CLIMATE CHANGE - RESPONSE

REPUBLIC OF NAURU RESPONSE

1ST NATIONAL COMMUNICATION - 1999

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

REPUBLIC OF NAURU – OCTOBER 1999

Cover: Pinnacles (Topside) as a result of the phosphate mining.

DEPARTMENT OF ISLANDS DEVELOPMENT AND INDUSTRY

UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

REPUBLIC OF NAURU

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The Republic of Nauru, the “Pleasant Island”.

TYPICAL SCENES FROM NAURU

Pinnacles on the “Topside”

Loading Phosphate at the Cantilevers

PREFACE

This report has been prepared by Nauru's National Committee on Climate Change with the assistance of the Energy Unit of the South Pacific Applied Geoscience Commission (SOPAC), and approved by the Government of the Republic of Nauru. The National Committee on Climate Change was established in February 1998 under the Pacific Island Climate Change Assistance Programme (PICCAP) being coordinated by the South Pacific Regional Environmental Programme (SPREP).

The objective of the programme was focused on enabling the Pacific Island countries participating in the programme to compile their own national communications as required under Art. 12 of the United Nations Framework Convention on Climate Change (UNFCCC), and in line with the guidelines provided in Conference of the Parties (COP) 2 decisions incorporated in document FCCC/CP/1996/L.12.

The PICCAP Programme has assisted in providing local and regional training programmes on methodologies for assessing greenhouse gas emissions and the vulnerability of key sectors, the provision of funding for staff positions and consultancies, and in identifying and assessing adaptation and mitigation options. These activities have enabled Nauru to establish the capacity to prepare this report and be in a position to monitor climate change and prepare subsequent communications as required under the UNFCCC.

The current PICCAP National Committee comprising 10 members is listed in ANNEX 1, ANNEX 2 provides a supplementary list of past members who are acknowledged here for having made significant contribution to Nauru's climate-change actions under the PICCAP Programme.

However, in the context of climate change for the Republic of Nauru, the contribution both directly and indirectly spreads much wider and therefore acknowledgment of these inputs is made openly here for all those who have participated but are not specifically listed.

The preparation of this, Nauru's First National Communication, is considered to be only one of the initial steps of many, in an already important process that will, in future years, help in ensuring that the Republic of Nauru will remain the "Pleasant Island".

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Ministerial Statement

Nauru has a long history of displaying international environmental concerns, however, still remains very mindful of its contribution towards the devastation and destruction of its own land. The National Committee on Climate Change, has prepared this report as part of the Government's ongoing concern about the effects of global warming and climatic change in the Pacific region and in particular Nauru. The Committee was established under the Pacific Islands Climate Change Assistance Programme (PICCAP) under the auspicious of the South Pacific Regional Environment Programme (SPREP) and has worked closely with the South Pacific Applied Geoscience Commission (SOPAC) in gathering the necessary data and preparing this report.

The Committee has identified a number of issues that are now facing, and will continue to preoccupy, this and future Governments. The report's findings highlight not only the possibility of eventually losing the lower coastal strip due to flooding by the rising sea levels, but also:

- the urgent need to begin the re-habilitation of the topside of the Island thus allowing re-settlement and re-vegetation of parts of the topside,
- damage to the environment caused by anthropogenic emissions and the discharge of polluting chemicals into the sea,
- education and housing issues relating to population growth,
- economic reform, especially as phosphate exports decline and the need for increased funding to meet the inevitable growing demand for larger infrastructure needs and employment creation,
- vulnerable areas relating to health, coastal, water resource and agriculture; and,
- degradation of the coral reefs and coastal erosion surrounding the Island.

Changes to lifestyles and to the cost of providing normal services will be necessary to meet the challenges facing our nation over the next few years. Along with the increases in the cost of services will be higher inflation and even greater losses of jobs as reform measures are implemented unless employment creation programmes are developed. In the early stages, the re-habilitation and reforestation programmes, apart from creating employment, will also be one way of combating climate change (these initiatives could also assist in stabilising Nauru's weather conditions) thus assisting with the international efforts to slow down global warming. Hence rehabilitation must aim at a sustainable, steady-state economy based on renewable energy.

Nauru does not face the problems of surrounding island nations, such as Tuvalu and Kiribati, but will nevertheless still have to undergo change that will affect the community and place a great demand on limited Government resources. Some of these changes will affect the lifestyle of the people and some of the necessary decisions may be hard on the community in general. The current Government of Nauru is taking a responsible and decisive approach to the problems by establishing review and planning committees to appraise the issues and address each problem in a systematic manner.

This present report has already been formally endorsed by the Government of Nauru and is the First Initial National Communication to the 5th Conference of Parties pursuant to Article 12 of the Framework Convention on Climate Change. In short, the Government is committed to meeting the Convention's obligations as well as the number of risks related to Climate Change to be managed and adapted by Nauru as we go into the new millennium.

Hon. Anthony Detsimea Audoa, M.P.
Statement by the Minister for Justice and Environment
October 1999

Executive Summary

The Republic of Nauru recognises the risks posed by global climate change and is committed to the development of a strategy on climate change. It is proposed that this strategy will over time address the emission of greenhouse gases as it relates to Nauru's situation and its neighbouring small island countries.

This, Nauru's First National Communication, establishes a baseline from which to work in meeting its commitments under the United Nations Framework Convention on Climate Change (UNFCCC) and has been prepared in conjunction with Nauru's First Greenhouse Gas Inventory and position as at 1994.

The National Communication identifies through a separate and focused study Nauru's vulnerability and adaptation with respect to climate change. In the context of climate change Nauru's geography and environment form the major determinants in establishing its current position and approach to addressing the climate change issues.

After almost a century of open-cast phosphate mining Nauru has become one of the most environmentally degraded areas on earth. With a land area of only 22 km^2 and a population of just over nine thousand it is one of the smallest independent Nations in the world. However, the income derived from the mining of phosphate has enabled Nauru to be economically independent, and to manage its own economy without external aid from developed countries is a situation unique in the Pacific.

This independence is evidenced in the very strong stand Nauru has taken in the international arena with respect to environmental issues. In an address to the Alliance of Small Island States (AOSIS) in 1994, Nauru's President Bernard Dowiyogo stated that:

> . . . development should be aimed at living our own preferred ways of life in a clean and sustainable environment. Development must not ride the cultural and spiritual integrity of our peoples . . . we see development as a process of guided change directed toward our preferred goals. A healthy environment, which is our responsibility to our children, and ourselves, is also the cornerstone of the process of sustainable development.

It is recorded that Nauru was the first signatory to the Climate Change Convention at Vienna in 1985. Since that time Nauru has officially shown concern for the environment, and sustainable development is high on Nauru's agenda. This is noted in its statement to AOSIS in

1994 where it tabled a protocol proposal. Subsequent to this at the Kyoto negotiations on 8th December 1997 His Excellency Kinza Clodumar, President and Minister for External Affairs stated that:

> "Nauru has long been deeply concerned about the effects of global warming and the special vulnerability of the world's poor to those effects. This led us to submit to the Alliance of Small Island States (AOSIS) in 1994 the draft protocol that has become known as the AOSIS protocol."

The AOSIS protocol remains on the table as a signpost of Nauru's continuing concern.

Nauru also continues actively addressing its own situation through;

- the National Environmental Management Strategy and National Environment Action Plan (NEMS–1996);
- a Programme for Rehabilitation and Development which is being guided by the seven reports prepared under the Nauru–Australian Cooperation "Rehabilitation and Development Feasibility Study";
- implementation of the Public Sector Reform Review; and
- a National Economic and Development Summit (February 1999) "Taking Nauru Beyond 2000".

Nauru's geographical position has made it a desirable location for the installation of climate monitoring equipment. These include the South Pacific Sea Level and Climate Monitoring Project measuring sea levels and water temperatures since 1993; the Atmospheric Radiation Measurement Programme – Climate Research Station (ARM – ARCS II) commencing atmospheric measurements in 1998; and the development of a National Meteorological and Hydrological Service, National Weather Service, NWS for short.

Nauru's economy has focused on the export of phosphate for nearly over a century, and knowing that the resource is not infinite, recognises the need to develop alternate economic-based activities for the future. This has been commenced through National Economic Development Summit – "Taking Nauru Beyond 2000" held in February 1999 and the implementation of the economic reform.

Nauru's energy sector is relatively uncomplicated with 65% (1994) of all imported petroleum product being diesel or heavy fuel oil, 19% is avgas/jet A1 consumed through international air

transport and 15% is petrol consumed in the road and sea transport. Significant opportunities exist on Nauru to reduce the consumption of fossil fuels, especially in the road transport sector where there is only 40 km in total of sealed and unsealed roads. For the power sector the introduction of a full cost recovery power tariff and the use of alternate fuels such as LPG for cooking and solar thermal for water heating will assist in reducing the relatively high levels of domestic power consumption. Hence, benefiting the power generation sector in reducing kilowatt-hours consumed, diesel and heavy fuel oil consumed and in turn reducing greenhouse gas emissions.

