCAP 1983), and d) a period of population stability through the 1980's to the present (Hayes 1992).

Preliminary figures of the 1991 census showed a population of 18,300 (Cook Islands Statistics Officer, pers com 1992), 96% of whom are of polynesian descent. The population is not distributed evenly throughout the island group. In 1986, 56% of the population lived on Rarotonga and preliminary figures from the 1991 census indicate that this proportion may have grown to over 60%. Likewise population densities range from 146 km<sup>-2</sup> in Rarotonga to 12 in Mitiaro (Table 1).

For the period 1981-1986 the average annual growth rate for the whole country was -0.16%. However, there was considerable variability in population growth by island. Some islands experienced a high rate of growth, such as Palmerston, while others recorded a major population decline, such as Atiu which had an average annual rate of -4.28%. These wide variations highlight the erratic nature inherent in small island populations and emphasize the need for consideration of longer term demographic processes (see Hayes 1992) complimented by micro-level analysis.

Table 1. Population distribution, density and change, 1981-1986

Island	Area (km <sup>2</sup> )	Population (1986)	Density (km <sup>-2</sup> )	Population growth# (1981-86)
Rarotonga	67.1	9,826	146	0.61
Aitutaki	18.3	2,390	131	0.47
Atiu	26.9	957	36	-4.82
Mangaia	51.8	1,229	24	-2.06
Manuae	6.2	-	-	-
Mauke	18.4	692	38	0.32
Mitiaro	22.3	273	12	1.29
Takutea	1.3	-	-	-
Manihiki	5.4	508	94	4.64
Pukapuka *	2.6	880	338	-1.10
Palmerston	2.1	66	31	5.29
Rakahanga	4.1	282	69	0.72
Penrhyn	9.8	497	51	-3.95
Suvarrow	0.5	-	-	-
Total	236.8	17,614	75	-0.16

# average annual growth rate assuming geometric growth

\* includes Nassau

Source: Derived from ESCAP 1983 and Cook Islands Statistics Office, CPD 23/91.

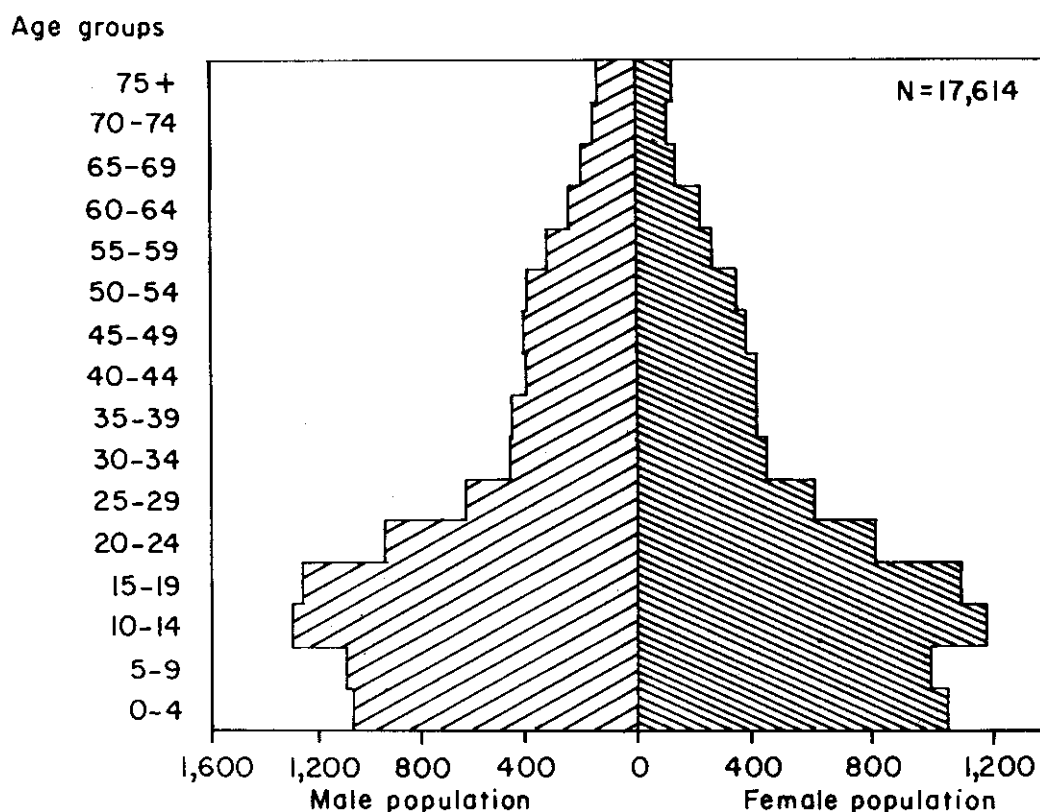
Although a low population growth rate is recorded, the age structure of the Cook Islands reveals potential for natural increase. In 1986, the Cook Islands population could be described, demographically, as young, having a relatively high proportion of the population in young age groups (i.e., under 20 years) and smaller numbers in the working age populations (Figure 2).

However, recent censuses show an ageing of the population with a 15% decline in the 0-14 age group between 1966 and 1986, and a 4% increase in those aged over 55 years during the same period. A further increase in aged Cook Islanders is likely to occur when the New Zealand government allows long-term Cook Island residents in New Zealand to receive New Zealand superannuation while permanently resident in the Cook Islands. At present, there is a residency restriction and many eligible superannuitants move between the two countries to retain their eligibility.

High population mobility between New Zealand and the Cook Islands characterises the migration history of the Cook Islands. A political status of self-government in free association with New Zealand grants Cook Islanders New Zealand citizenship, thus allowing free movement between the two countries. More Cook Islanders live in New Zealand (21,000 in 1986) than in the Cook islands but there is much movement between the two countries. Since 1987 more than 3,000 overseas Cook Islanders visited the country each year.

Population movement between the two countries in the future will be influenced by a variety of factors, any combination of which will alter the composition of the population in the Cook Islands. On the one hand, outward flows from the Cook Islands to New Zealand may diminish because of the current structural adjustment of the New Zealand economy. Fewer jobs will be available for young Cook Islanders who are most likely to leave the country for work in New Zealand. On the other hand, many Cook Islanders resident in New Zealand belong to the vulnerable lower income group and may consider returning to the Cook Islands.

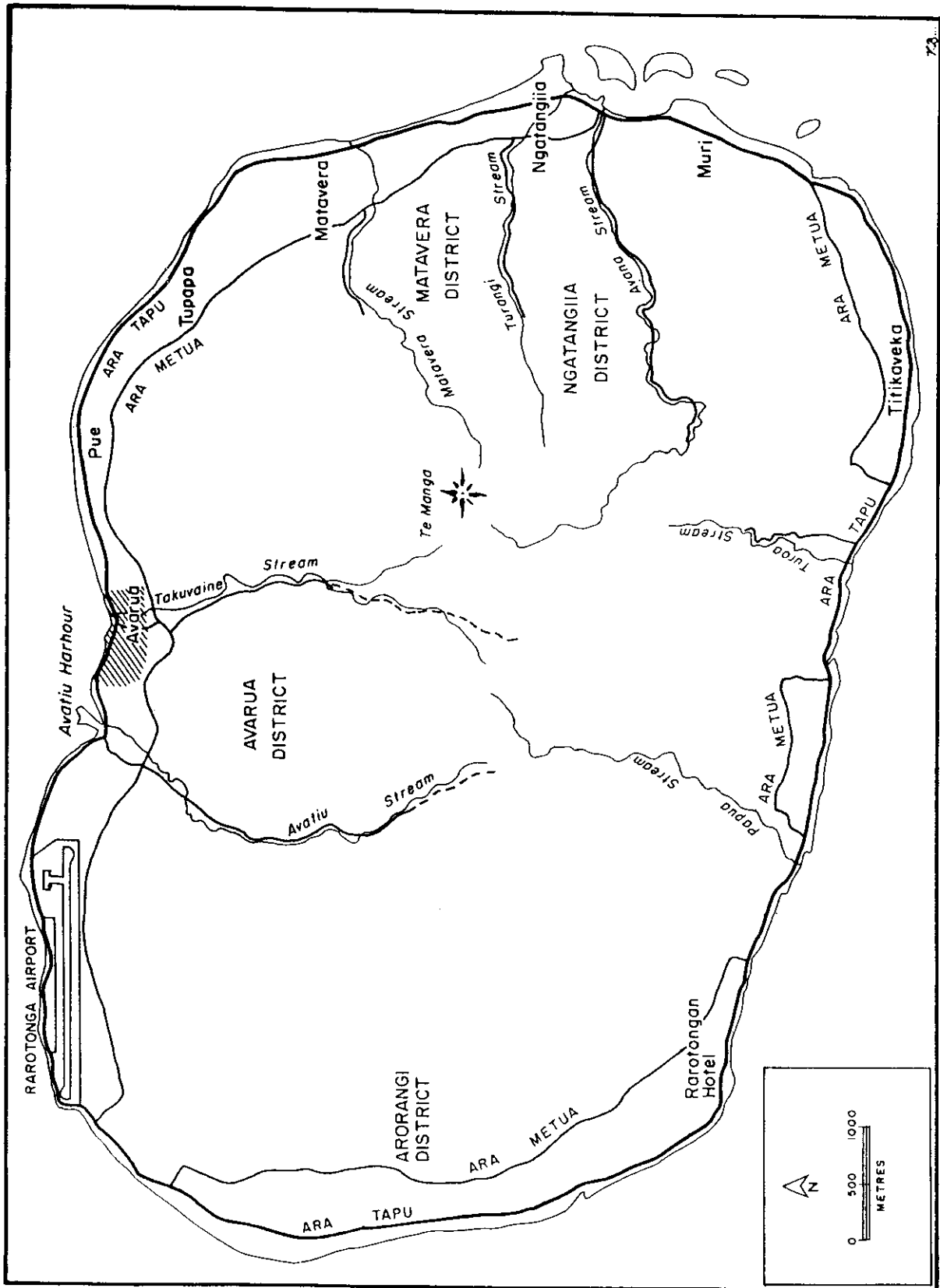
Figure 2. Population Structure of the Cook Islands, 1986