Nauru's Greenhouse Gas Inventory has been based on the Inter-governmental Panel on Climate Change (IPCC) methodology with emissions being determined using the reference approach. This level of calculation was considered the most appropriate for preparation of Nauru's first inventory, considering the lack of readily available sector data and information and also the need to more fully understand some of the processes involved in the generation of greenhouse gases. The key issue for Nauru is that 98% of its emissions are carbon dioxide, that is predominantly from the combustion of imported fossil fuels. As noted above the highest emission sectors are those of transformation (electricity generation) (61%), international air transport (19%) and road transport (14%). A significant number of potential opportunities exist for reducing these emissions in the future, and at the same reducing Nauru's reliance on imported fossil fuels.

In assessing Nauru's situation in respect to vulnerability and adaptation to climate and sea-level change, this first National Communication assists in developing an appropriate response strategy. However, it is important to recognise that in making these assessments there are still a number of continuing uncertainties. These include knowledge relating to the rate and magnitude of climate and sea-level change in Nauru, the sensitivities within Nauru to such changes, and how the last 90 years of phosphate mining will effect the future.

Areas of particular concern include the coral reef and marine environment, coastal erosion, water resources, vegetation, and human health. Although Nauru has not yet established a specific environmental policy, a no-regrets approach has been adopted to adaptation accommodating climate and sea-level change considerations and implementation of the National Environmental Action Plan and the Rehabilitation Master Land-use Plan.

Nauru's level of vulnerability to climate and sea-level change is identified as being determined by the success of the proposed adaptation strategy. More specifically, adaptation measures such as an ICZM plan and a water-resource management plan. To enable Nauru to plan and implement appropriate responses to climate and sea-level change

the following priority areas have been identified: education and training; institutional strengthening; monitoring of important baselines; and evaluation of the Rehabilitation Master Land-use Plan and the National Environmental Action Plan.

The possible affects of climate and sea-level change on these proposed activities remains uncertain especially with respect to how these might need to be modified to accommodate adaptation. None the less Nauru cannot afford to neglect the future predictions relating to climate and sea-level change. Considering that the greater percentage of the Nauruan population live on the coastal perimeter, currently there is no where for them to move since the "Topside" area remains uninhabitable until such time the rehabilitation programme is implemented.

The key policies relating to the environment and climate change have been well documented and recorded and Nauru's commitment to the UNFCCC and AOSIS elaborated in individual international fora. Through the current economic reform and the National Economic and Development Summit – "Taking Nauru Beyond 2000" Nauru can only assist in ensuring that an appropriate position is established. Opportunities abound in the energy sector to reduce emissions through appropriate energy efficiency measures primarily leading to a reduction in the use, and the need to import fossil fuels. These opportunities along with the inevitable rehabilitation programme will be significant to Nauru's overall position.

Nauru is committed to addressing the issue of changing climate and better understanding the mechanisms relating to vulnerability of the Pacific's small island states and therefore considers that the need to remain current and informed with respect to changing climate is of prime importance to Nauru and its future position.

Nauru on the 14th September became the 187th member of the United Nations. His Excellency the President of the Republic of Nauru, the Honourable Rene Harris, reiterated the concern voiced by many small islands states that the "immeasurable" threat of global climate change to the existence and survival of vulnerable islands like Nauru should be addressed by developed countries.

> "Although the economic benefits of global industrialisation has largely missed Nauru, it targets first and foremost, through global climate change, the destruction of small and extremely vulnerable island states like Nauru. These changes will, in the new millennium, add immeasurable threat to the very existence of small island countries like Nauru, and to the very survival of complete island cultures such as the people of Nauru."

Acronyms and Abbreviations

ADO	Automotive Diesel Oil		**mm**	millimetres
ADB	Asian Development Bank		**MW**	mega-watts
AOSIS	Alliance of Small Island States		**NACRDFS**	Nauru-Australia Cooperation Rehabilitation and Development Feasibility Study
ARCS II	Atmospheric Radiation and Cloud Station		**NOAA**	National Oceanic and Atmospheric Administration
ARM	Atmospheric Radiation Measurement Programme		**NEAP**	National Environmental Action Plan
BPC	British Phosphate Corporation		**NEMS**	National Environmental Management Strategy and National Environmental Action Plan
CART	Cloud and Atmospheric Testbed		**NEU**	Nauru Energy Unit
CCDD	United Nations Convention to Combat Desertification and Drought		**NFMRA**	Nauru Fisheries and Marine Resources Agency
COP	Conference of the Parties		**NMHS**	National Meteorological and Hydrological Service
CRU	Climate Research Unit		**NPC**	Nauru Phosphate Corporation
DPK	Dual Purpose Kerosene		**NPRT**	Nauru Phosphate Royalties Trust
DSM	Demand Side Management		**NPT**	Treaty on Non Proliferation of Nuclear Weapons
EIA	Environmental Impact Assessment		**NTF**	National Tidal Foundation
ENSO	El Niño – Southern Oscillation		**NTV**	Nauru Television
EEZ	Exclusive Economic Zone		**NWS**	National Weather Service
ERC	Economic Reform Committee		**PICCAP**	Pacific Island Climate Change Assistance Programme
FADs	Fish Aggregation Devices		**RMLP**	Rehabilitation Master Land-use Plan
GCMs	General Circulation Models		**SLCM**	Sea-level and Climate Change
GDP	Gross Domestic Product		**SIDS**	Small Island Developing States
GG	Greenhouse Gas		**SIS**	Small Island States
Gg	giga-grams		**SOI**	Southern Oscillation Index
GHG	Greenhouse Gas		**SOPAC**	South Pacific Applied Geoscience Commission
HFO	Heavy Fuel Oil		**SPaRCE**	Schools of the Pacific Rainfall Climate Experiment
ICZM	Integral Coastal Zone Management		**SPREP**	South Pacific Regional Environmental Programme
IDI	Department of Island Development and Industry		**TWP**	Tropical Western Pacific
IGCI	International Global Change Institute		**UNFCCC**	United Nations Framework Convention on Climate Change
IPCC	Inter-governmental Panel of Climate Change		**UN**	United Nations
LPG	Liquid Petroleum Gas		**US**	United States of America
Lubes	Lubricants		**V&A**	Vulnerability and Adaptation

Chemical Compounds

CO	Carbon Monoxide		**CF_4**	Tetrafluoromethane
CO_2	Carbon Dioxide		**C_2F_6**	Hexafluroethane
CH_4	Methane		**NO_x**	Nitrogen Oxides
CFCs	Chorofluorocarbons		**N_2O**	Nitrous Oxide
HFCs	Hydrofluorocarbons		**NH_3**	Ammonia
PFCs	Perfluorocarbons		**SF6**	Sulphur Hexafluoride
SO_2	Sulphur Dioxide		**CCl_4**	Carbon Tetrachloride