Settlement of Rarotonga is concentrated on the coastal zone extending along the 33km main encircling road, the *Ara Tapu*. The main town of Avarua and the nearby Avatiu Harbour on the northern side of the island comprise the only built-up commercial area in the country (Figure 3). Continuous residential settlement is found from the main town of Avarua, westward past Avatiu Harbour and the airport, and through to Arorangi district. Continuing anti-clockwise around the island, residential settlement is clustered around Titikaveka, Muri, Ngatangia, Matavera and Tupapa. In the last few years houses have been built on the flanks of mountainous central core of Rarotonga.

On the other islands of the Southern Group, people are concentrated in two or three main villages, some inland and others on the coast. On the atolls of the Northern Group, two or three villages are located on the large islets with frequent movement by motor boats between these large islets and small uninhabited *motus*.

Figure 3. Rarotonga, Cook Islands.



These population patterns have a notable effect in the Cook Islands. On Rarotonga, more houses are being built and there is concern about the strain on the physical infrastructure. There is also a perception that land previously used for agriculture is threatened by people building further up the slopes. On some outer islands, especially in the Northern Group, growing population puts pressure on valuable land for gardening, and water and sewage facilities.

Although these population trends and patterns are not directly affected by expected climatic change, being due mainly to economic and social factors, a growing population will put pressure on the environment. The added stress of climatic change on the physical environment will have a direct feed-back effect on population and settlement patterns. However, combining the free and therefore unrestricted entry of Cook Islanders to New Zealand with the close family connections there, it is unlikely that Cook Islanders will be without another place to live in the event of devastating natural disasters.

### **3.2 Economic Structure**

Most Cook Islanders are employed in social and public services, and agriculture. The services sector dominates the economy contributing 77% of GDP, most of which comes from public administration (Ministry of Planning and Economic Development 1992). The agricultural sector is relatively weak contributing 18% of the GDP although 67% of households are recorded as being agriculturally active, mostly in subsistence activity (Agricultural Census 1988). The manufacturing sector is small but has potential for growth with the expected development of tourism and the black pearl industry.

Overall economic growth between 1983 and 1990 averaged 6%, though the effect of this was not evenly spread throughout the country. As the seat of government, and the main commercial and trading centre, Rarotonga attracts most development funds. Rarotonga is also a fertile volcanic island, suited to agricultural development, while the Outer Islands have most of their economic potential in human and marine resources.

### **3.3 Economic Development**

Economic development in the Cook Islands between 1982 and 1990 has been summarised by the Ministry of Planning and Economic Development 1992 as follows:

- 1) weak agricultural growth, especially in the Outer Islands,
- 2) an increase in industrial output up to 1987,
- 3) weak export performance with a decline in both export volume and world prices,
- 4) a climbing trade deficit,
- 5) substantial increases in tourism revenue, and
- 6) an increase in the level of overseas debt.

The Cook Islands has committed itself to a development strategy which will affect its social and economic structure more than any long-term environmental change.

Direct budgetary support from New Zealand is being phased-out and new sources of capital are being sought and secured. Although aid flows will continue to comprise much of the development budget, foreign loans will grow, thus exposing the economy of the Cook Islands to the vagaries of changes in external credit conditions. The Cook Island Government is confident of being able to turn future investments into self-sustaining growth areas (Ministry of Planning and Economic Development 1992).

Future directions in the economic development of the Cook Islands focus on the physical infrastructure (improving roads, harbours, water and sanitation services), tourism (developing local resources, expanding the market into North America), agriculture (developing off-season fruit, import substitution), marine resources (extending local offshore pelagic fishing, pearl farming), off-shore financial services, and human resources (strengthening education and health).

Most of these developments are targeted for Rarotonga and the Southern Group. The notable exceptions are harbour developments for Penrhyn, Aitutaki, Mangaia, Atiu and Mauke and marine resource developments such as pearl shell and trochus in the Northern Group.

## **4. Current Environmental Management Problems**

### **4.1 Legislative framework**

Environmental management in the Cook Islands has in the past suffered from the lack of a comprehensive legislation covering all aspects of environmental management and procedures. However, under the *Conservation Act 1986-1987*, a Conservation Service was established as a corporate body responsible for administering, protecting, conserving, managing, and controlling areas physical, biological, social and cultural in the country. This Act was later found to be insufficient on legal and technical grounds which in effect undermined the existence of a Conservation Service as a corporate body.