Chapter One

Nauru in Context

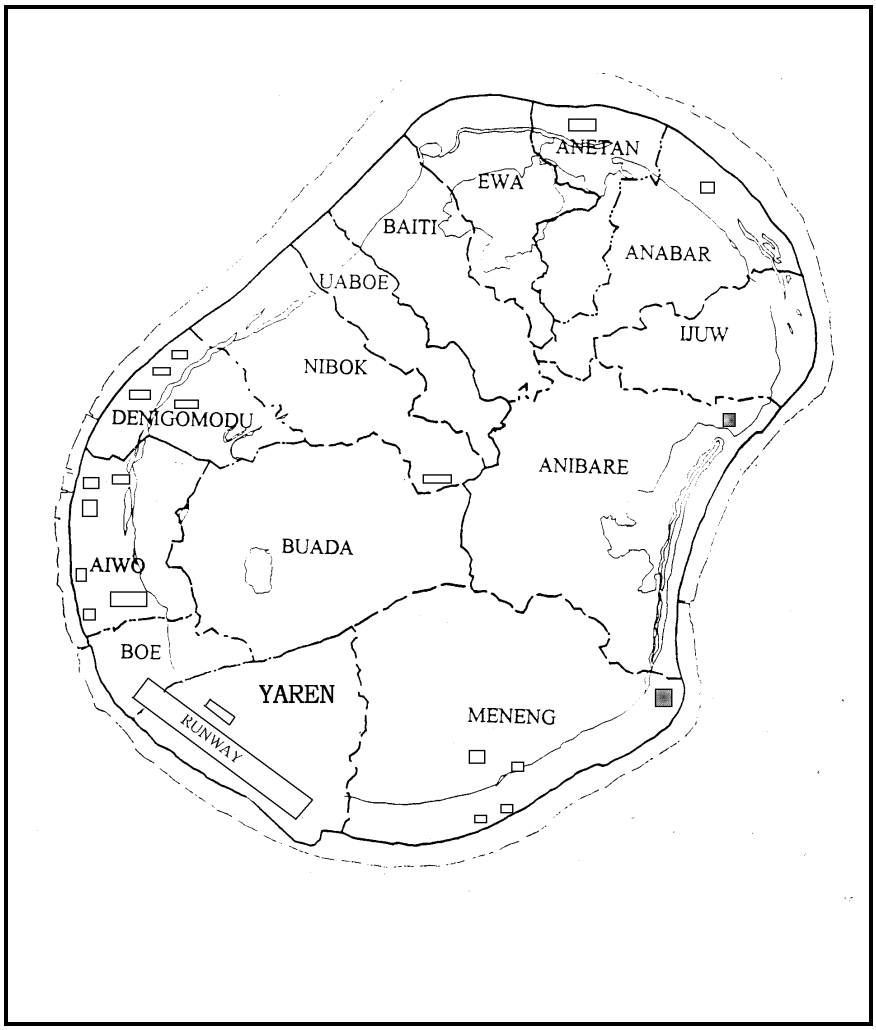
1.0 Introduction

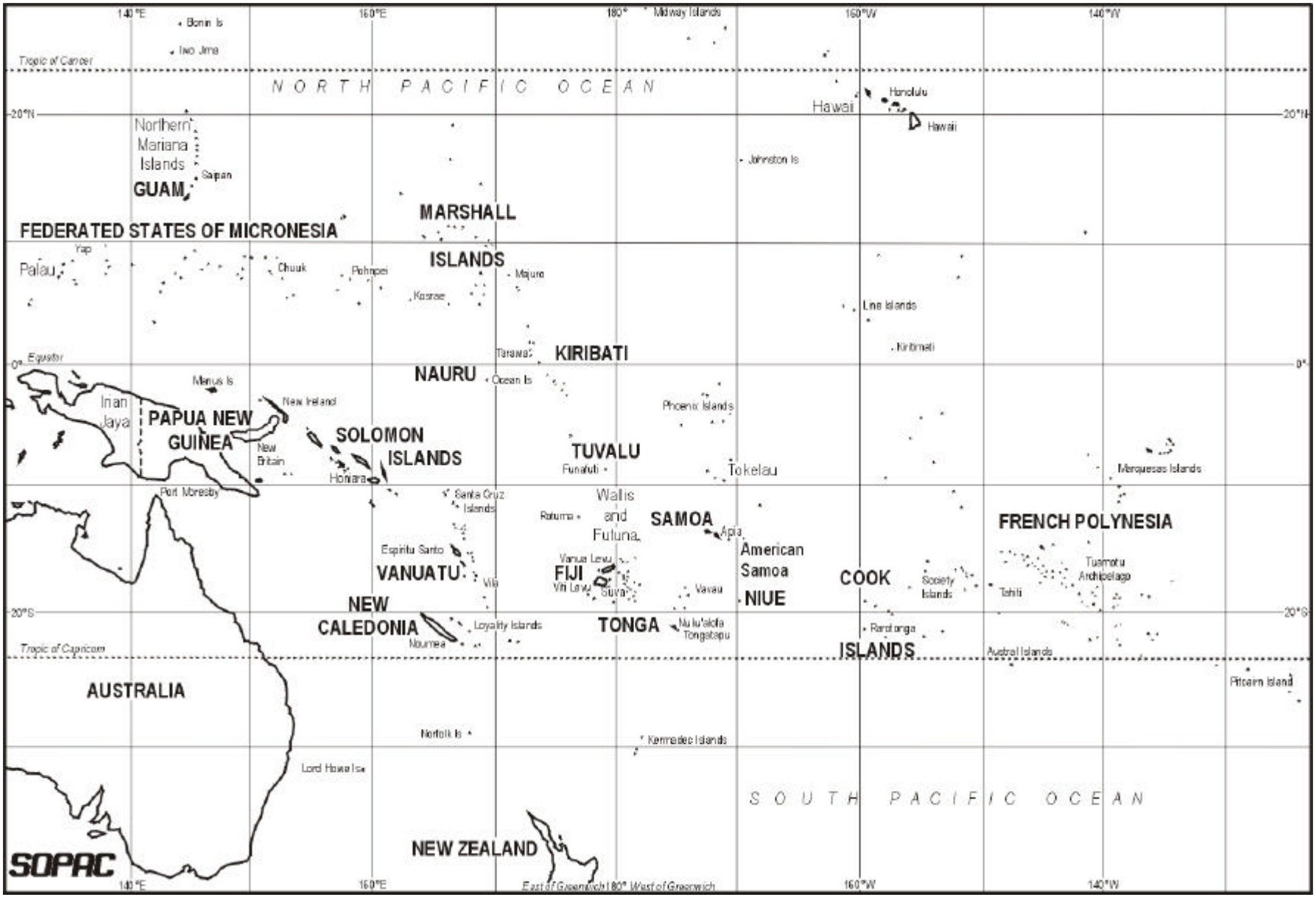
In the context of climate change Nauru's geography and environment form the major determinants in establishing its current position and approach to addressing the climate change issues.

Nauru is very mindful of the need to address these issues following nearly a century of open cast phosphate mining.

The following information helps to provide a picture of Nauru, through its history of mining and affluent economic past, its people and culture, its once beautiful natural environment and a proposed future focusing on rehabilitation.

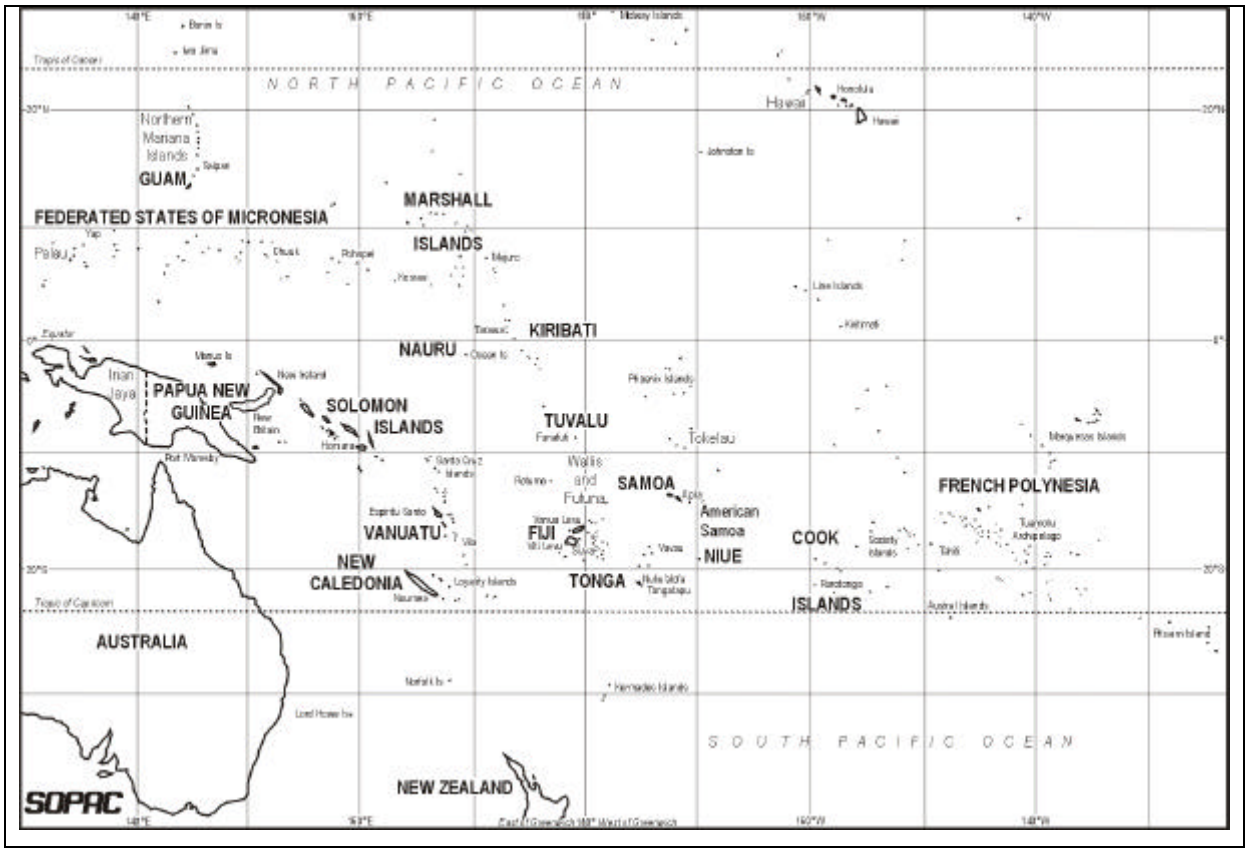
In assessing Nauru's emissions for inclusion in the first greenhouse gas inventory the "reference approach" has been adopted. Default values have been used in a number of the calculations for evaluation of the emissions. Along with the limited levels of detailed information available, this first greenhouse gas inventory provides an initial baseline which can be refined in the future and used as a starting point for the preparation of subsequent greenhouse gas inventories.