Despite this the Conservation Service is actively involved in a number of projects. It has recently established a Technical Committee on Climate Change which will organise, coordinate, advise and disseminate information concerning climate change coming into the Cook Islands.

The Conservation Service cannot, at present, carry out and perform its functions effectively. New legislation is being drafted for approval by Parliament in April 1992. The New Conservation Act 1992 will give wide-ranging functions and powers to the Officers of the Conservation Service, including environmental impact assessment capability and the ability to generate funds from within the country and also from outside sources.

Social impact assessment is also a critical component of environmental management but is currently not being undertaken by any organisation in the country. It could be included within the scope of the Conservation service under the proposed new Act.

Besides the lack of a legislative framework for environmental management, a number of environmental problems are experienced in the Cook Islands including garbage and sewage disposal, coastal erosion, reduced land capabilities and endangered bird-life. All of these problems are likely to be exacerbated by climate change and potential sea-level change. However, the conclusion of the Cook Island Technical Committee on Climate Change was that the different time spans within which these problems will be felt, warrant different priority for action. Thus the problem of garbage and sewage disposal is seen as an immediate problem requiring immediate consideration without necessarily considering the longer term effects of climate change and sea level rise.

## **4.2 Sewage disposal in the Northern Group.**

Currently there is a widespread concern over the disposal of sewerage in the Outer Islands. Since 1986, the Public Health Department has embarked on a programme of converting over-the-water latrines (banjo) into pour-flush toilets. By 1989, two thirds of all dwellings in the Northern Group had pour-flush toilets with some households having access to both types of toilets, the banjo being reserved for times of insufficient water supply. The introduction of pour-flush toilets has caused water shortages already and this is directly related to climatic variability. Prolonged dry periods and the subsequent shrinking of rain-fed fresh water lenses will hasten groundwater contamination and put more pressure on rain-fed water tanks.

## **4.3 Storm induced coastal erosion**

Coastal erosion due to storms is a concern, particularly around the densely populated northern and western coastline of Rarotonga, but also on the Outer Islands. Currently protection against beach erosion involves dumping of rocks on the eroded coastline. This method does not seem to be viable and effective because in the event of high seas these rocks maybe washed onto the shores, and at times are life-threatening.

An erosion and inundation scheme has been suggested for use in the protection of the coastline (Kirk 1991, Dorell pers. com. 1992). Concrete coastal protection units (CPUs) function as open-ended permeable traps which retain sand. Such units at the frontage of the Rarotongan Hotel in Rarotonga trapped 1200m<sup>3</sup> of sand in 3.5 months. This gives an equivalent average rate of 10 tonnes of sand per day (Kirk 1991). Evidence from monitoring these CPUs, indicate beach accretion along the frontage of the Rarotongan Hotel. Such technology could be applied to the coastlines where erosion is occurring.

## **4.4 Threatened coral reef system**

Another commonly expressed environmental concern was the state of the coral reef system. Increasing turbidity from storms and land use practices such as development of tourist facilities on the foreshore, are currently threatening the coral reef system. The Cook Islands Technical Committee on Climate Change held the unequivocal view that fringing reef systems around Rarotonga and some Outer Islands are threatened by commercial foreshore development. Unfortunately there is no scientific evidence to substantiate this view. Studies are needed to assess the significance of such impacts. It is expected that the extent of this threat to the fringing reefs will be known at the completion of the coral reef inventory project (see page 18).

## **5. Vulnerable Components and Sites**

The most vulnerable components and sites affected by greenhouse-forced climate change in the Cook Islands are outlined here, first by reference to natural features of the environment, then in terms of economic sectors.

## **5.1 Shorelines**

The potential impact of climate change on coastlines in the Cook Islands is likely to be more dramatic than the consequent sea-level rise. This is because much of the coastline consists of unconsolidated and permeable beach rock which can be easily eroded either by high energy wave storminess or by lateral erosion caused by heavy rainfall on high islands. Sea-level rise will also affect shorelines through inundation. A study by Nunn (1990) showed that 17% of Rarotonga is below 1.5m and if the sea-level was to rise by 1.5m much of this land area would be inundated.

## **5.2 Freshwater lenses**

Saltwater intrusion into the freshwater lenses could pose a threat to sustained drinking water supply (Sullivan and Gibson 1990). This is most critical for the people in the Northern Group who rely completely on the freshwater lenses and rain-fed water tanks. In addition, saltwater intrusion could create problems for agricultural activities, particularly on Rarotonga, with the development of brackish water bodies in low lying cultivation areas, especially during long dry periods.