140°E
160°E
180°
Midway Islands
160°W
140°W
Bonin Is
Iwo Jima
Tropic of Cancer
NORTH PACIFIC OCEAN
20°N
Hawaii
Honolulu
Hawaii
Northern Mariana Islands
Saipan
GUAM
Johnston Is
MARSHALL ISLANDS
FEDERATED STATES OF MICRONESIA
Yap
Palau
Chuuk
Pohnpei
Kosrae
Majuro
Line Islands
Kiribati
Equator
0°
Tarawa
KIRIBATI
NAURU
Ocean Is
Manus Is
New Ireland
Irian Jaya
PAPUA NEW GUINEA
New Britain
SOLOMON ISLANDS
Honiara
Phoenix Islands
TUVALU
Funafuti
Tokelau
Marquesas Islands
Port Moresby
Santa Cruz Islands
Wallis and Futuna
Rotuma
SAMOA
Apia
FRENCH POLYNESIA
Espiritu Santo
VANUATU
Vila
Vanua Levu
FIJI
Viti Levu
Suva
Vavau
American Samoa
NIUE
COOK ISLANDS
Society Islands
Tahiti
Tuamotu Archipelago
20°S
NEW CALEDONIA
Loyalty Islands
Noumea
TONGA
Nuku'alofa
Tongatapu
Rarotonga
Tropic of Capricorn
Austral Islands
Pitcairn Island
AUSTRALIA
Norfolk Is
Kermadec Islands
Lord Howe Is
SOUTH PACIFIC OCEAN
SOPAC
NEW ZEALAND
East of Greenwich
180° West of Greenwich

1.1 Geography and Environment

1.1.1 Geographical Location



Nauru is an isolated, uplifted limestone island located 41 km South of the equator at 0^{o} 32' South latitude and 166^{o} 56' East longitude. It is some 2000 km East-Northeast of Papua New Guinea, 4450 km South-Southeast of the Philippines and an equal distance to the Southwest of Hawaii. The nearest island is Banaba (Ocean Island), 300 km due East, which is part of the Republic of Kiribati. The main islands of Kiribati lie a further 400 km to the East.

1.1.2 Topography

The total land area of Nauru is only 22 km^2 (2200 ha). The island is surrounded by a fringing coral reef between 120 and 300 metres wide. The reef drops away sharply on the seaward edge, at an angle of about 40^{o}, to a depth of about 4000 metres. The land area consists of a narrow coastal plain or "Bottomside", ranging from 100 to 300 metres wide, which encircles a limestone escarpment rising some 30 metres to a central plateau, known locally as "Topside".

The coastal plain is composed of a zone of sandy or rocky beach on the seaward edge, and a beach ridge or fore-dune, behind which is either relatively flat ground or, in some places, low-lying depressions or small lagoons filled by brackish water where the surface level is below the water table (freshwater lens). The most extensive system of these landlocked lagoons is found near the border of Ijuw and Anabar Districts. Scattered limestone outcrops or pinnacles can also be found on both the coastal plain and on the inter-tidal flats of the fringing reef, with particularly good examples in the Anibare Bay area.

The escarpment ranges in gradient from vertical cliffs to gradually sloping areas of colluvial soil (deposits that accumulate on and at the base of slopes as a result of movement by gravity) interspersed with limestone outcrops and pinnacles.

The raised central plateau or Topside consists of a matrix of coral-limestone pinnacles and limestone outcrops, between which lie extensive deposits of soil and high-grade tricalcic phosphate rock (Tyrer 1963, Viviani 1970). This area covers approximately 1600 ha (over 70% of the island) and has been the focus of phosphate mining for over 80 years. Relative elevations on Topside vary generally between 20 and 45 metres above sea-level, with occasional pinnacle outcrops reaching elevations of 50 to a maximum of 70 metres above sea-level. The topography remaining after completion of primary phosphate mining is a pinnacle-and-pit relief varying between 2 and 10 metres from the top of the pinnacles to the bottom of the pits. The highest point on the island is Command Ridge in the west at an elevation of 71 metres above sea-level.

Buada Lagoon, a landlocked, slightly brackish, freshwater lake, and its associated fertile depression (about 12 ha in area), is located in the low-lying Southwest-central portion of the island at an elevation of about 5 metres above sea-level.

1.1.3 Environment

The Republic of Nauru adopted its National Environmental Management Strategy (NEMS) and National Environmental Action Plan in September 1997. The NEMS was initiated under the United Nations Capacity 21 Programme and funded by the United Nations Development Programme (UNDP) and the South Pacific Regional Environmental Programme (SPREP). The NEMS maps a return to the idea of stewardship, of looking after the surrounding environment for future generations and provides a mechanism for developing a change of attitude, of caring and nurturing an environmental credo.

It in particular focuses on:

- Living a life without harming the environment or culture;
- Not exploiting the land or marine environment for food or resources beyond what is needed for individuals and families;
- Encouraging cooperative decision making on what is best for the environment and participate actively in the decision making process;
- Encouraging the Principles of Sustainable Development;
- Developing as necessary a new model of Nauruan life, which is a blend of traditional culture and modern technology; and
- Protecting and nurturing the island environment, flora, fauna and all its inhabitants as a basis for sustainable living for the future.

1.1.4 Natural Resources and Land-use

Land in Nauru is limited both in its availability and also in its use. Of the total area of 22 square kilometres, 70% has been utilised for the mining of phosphate. The balance provides space for the domestic, government, commercial and industrial sectors. The international airport takes up a significant proportion of this area. There are very limited recreational areas, and agricultural activities are currently minimal due to fruit fly problems for which a concentrated eradication programme has been successfully commenced. The soil in the coastal areas is only about 25 cm deep, is coarse textured and contains more coral gravel than sand, and the fertility is highly dependent on organic matter. The plateau soils vary from shallow soils, on the tops of limestone pinnacles, composed primarily of organic material and sand or dolomite, with very little phosphate, to deep phosphatic soils and sandy phosphatic rock, up to more than 2 m deep between the pinnacles. The topsoil ranges from 10 to 30 cm in depth, overlying deeper subsoil, which is frequently reddish yellow, and between 25 and 75 cm deep. The undisturbed plateau soils have a high level of organic material and are generally fertile. In more recent years these soil deposits have been stripped from the phosphate mining areas and stockpiled for use in future rehabilitation activities. Preliminary excavation and investigation was carried out in 1988 to determine the depth and extent of the secondary phosphate deposits, but these still remain to be quantified (Drayton 1995). The lack of land for urban development and a secure groundwater supply are the two main issues currently being addressed by Nauru through a detailed rehabilitation programme.

1.1.5 Rehabilitation

In settlement of a case before the International Court of Justice, Australia and Nauru signed a compact of settlement in August 1993. The settlement provided for a programme of rehabilitation of pinnacle fields left by phosphate mining on Nauru and established realistic options and implementation plans for the rehabilitation.

In September 1994, through the Nauru-Australia Cooperation, seven volumes were presented as the outcome of the Rehabilitation and Development Feasibility Study (NACRDFS). The reports provide a blueprint for rehabilitation including residual mining, pinnacle removal and crushing, the economical use of pinnacle rock and aggregate, reforestation, agricultural development, environmental protection, housing, and human resource development.

Implementation of the recommendations to carry out the rehabilitation as proposed in the plan depends on a number of factors. The most important of these is determination of the priorities for development, the land tenure arrangements and compensation to landowners.

As an example of determining the priorities fro development it is recommended that sight should not be lost of the possible economic value of the pinnacles. Hence the need to ensure that their value has been properly assessed in the international dimensional stone market before irrevocable Topside rehabilitation commences.

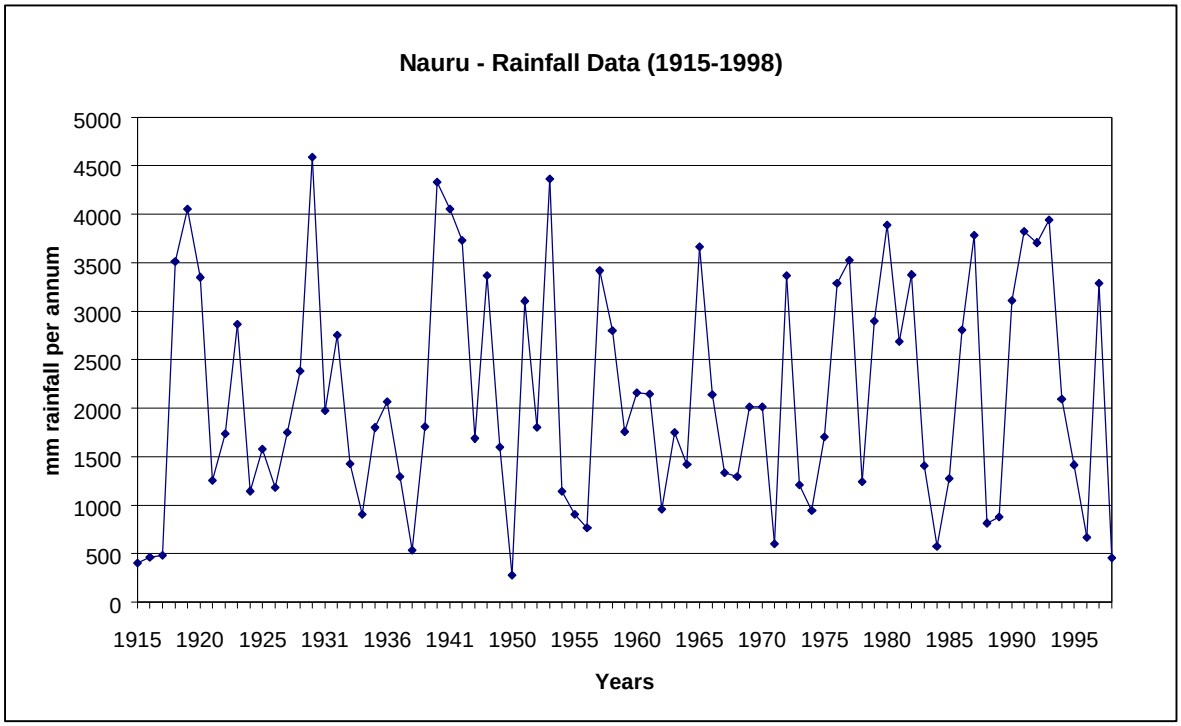
1.2 Climate

1.2.1 Temperature and Rainfall

Nauru is located in the dry belt of the equatorial oceanic zone, with diurnal temperatures ranging from 26^{o}C to 35^{o}C, and nocturnal temperatures between 22^{o}C and 28^{o}C.