## **5.3 Coral reef systems**

The impacts of global warming and consequent sea-level rise on coral reefs has been well documented, with variable results (Wiens 1962, Buddmeier and Hopley 1988, Hopley and Kinsey 1988 and Gray 1991). It is clear that climatic variability enhanced by greenhouse-forced global warming will affect the reef ecosystem more so than the consequent sea-level rise. Coral reef growth is correlated with rising sea-levels, although coral growth may lag behind the apparent increase in sea-level due to thermal inertia of oceans (Woodroffe and McClean 1990). Therefore, the rate at which climatic change may occur is a major threat to the coral reef systems.

The assumed doubling of CO<sub>2</sub> levels and rise in ocean surface temperatures may alter the temperature regime conducive to reef growth. However, land development and disturbance to the coastline by construction, together with climatic variability, are likely to affect coral reef ecosystems not only around Rarotonga but also on Outer Islands and atolls. A recording and monitoring system is required so that greenhouse-forced changes in reef environments are differentiated from changes that are immediately natural and human.

## **5.4 Sea bird colonies**

Suvarrow atoll in the Northern Group and Takutea island in the Southern Group have two of the most vulnerable bird colonies in the Cook Islands (McCormack and Kunzle 1990). No comprehensive study exists for the potential impact of climate change on the ecology of bird colonies. Climatic variability including a greater incidence of tropical weather extremes, such as drought and tropical cyclones, could decimate sea bird populations.

## **5.5 Marine life**

The Cook Islands Ministry of Marine Resource perceives marine life, such as fish, crustacea and mollusc, to be threatened by the long-term effects of climate change, its impact on ocean circulation and sea-level rise. Further, global warming and circulation of the ocean was also thought to affect the considerable fishery resource of the Cook Islands 200-mile economic zone.



## **5.6 Socio-economic structure**

Considerable socio-economic change is occurring in the Cook Islands, but climatic change is not a major contributory factor. Far more important factors are the restructuring of the economy as it shifts away from direct budgetary aid from New Zealand, the development of tourism as the king-pin of the economy, population mobility between New Zealand and the Cook Islands, and the rapid development of black pearl farming in the Northern Group. The relegation of climate change to an insignificant component in the social and economic development of the Cook Islands is due to the timescale in which climate is expected to change and the lack of indicators specific to the Cook Islands environment.

## **5.7 Agriculture**

Climatic variability may prolong both the length of dry spells and the intensity and amount of rainfall. There is a concern that prolonged droughts will raise the likelihood of fires which destroy protective vegetation and agricultural crops, thus increasing the incidence of soil erosion, and in turn reducing land productivity. Concern was expressed by agricultural experts in the Cook Islands that excessive rainfall would threaten the viability of certain crops. Controlled watering through irrigation was suggested as one response but more work is needed to explore this option.

## **5.8 Tourism**

Climatic change has been identified as a potential factor shaping future tourist activities. More specifically, consideration is being given to the development of indoor activities for 'inhospitable days'. Strategic consideration is also given to the siting of costly tourist facilities on sea-front locations. The tourism industry in the Cook Islands, and throughout the Pacific, is particularly sensitive to such climatic variability and therefore requires careful consideration during future planning by the industry (Cook Islands Tourism Plan).

## **5.9 Marine resources**

Pearl shell farming is being given a high priority in the economic development of the Cook Islands, with a total export value of NZD565,000 in 1990, up from NZD50,000 in 1988. As yet little consideration has been given to the impact of climate change on this valuable resource. A comprehensive evaluation of the physical and socio-economic environment of pearl shell farming is yet to occur, but is a high priority for government. Other marine resources such as trochus shell and particular species of protein-rich fish may also be affected by climatic change and techniques are needed to identify the extent of vulnerability of such resources to climatic variation.

## **5.10 Physical infrastructure**

As the main island in the Cook Group, Rarotonga is notably endowed with roads, airport and port facilities. This infrastructure is currently targeted for donor aid money as it is seen as a critical component of economic growth and social development. In addition to upgrading the main coastal road, the *Ara Tapu*, major improvements have been made to the inland road, the *Ara Metua*, although it is still a narrower secondary road which does not quite encircle the island. Such improvements, though not stimulated by concerns over sea-level rise, ease the reliance on the coastal road which is more vulnerable to inundation due to storms.

The proposal to relocate government offices away from the present harbourside location in Avarua is sensible in light of the potential risk facing coastal locations. However, the stimulus is not concern over rising sea-levels, rather the commercial attractiveness of the site. A decision to relocate government offices inland may have spin-offs for further relocation plans should the coastal zone become increasingly threatened by storms.

The implications of moving non-agricultural activities like government offices onto prime, but limited, agricultural land need to be resolved. Furthermore, aspects of the land tenure system, such as the multiplicity of ownership and subsequent title fragmentation (Crocombe 1964), requires attention before Government is able to have a free hand in land-use planning. Although individualisation of land titles is increasing, title fragmentation and absentee land rights are critical areas for review (Matheson 1987).