Annual rainfall is extremely variable, averaging 2126 mm per year (data from 77 years from 1916 to 1993) with a range of 280 to 4590 mm. Monthly rainfall data available for the period 1977 to 1993 indicate a range of 0 to 746 mm, with 62 months out of 204 months (for which data were available) having less than 100 mm of rain. Rain tends to be more frequent during the months of December to April. Prolonged droughts are common and place severe stress on the natural species and lead to the death of non-coastal exotics and fruit trees (such as breadfruit).

Rainfall data provided from Davey 1966 and NPC Analytical Laboratory Reports.



The wind direction during the drier months from May to November is generally from the Easterly sector at speeds of 5 to 10 knots, and during the wetter months from December to April is generally from the Westerly sector at speeds of 10 to 18 knots. During squally weather wind speeds of up to 30 to 35 knots have been recorded. Nauru does not experience tropical cyclones although it is subjected to very strong winds and seas from time to time.

Although Nauru's climate data are relatively well documented these records to date have been kept for different purposes. A separate meteorological office / observatory does not exist in Nauru and although rainfall records date back to 1916 these have been kept by the Nauru Phosphate Corporation. However, recently in Nauru there have been two monitoring stations established, one for sea-level and the other for atmospheric radiation measurements. Both these projects were established as components of a larger regional monitoring programme. Details of these monitoring programmes are provided below. In addition it is proposed to establish a National Meteorological and Hydrological Service.

(i) The South Pacific Sea-level and Climate Monitoring Project

This programme was developed as an Australian response to concerns raised by members of the South Pacific Forum countries over the potential impacts of the Greenhouse Effect on Climate and Sea-levels in the region. The programme commenced in 1991 with the

objective of installing eleven monitoring stations across the Pacific Basin. All stations were operational by October 1994 with Nauru's station being installed in June 1993.

Since June 1993 up until May 1999 and based on 69 months of data, there have been recent short-term sea-level trends in the project area based upon the SEAFRAME Data. For Nauru the recorded trend for January '99 was -29.0 mm/year and at May '99, -27.5 mm/year. The trend includes natural variability such as El Niño and effects due to many other atmospheric, oceanographic and geological processes.

(ii) Atmospheric Radiation Measurement Programme (ARM)

The object of the ARM project is to generally study how the interactions of earth's oceans and its atmosphere causes global weather change. The Nauru Climate Research Station (ARCS II) is part of the Tropical Western Pacific (TWP) field site that is located in the "Warm Pool". The TWP, Cloud and Atmospheric Testbed (CART) area covers roughly 10^{o}N to 10^{o}S. This area consistently has the warmest sea surface temperatures and supplies heat and moisture to the atmosphere above it, resulting in the formation of deep convective cloud systems, producing high-altitude cirrus clouds that may cover much of the region. These cloud systems affect the amount of solar energy reaching the earth's surface and the amount of heat energy that can escape into space.

The monitoring at the ARM project commenced in Nauru on 20th November 1998. The location of the CART is in the Denigomodu District, located on the South/West end of the island. It is proposed that the study will last from 7-10 years and assist in improving the way general circulation computer models predict the weather and climate changes throughout the world.

(iii) National Meteorological and Hydrological Service

Nauru's past meteorological observation has predominantly been limited to the collection of rainfall and temperature data by the Nauru Phosphate Corporation (NPC) and it predecessors, British Phosphate Corporation (BPC), which dates back to 1915. A public weather information service was established with Telecom in 1968. This service utilised telecom data and information provided by the Bureau of Meteorology in Australia and from the Tsunami Warning Centre in Honolulu. From the early 1980s a Flight Information Centre within the Department of Island Development took over from Telecom. Separately, the Marine Division addressed the need for weather information for shipping purposes. However, few other detailed historical climate data have been collected up until recently.

As noted earlier, Nauru has recently been actively participating in regional meteorological activities. These include the (Sea Frame / ARM / etc) and the Management of Meteorological and Hydrological Services in Region Association V (South-West Pacific). To date Nauru has not formally established its own Meteorological Service.

Nauru considers the development of a National Meteorological and Hydrological Service (NMHS) as a priority activity, and therefore to develop this service through international and regional cooperation and its commitment to meet the requirements of the United Nations Framework on Climate Change and the Convention on Biodiversity plans.

The development of the NMHS [National Weather Service, NWS for short] under the Department of Island Development and Industry (IDI) is proposed to provide the following:

- The collection and maintenance of all relevant weather and climate data;
- Provision of the data to relevant national government department, agencies and organisations; and
- Coordination with other relevant regional Meteorological Service providers.

In particular the NWS will include provision for:

- Capacity building through training and technology transfer;
- Informed policy and decision making;
- Supporting and participating in AOSIS activities;
- Scientific and technological transfer; and
- Developing long term projects and programme activities.

It is proposed in the longer term that these projects/programmes will provide information relevant to climate and sea-level changes that will assist Nauru to better determine and understand its overall situation in respect to its environmental position.

1.2.2 Hydrology and Water Supply

Apart from Buada Lagoon there are no surface freshwater resources on Nauru, although there are a few brackish ponds near the base of the escarpment, especially on the northeast of the island in Ijuw and Anabar Districts, and an underground lake in Makwa (Moqua) Cave in the Southeast (Viviani 1970). The only significant permanent freshwater resource is groundwater in the form of a "lens" of often slightly brackish freshwater, hydrostatically "floating" on higher-density saltwater beneath it. The height of the freshwater lens above sea-level and the level of salinity vary in relation to the elevation, geology, texture and shape of

the island, and with the amount of water use and rainfall. Currently Nauru's population are reliant on water supplied either from a desalination plant run by the Nauru Phosphate Corporation (1150 tonnes/day) or from local wells. There is little use made of roof rainwater catchments on the island. Existing long term potential threats to the quality of the groundwater resource include contamination by cadmium, rubbish dump leachate, sewage and household waste water e.g. bathroom, kitchen and laundry.

1.3 Flora, Fauna and Marine

1.3.1 Flora and Vegetation

Nauru's indigenous flora and the vegetation as a whole are among the most limited on earth. Because of Nauru's small size, limited habitat diversity, and its physical isolation from continents and other, larger islands, only 60 indigenous species of vascular plants have been recorded. There are no endemic plants (plants unique to Nauru). The long settlement, widespread destruction during World War II, monocultural expansion of coconut palms, and over 80 years of open-cast phosphate mining have led to serious vegetation degradation, disturbance, and displacement. Although greatly outnumbered by exotics, the indigenous species (16.5% by area) still constitute the most culturally useful and ecologically important species, and their protection and enhancement are crucial as a basis for sustainable development on Nauru. Regenerated vegetation after mining covers 63% of Nauru's land area.

1.3.2 Terrestrial Fauna

Nauru's main indigenous land animals are birds, insects and some land crabs which accord varying degrees of importance to sustainable development, in terms of both their ecological and cultural utility and their possible importance to the development of National Reserves and a limited tourist industry. There are no indigenous land mammals on Nauru.

Birds, most of which are either sea birds or migratory species, constitute the most visible and among the most culturally important indigenous animals of Nauru. Migratory species use the island to stop and feed, and sometimes to breed and nest. The single species regarded as endemic is the Nauruan Reed Warbler or Nauru Canary. The brown and black (white-capped) noddies, common fairy terns and the great frigate bird are all culturally important.

1.3.3 Fisheries and Marine Life

Despite the limited extent of its coral reefs, inter-tidal zone, and its 200-mile Exclusive Economic Zone (EEZ) which has an area of approximately 320000 km^2, Naurus once relatively rich marine biota is now estimated to be 40% dead[1]. This is predicted to be due to the run-off of fresh water from the Topside with a high silt and phosphate content due to the extensive deforestation carries out prior to the phosphate mining.