### **5.11 Disaster Preparedness Programme**

The Cook Island has had a Hurricane Safety Act since 1973 in recognition of the susceptibility of the country to hurricanes from about November to April. According to the Chief Hurricane Safety Officer, the Cook Islands Hurricane Safety Plan appears to operate efficiently. Although increases in the frequency of storms and cyclones are expected, it was thought that the current Plan would be sufficient until the next century as its scope is limited to action taken during and immediately after a hurricane. The main area for improving its effectiveness lies in informing the public about being prepared. Restoring reasonable standards of living is the responsibility of the Ministry of Civil Defence, and mitigating the effects of hurricanes would require modifying the physical infrastructure - an area beyond the authority of the Hurricane Safety Plan.

## **6. Proposal for Future In-Depth Evaluation of Impacts**

### **6.1 Approach to future in-depth studies**

Among the individuals, organisations and authorities consulted, there was a general awareness of the impact climate change and sea level rise may have in the Cook Islands. However, in general, there was a sense of indifference about the need for **specific** in-depth evaluations of such impacts.

Those directly responsible for the physical environment indicated their desire for greater local capability in monitoring and measuring changes. This is seen as a means of building up country specific information on environmental change including, but not limited to, climatic variability and potential sea-level rise. Any such systems were required to be able to differentiate between green-house forced changes and changes that are caused by natural and human factors.

Those involved in the development of social and economic activities, expressed little support for in-depth evaluation in this area. The reason for this stems from the belief that other more critical factors are causing social and economic change, that island communities will adapt to climatic changes as they have in the past, and that the timescale for climate change and sea level rise was too long and therefore subject to much uncertainty. Furthermore, there was a view expressed that research into social and economic impacts would need to have a component for funding any proposed response options. For instance, a study investigating the effect of climate change on the supply of potable water on the atolls and recommending greater use of covered water tanks, would only solve half the problem unless there were funds forthcoming to build more water tanks.

This proposal focuses on the expressed desire for a programme of monitoring the impacts of climate change which can be incorporated into on-going programmes and projects so that a reliable Cook Island specific information base is established, with in-country skills to maintain it. Once this is available, suitable response options can be formulated. The Technical Committee on Climate Change felt that this monitoring would have to precede the development of response options, if government was going to fund such options.

The proposed projects which follow have been refined after initial discussions with the Technical Committee on Climate Change in Rarotonga. During these discussions the basic principle of future in-depth work on climate change in the Cook Islands, was identified; that is to enhance current programmes. Thus specific details regarding funding and timing should be developed in association with the specified lead agency.

## **6.2 Rarotonga Foreshore Monitoring Programme**

This is a long-term project begun in 1989 with a baseline survey of the Rarotonga coastline and the establishment of 33 sites for on-going monitoring. The methodology for this monitoring is simple but requires more funds for staff and transport to maintain the collection of data on a 6-monthly basis, or more often after storms.

This project has also included an aerial photographic survey to examine the changes in the coastline. More funds are required for a project to establish a baseline map of buildings located within the foreshore area.

### **Additional Programme Requirements:**

One extra staff and one vehicle

### **Lead Agency:**

Conservation Service

### **Support Agencies:**

Marine Resources

Trade, Labour and Transport (Harbour Engineers)

Survey Department

Ministry of Planning and Economic Development

### **Time-frame:**

Before 1993

## **6.3 Coral Reef Inventory Programme**

This is scheduled to begin in April 1992 in conjunction with a team from the University of Hawaii. It will provide the baseline study for subsequent coral reef monitoring. The study should involve simple methodology and the development of indicators of change which can be adopted locally. Local staff require in-country practical training in the use of technology for measuring such parameters as water quality, reef growth and reef die-back. Microatolls as natural recorders of sea-level changes (see Woodroffe and McLean 1990) could be identified and established around the Cook Islands to supplement the sea-level data collected from tide gauges.

**Additional Programme requirements:**

In-house training programme for local staff to learn practical techniques of measuring and monitoring water quality, reef growth, and reef die-back.

**Lead Agency:**

Conservation Service

**Support Agencies:**

Marine Resources

**Time-frame:**

Immediate and on-going

#### 6.4 Studying seabird ecology

Research has established the breeding phenology of seabirds on Suvarrow and Takutea. This provides a valuable baseline for future work. Given the significance of the atolls for breeding, more work is needed to monitor changes in the physical environment and how they affect breeding activities.

**Additional Programme requirements:**

Systematic study of physical environment and indicators of potential sea-level changes.

**Lead Agency:**

Conservation Service

**Support Agency:**

Marine Resources

**Time-frame:**

Before 1994

#### 6.5 On-site meteorological forecasting capabilities

Currently, all forecasting for the Cook Islands comes from Fiji and Hawaii. Inquiries are needed to check if meteorological data provided in American Samoa and French Polynesia is available to the Cook Islands. Another meteorological officer is also needed for on-site forecasting.