The main categories of marine resources include a wide range of finfish and a more limited range of turtles, crustaceans, octopus, shellfish, beche-de-mer, other invertebrates and algae.

Nauru's main fisheries zones are:

- the fresh-to brackish-water ponds found inland from the coast;
- the shallow fringing reef or intertidal zone;
- the sub-tidal areas and reef slope (to about 25 m depth);
- the deep reef and near-shore deepwater areas below 25 m; and
- the open ocean or pelagic fishery.

All of these areas are of critical subsistence importance, although currently of limited local commercial importance. A variety of fishing techniques is used, ranging from a variety of nets to spearfishing, handlining, poling and trolling. Fish Aggregation Devices (FADs) have been deployed in the past to increase both subsistence and commercial catches.

Although Nauru's fisheries resource is still relatively plentiful, there is a need to manage and monitor the marine resources so as to ensure sustainability in the future. The individual fisheries zones identified lend themselves to a variety of mechanisms, from traditional and modern conservation practices to protective legislation and sustainable harvesting strategies. Management in particular becomes important with the growing trend from subsistence fishing towards commercial fishing, thus applying more pressure on the fisheries resources. A number of these issues are currently being addressed under the National Fisheries Development Strategy 1996-2001.

[1] Prof. W Jackson Davis, 2 October 1999.

The development of a community boat harbour at the existing Anibare Bay channel, which commenced in July 1999, will assist in:

- providing safer access to the sea for local fishermen,
- providing an alternate facility for servicing larger, commercial fishing boats; and
- facilitating the off-loading of cargo when weather conditions (westerlies) prevent the use of the existing boat harbour.

1.4 Culture and Population

1.4.1 Culture

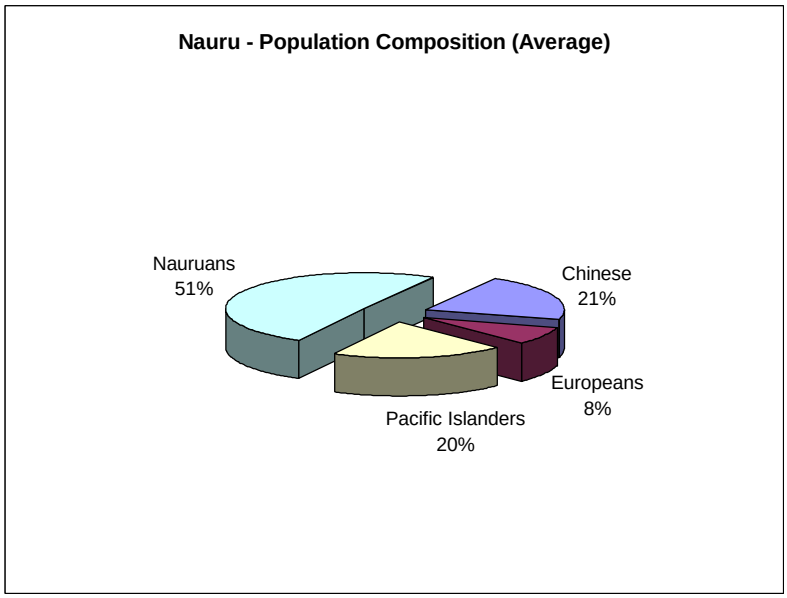
The Nauruans are Micronesians inhabiting the island for up to 3,000 years, with evidence of Melanesian and possibly Polynesian influence. The Nauruan language is distinct from other Pacific languages yet it shares many words with other Micronesian islands, e.g. Kiribati and the Marshall Islands. The society is matrilineal and the people are drawn from twelve tribes that are totemic in origin.

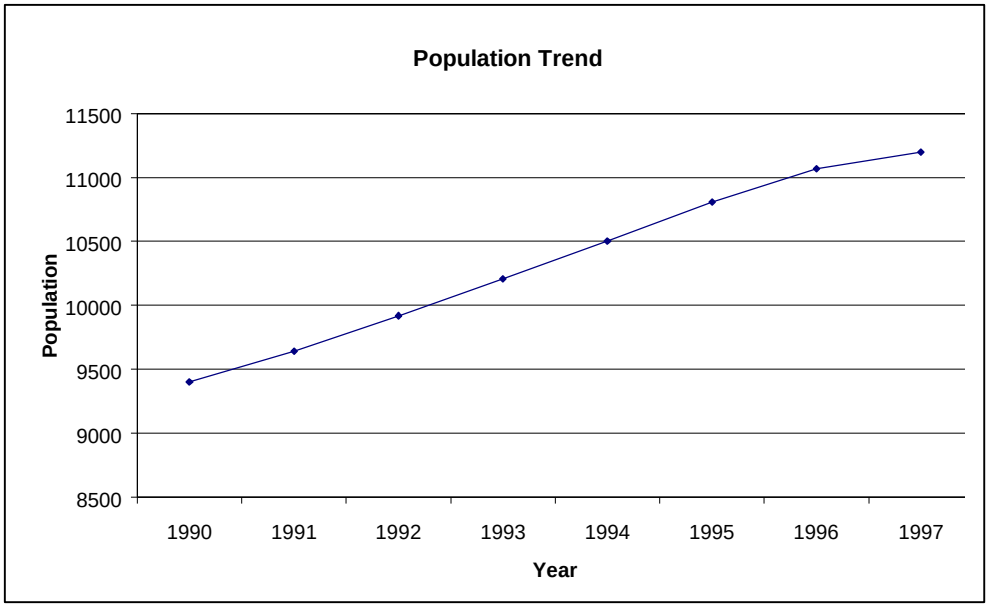
The Nauruans are Christian and adhere to the Nauruan Congregational Church and the Roman Catholic Church. Approximately 70% of the Christian population is Protestant.

Nauruans traditionally existed on a subsistence economy until the discovery of phosphate deposits shortly after 1888. At the turn of the century and with the commencement of mining in 1906 there was a significant change in lifestyle and economy, which has been apparent by the very high per capita GDP. The GDP was $A5000 in 1994, high compared to the rest of the small South Pacific countries (for instance Samoa - $A1288 in 1995, PNG - $A1859 in 1994, Solomon Islands - $A1196 in 1995). The advent of phosphate mining has led to a dramatic change in lifestyle for the Nauruan people, and effectively transformed the culture into one that is compatible with a cash economy.

1.4.2 Population

The Nauruan population has fluctuated significantly over the last century and a half. In the late 1800s and early 1900s this was due to introduced diseases against which Nauruans had no natural resistance, and from incessant tribal warfare. In the past decade, population growth has been more stable around 2.4% per annum.





Population trend is an increase of 2.4% per annum.

1.4.3 Land Tenure

Land tenure is of prime importance in Nauru, representing wealth in both the spiritual and material sense, and has always been a mark of status contributing strongly to a person's identity as a Nauruan. Still today the concept of ***angam*** refers to the strong emotional tie between Nauruans and their home island. Although individuals hold rights to land established by their ancestors, a strong concept of "family lands" persists, with most land still being regarded as belonging to the extended family. Inherited rights traditionally covered both "coconut land" (residential land) and "pandanus land" (Topside land).

Prior to mining, the boundaries of the named portions of phosphate and other lands were formalised by modern cadastral survey; the coordinates of these are recorded, along with the names of all shareholders in each piece of land.

Due to the current desire to have land shareholding rights rather than the traditional "individual" rights to whole pieces of land, a situation now exists which frequently complicates government and other efforts to access or develop land. This issue is currently being addressed in the context of the rehabilitation of the mined areas and the introduction of a system to protect areas on Nauru.

Currently a Lands Negotiation Committee has been established to negotiate with the Landowners for Government to extend land leases. Most of the leases for Government leased land are scheduled to expire either at the end of 1999 or early 2000. Government does not own the land per se.

1.4.4 Constitutional Arrangements - Origin[2]

After the Second World War, under the Trusteeship agreement approved by the United Nations on 1st November 1947, Nauru became a Trust Territory jointly administered by the Governments of the United Kingdom, Australia and New Zealand. Under a further agreement between the three Governments, the Government of Australia exercised full powers of legislation, administration and jurisdiction over Nauru. In 1951, Nauru Local Government Council was set up, and the first elections to the Council were held on 15th December 1951.

In 1965, in pursuance of a further agreement between the governments of the United Kingdom, Australia and New Zealand, the Federal Parliament of Australia enacted the Nauru Act, 1965, which provided for the Legislative Council and Executive Council of Nauru. First general elections for the Legislative Council were held on 22nd January 1966, and the inaugural meeting of the Council was held on 31st January 1966.

The Constitution of Nauru declaring the country as a Sovereign Republic was adopted by the people on Nauru in the Constitutional Convention on 29th January 1968, and the country became a Sovereign Republic on 31st January 1968.

The Constitution provides for the Parliament to make laws for peace, order and good government of Nauru. As noted above, the first Parliament came into existence on 31st January 1968, under the name of Legislative Assembly of Nauru. It started functioning under

the name of Parliament from 17th May 1968, which since then has been the Constitution Day of Nauru.