**Additional Programme requirements:**

One meteorological officer

**Lead Agency:**

Meteorological Service

**Support Agency:**

Conservation Service

**Time-frame:**

Before 1993

## 6.6 Expansion of climate and weather monitoring capabilities

At the present time there is a first-class weather station in Rarotonga and an automatic weather station in Suwarrow. Possibly two more automatic stations are required for other uninhabited islands. Plans are now underway to install an anemometer on Pukapuka, in mid-1992 as part of a World Meteorological Organization (WMO) project.

Tide gauges, installed by the Tropical Oceans Global Atmosphere Programme (TOGA), have been recording sea level changes in Avarua and Penrhyn since 1977. An automatic tide gauge is planned for installation at Avatiu Harbour on Rarotonga, although a better location would be Pukapuka to provide better geographical coverage and prevent duplication.

The Intergovernmental Panel on Climate Change (IPCC) has estimated that sea-level will rise at a rate of 6 cm per decade due to the thermal expansion of sea water and melting of glaciers (IPCC 1992). A long, continuous and precise time series of temperature measurements are required for observing and recording global warming. Tide gauge records in the Pacific have shown an apparent rise in sea-level (Wyrski 1990) but this rise has been confused with vertical movements of the land. A monitoring system is required that can differentiate between the sea-level rise due to global warming and the sea-level rise due to subsidence, not only in the Cook Islands but also in other parts of the South Pacific.

### **Additional Programme requirements:**

Two automatic weather stations.  
One physical scientist to collate and analyse sea-level changes due to global warming and tectonism (subsidence and uplift).

### **Lead Agency:**

Meteorological Service

### **Support Agency:**

Conservation Service

### **Time-frame:**

Before 1994

## 6.7 Resource accounting in the National Accounts System

The Cook Islands has recently established a system of national accounts based in the Statistics Office. Such an internationally comparable system provides more timely, relevant and reliable national accounts. The Statistics Office itself is committed to the regular maintenance and development of the system and this will become an increasingly important source of information on the economic structure of the Cook Islands.

There is a climatic variability index in the National Accounts System. This index allows for the effects of changes in the weather on annual production, e.g., Hurricane Sally significantly reduced fruit crops in 1987, so the index should be well below other "normal" years. The index was set at 100 for the period 1982 to 1986, and is reviewed in consultation with the Agricultural Planning Unit (Statistics Office 1990). Closer consideration of the applicability of this concept in the Cook Islands is worthy of further investigation. Key considerations would be to ensure that similar indices would be meaningful in small economies such as the Cook Islands. This system would have to be sustainable in terms of data collection given the current shortage of human and capital resources in the Statistics Office.

**Programme requirements:**

Funding for a Pacific-wide taskforce to explore the applicability and feasibility of resource accounting. This taskforce would comprise country representatives in Statistics, Treasury and Conservation / Environment in addition to qualified resource accounting consultants.

**Lead Agency in the Cook Islands:**

Statistics Office

**Support Agencies in the Cook Islands:**

Ministry of Planning and Economic Development  
Conservation Service

**Time-frame:**

Before 1994

### 6.8 Systematic study of Manihiki atoll

Because of the current and potential importance of Manihiki to the national accounts through the sale of black pearls, a multi-disciplinary study of the atoll would provide invaluable information on the sustainability of this industry. In addition to providing baseline information on the marine environment and establishing procedures for monitoring subsequent changes including climatic changes, it could also provide insights into the process of rapid socio-economic change currently happening on the island.

**Programme requirements:**

Multi-disciplinary team comprising a social scientist, a marine biologist, a marine geologist and a biogeographer to undertake an in-depth study of the physical, oceanic, social, economic and cultural environment.

**Lead Agency:**

Conservation Service

**Support Agencies:**

Marine Resources  
Ministry of Planning and Economic Development  
Statistics

**Time-frame:**

Before 1993

## **6.9 Summary of proposed projects**

- One staff member and vehicle for the Rarotonga Foreshore Monitoring Project.
- In-house training programmes to develop skills in the coral reef inventory programme.
- Study of seabird ecology.
- One meteorological officer for forecasting.
- Two automatic weather stations.
- One physical scientist for sea-level analysis.
- Taskforce on resource accounting.
- Manihiki study.

## **7. Institutional Arrangements**

The Conservation Service is seen as the organisation best-placed to co-ordinate efforts concerning climate change and sea-level rise. However, although the Conservation Service can continue its co-ordinating function of issues concerning climate change, it requires a legislative mandate to ensure both broad and more specific environmental issues like climate change are integrated into the current planning process.

The Government of the Cook Islands has recognised the critical importance of the environment to the future sustainable development of the country. Establishing a solid base of Cook Island specific information on environmental change will enable more responsive action to climatic variability and sea-level rise.