At the time of independence in 1968, the Republic of Nauru was under the Inaugural Presidency of Hammer de Roburt, and since then has been governed by a Westminster-style democracy with an elected Parliament and a President who is elected by that Parliament.

The original Districts formed the basis of the democratic electorate and provide the structure for the political units. From 1951 to 1992 Councilors for the Nauru Local Government Council were elected from the Districts. More recently, Districts elected Councillors to the Nauru Island Council[3].

To date there have been no other significant changes in the Constitutional arrangements for Nauru.

1.5 Economy

1.5.1 Overview

The economy of Nauru has revolved around the Nauru Phosphate Corporation since 1968. The revenue generated from the phosphate mining has been responsible for the major cash flow into the recurrent budget. The fact that the mining of phosphate, as a non-renewable capital resource and a source of income, will probably cease shortly after the turn of the century, means that development efforts must refocus so as to take account of the cessation of phosphate income. Trials have been carried out in an attempt to identify the most appropriate method for secondary mining and developing an appropriate framework and strategic plan for the rehabilitation of the mined areas.

Up until recently Nauru's economy was structured on previous levels of income from the phosphate and from the Nauru Phosphate Royalty Trust Fund. However, Nauru has now realised that dependence on an income generated from phosphate mining, and the earlier establishment of the Nauru Phosphate Royalty Trust Fund, will be unable to provide long term security. Hence the need for Nauru to develop alternate economic-based activities for the future.

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[2] The Parliament of Nauru – December 1989

The development of this formally commenced in February 1999 when the Republic of Nauru convened a National Economic and Development Summit – "Taking Nauru beyond 2000". The "Issues and Findings" of the summit specifically identified the following priority areas which have been presented in a Summary Record comprising 12 Sessions.

Overview of the Economy and State of Development of Nauru

- Phosphate mining, the source of Nauru's income, wealth and economic activity, is entering its final few years;
- The identification of new forms of economic activity is considered to be urgent;
- Rehabilitation of mined areas has not commenced;
- The Public Service has become too large and too costly to manage, requiring transformation into a smaller, merit-based and performance oriented organisation;
- Encouragement should be given to private-sector-based activities that can perform the commercial-type activities currently carried out by the government;
- There is a need to reduce the budget deficit and live within its income;
- Nauru Phosphate Royalty Trust Fund requires reviewing and the investment portfolio re-established; and
- NPC should be encouraged to remove subsidies on the services that it provides for electricity and water, allowing it to realise a true operating budget.

Other more general concerns are the need for a better gender balance in senior positions both in government and the private sector, to maintain and improve the healthcare service, improve education levels and facilities, and to ensure that population growth does not reach a level where the standard of living is affected.

GDP in $AU/capita

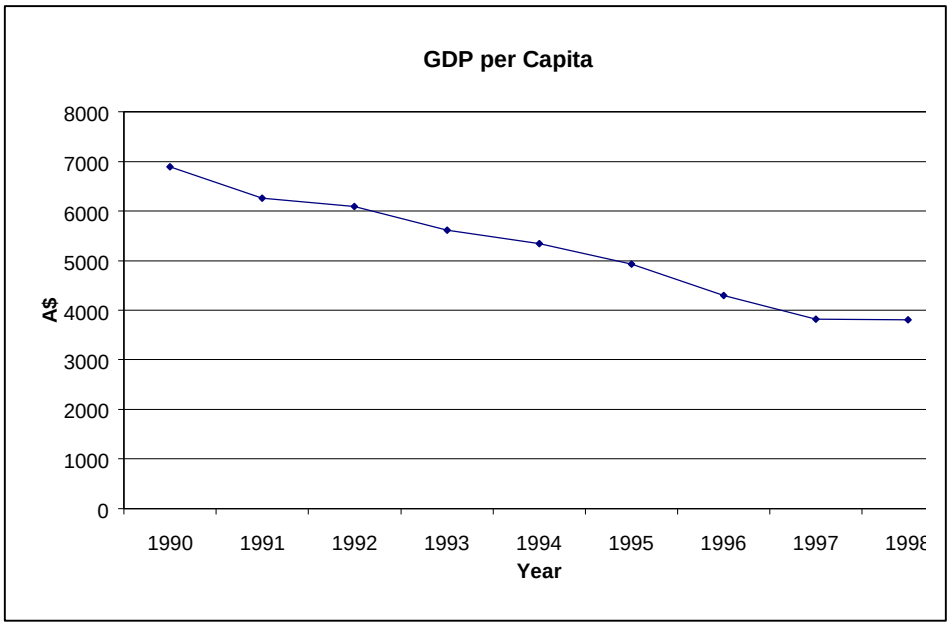
Year	GDP $AU/capita
1990	6894
1991	6255
1992	6089
1996	4300
1998	3800

Average decline of 4.9% per annum

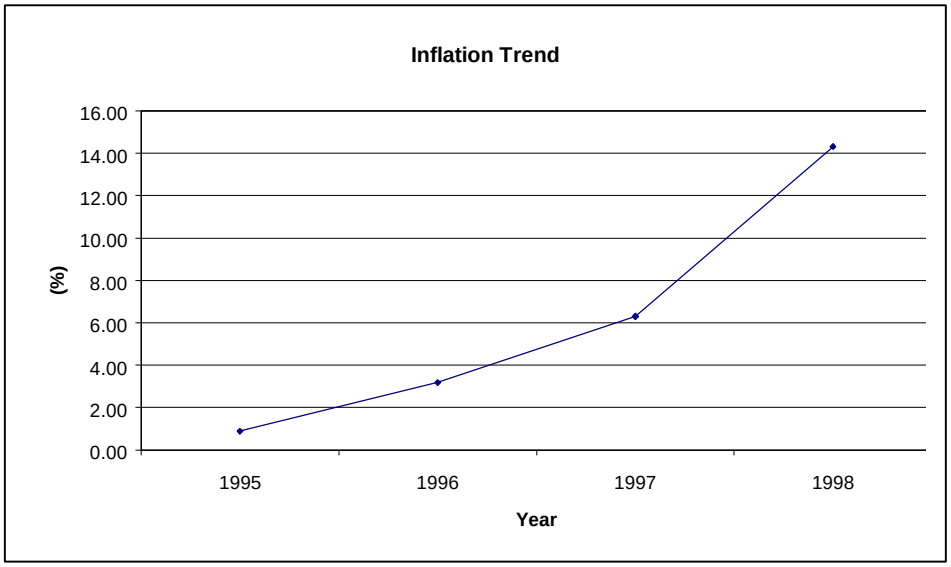
INFLATION (%)

Year	Inflation %
1995	0.88
1996	3.18
1997	6.30
1998	14.31

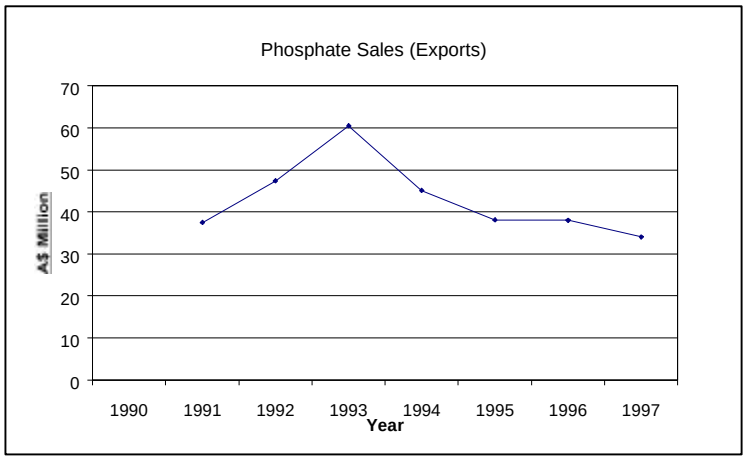
[3] The Nauru Island Council was dissolved in April 1999 by the Parliament current at that time.



GDP per capita with an average decline of 4.9%.