## **8. Conclusion**

The Cook Islands is a small island country vulnerable to vagaries of change; economic, social as well as environmental. The ability of the country to successfully cope with such changes, most of which are externally driven, lies ultimately with Cook Islanders themselves. Thus their perception of the impact of various interrelated changes is important because it is this perception which accords priority to dealing with the various issues. Thus the impact of climate change and sea-level rise must be assessed alongside that of economic, social and political development.

Two major problems became apparent during consultation and meetings with appropriate Cook Island authorities and organisations. First, is that there is a general lack of Cook Island-specific information about the impacts of the greenhouse-forced climate change and consequent sea-level rise. Second, although most authorities and organisations are aware of the possible impacts of climate change and sea-level rise, programmes for studying and monitoring such impacts have been relegated low priority due to the urgency of other social and economic issues. The lack of appropriately-qualified personnel and funds for specific climate change and sea-level rise studies also contribute to the low priority given to this area.

Future in-depth evaluation of impacts need to be incorporated into local on-going programmes, facilitated by external experts but managed by local authorities and organisations.

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# Annex

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## **Annex I: Programme of Visit to the Cook Islands**

### **Monday 13 January**

Arrived from New Zealand 10.30pm

### **Tuesday 14 January**

**Morning** Preliminary discussions with Director of Conservation, Mr Teariki Rongo, and Senior Conservation Officer, Mr Wayne King. Arranged meetings for following week.

**Afternoon** Arranged transport and accommodation.

### **Wednesday 15 January**

**Morning** Courtesy call and discussions with Hon. Vaine Tairea, Minister of Conservation, Agriculture, Trade, Labour and Transport, Civil Aviation, Shipping, Waterfront Commission. Acting Director of Research, Ministry of Marine Resources, Ms Patrica Tuara.

**Afternoon** Secretary of Internal Affairs, Mr Tony Utanga.  
Manager, Meteorological Services, Mr Arona Ngari.

### **Thursday 16 January**

**Morning** Full discussions with Conservation Service Staff including the Director, Senior Conservation Officer, Wildlife Officer, Ms Anna Tiraa, Foreshore Monitoring Officer, Mr Vaitoti Tupa.

**Afternoon** Development Economist, Ministry of Planning and Economic Development, Mr Brent Dark (Underhill). Research Scientist (SOPAC), Mr Stuart Kingan (Sem).

### **Friday 17 January**

**Morning** Statistics Officer, Mr Andrew Turua. Harbour Engineer, Ministry of Trade, Labour and Transport, Mr Ata Hermann and Mr Ben Parakuiti (Underhill).

**Afternoon** Chief Forestry Officer, Ministry of Agriculture, Mr Othaniel Tangianau.  
Director of Advisory, Ministry of Agriculture, Mr Anau Manarangi.

### **Monday 20 January**

**Morning** Manager of Meteorological Services (Sem).  
Chief Hurricane Safety Officer and Superintendent of Police, Mr Goldie Goldie.

**Afternoon** Director of Water Supply, Ministry of Public Works, Mr Kenneth Browne (Sem).  
Manager, Cook Island Tourist Authority, Mr Chris Wong (Underhill).

## **Tuesday 21 January**

- Morning Secretary of Health, Dr George Koteka (Underhill).  
Manager of Motor Centre and Environmental Consultant, Mr Don Dorrel (Sem).
- Afternoon Discussions with Technical Committee on Climate Change organised by the Conservation Service to discuss our preliminary suggestions for further in-depth work in the Cook Islands.

## **Wednesday 22 January**

- Morning Statistics Officer, Mr Andrew Turua.  
Government Anthropologist, Mr Kauraka Kauraka (brief).  
Director of National Museum, Mr Makuiti Tongia (brief).
- Interview with Cook Island Television on the purpose and findings of our mission.
- Afternoon Departed 3pm to Nandi and Auckland.

# Acknowledgements

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We would like to thank the Conservation Service, in particular Wayne King and Teariki Rongo, for assisting in the arrangements during our stay in Rarotonga, and allowing us access to their facilities. We appreciated the open and frank discussions we had with everybody, and thank them all for their time.

In addition to the above formal meetings, several informal discussions were held with many other people because they were on leave or they were just interested in the issues raised by our visit. In particular, we would like to thank the General Manager of Pacific Resort Villas, Mr Thomas Koteka; the Director of the Agricultural Research Station, Dr Matairangi Porea; the Secretary of Cultural Office, Mr Jon Jonassen; the Manager of Kiiiki Motel, Mrs Pauline Napa; and the Secretary of the Mataiapo Committee, Mr Tekeu Framhein.

Finally, thank you to Dr. Chalapan Kaluwin from SPREP who arranged our travel from Papua New Guinea to Cook Islands.