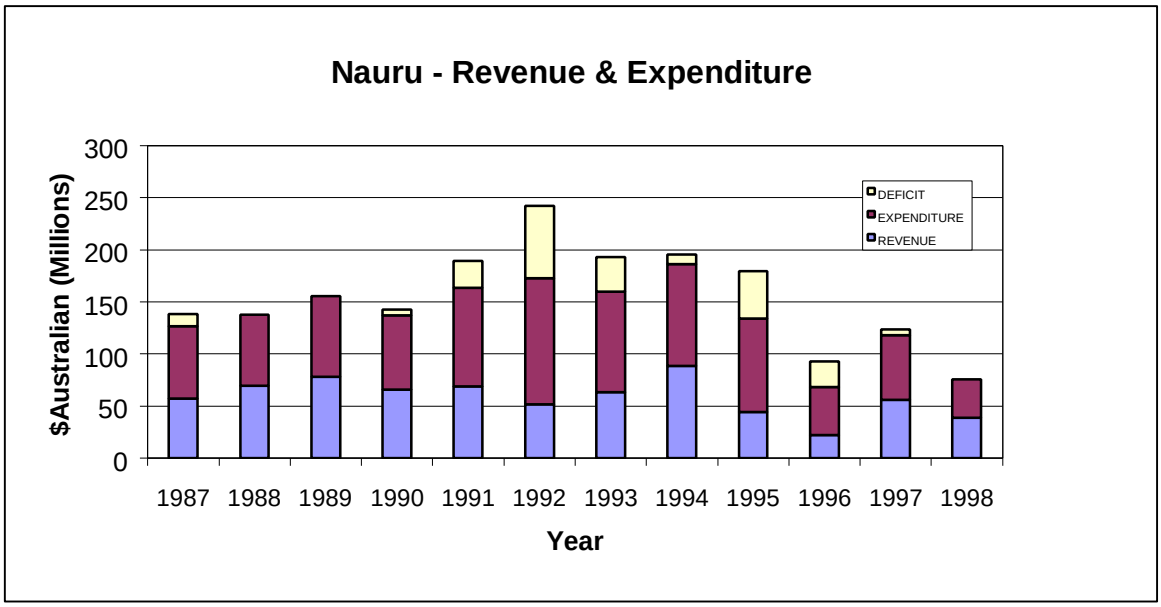
Inflation for Nauru is currently increasing at 4.3% per annum.



Note: The peak in the Phosphate Sales (exports) graph relates to Nauru selling extra phosphate in the 1992-94 period to cover costs associated with infrastructure (hotels, civic centre and airport extension) development and improvements in conjunction with hosting the 1993 South Pacific Forum Meeting on Nauru.

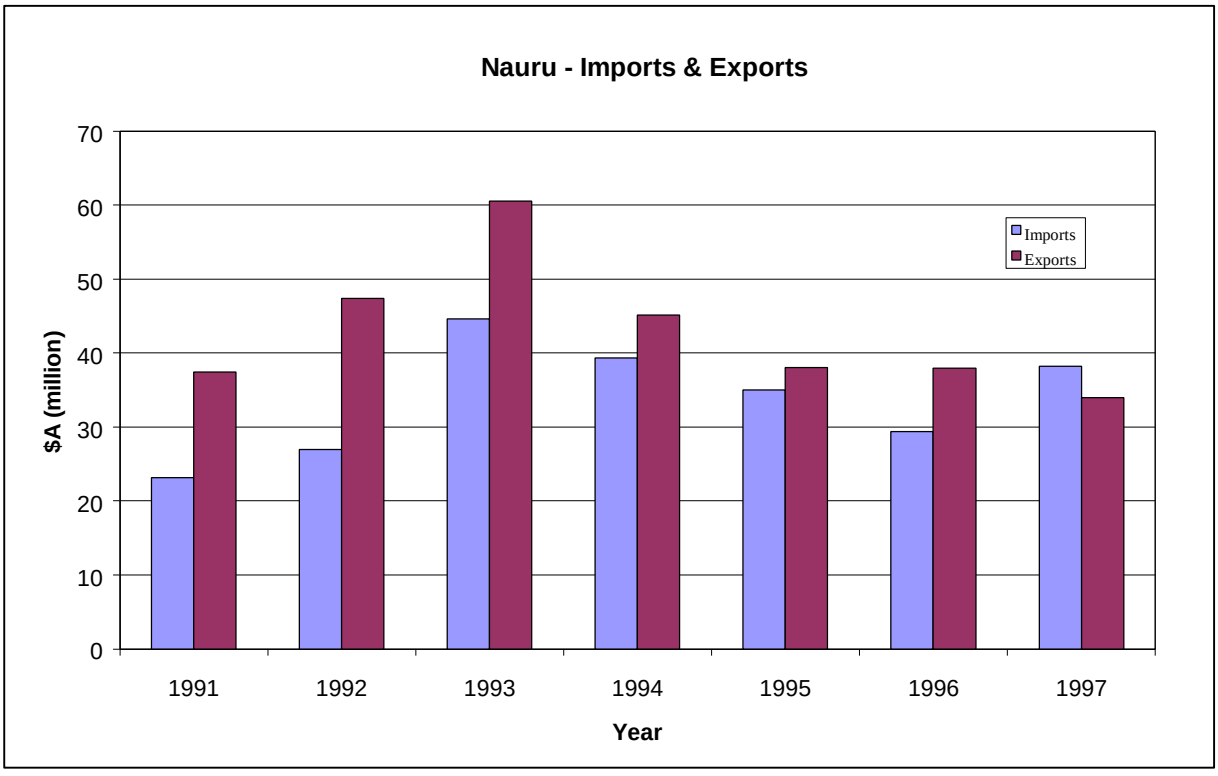
BUDGET REVENUE AND EXPENDITURE

Year	Revenue ($A x 10^6)	Expenditure ($A x 10^6)	Deficit /(Surplus) ($A x 10^6)
87/88	57.52	69.30	11.78
88/89	69.76	67.85	(1.91)
89/90	77.88	77.88	0.00
90/91	65.64	71.23	5.59
91/92	68.94	94.57	25.63
92/93	51.68	121.06	69.38
93/94	63.33	96.41	33.08
94/95	88.62	97.59	8.97
95/96	44.13	89.87	45.74
96/97	22.10	46.47	24.36
97/98	55.98	61.84	5.86
98/99	38.66	37.15	(1.5)



TRADE STATISTICS

Year	Imports ($Australian x$10^6$)	Exports ($Australian x 10^6) (Phosphate Sales Only)
1991	23.12	37.48
1992	26.98	47.42
1993	44.66	60.54
1994	39.34	45.11
1995	35.00	38.08
1996	29.42	38.00
1997	38.18	34.00



1.5.2 Economic Reform

In respect to Nauru's economy, the most recent and important development activity has been the implementation of an economic reform process. The economic reform commenced in 1998 with the assistance of the Asian Development Bank (ADB), and subsequent to this, a further technical assistance also provided by the Asian Development Bank has been provided to address and assist with the "Social Awareness and Transitional Requirements for the Reform Programme".

The actual economic reform process was initiated because of the following factors:

- Fall in phosphate exports in the early 1990s;
- The resulting decrease in dividends to Government;
- Continued high levels of expenditure in government budgets (deficits);
- Excessive loans from the Bank of Nauru as well as other external sources;
- Excessive loans from the Nauru Phosphate Royalties Trust (NPRT);
- Liquidity problems domestically – deposits and withdrawals;
- Continued currency hoarding to meet external payments; and
- Poor management of investment portfolios (NPRT assets).

The implementation of the reform programme has focused on the following objectives, which have been structured so as to be implemented in a series of "Tranches".

- Reduce fiscal deficit;
- Enhance returns to the economy from NPC & NPRT;
- Transparency and accountability to the management of the budget process and financial transactions;
- Establish a viable banking system;
- Improve the efficiency and effectiveness of the public service sector;
- Soften the impacts of the reforms; and
- Ensure social and community participation in the reform process.

The reform programme Technical Assistance (TA) commenced in February 1999 and is scheduled to be completed in October 1999, the objective of the TA being to assist the Economic Reform Committee (ERC) to promote understanding and gain wide public awareness and support for the Government's reform programme. This will be provided through a "Social Awareness and Public Relations Consultant" and "Transition Services Unit Counselors".

1.5.3 Agriculture

Primary production is confined to fruit and vegetable for domestic consumption, although Nauru is nowhere near self-sufficient in this regard. Bananas, pineapples, pawpaw, mangoes, breadfruit, coconuts and some root crops are grown o the coastal fringe. Currently a fruit-fly eradication programme has been introduced into Nauru in an attempt to reduce the numbers of fruit flies and white flies. Indications are that this eradication programme is proving successful and will assist in increasing the percentage of locally grown products reducing the need to import in the longer term.

1.5.4 Industrial / Mining

Industrial activities on Nauru are limited to the mining and production of phosphate. The Department of Islands Development and Industry (IDI) has been instrumental in establishing small commercial activities, but these are currently limited to eggs and poultry.

Other government instrumentalities such as NPC and Rehabilitation Corporation have the capacity also to provide small scale industrial and commercial activities such as production of soft drinks and milk.

All other agricultural activity and production of coconut, fruit and vegetables has been very limited and all products are consumed locally.

1.5.5 Trade and Tourism

Exports from Nauru to date have been limited to phosphate. The export of fish has been tried unsuccessfully in the past, but with the current vision and the establishment of the Nauru Fisheries and Marine Resources Authority it is anticipated that fishing will provide an export opportunity for Nauru.

Construction of a new slipway and associated infrastructure to give a secondary port facility at Anibare Bay, providing an alternate access for fishing boats commenced in June 1999. The development of this alternate slipway will provide access for commercial fishing boats up to 10-15 metres in length when the frequently prevailing weather conditions on the South-Western side of the island make it impractical or impossible to use the existing slipway at Boe.

The number of visitors to Nauru as a destination is very small. Nonetheless, many travellers to Nauru are transit passengers and do not stay overnight. Most of the visitors to Nauru are usually on government business or visiting friends and relatives. Nauru is serviced by one airline, Air Nauru that links Nauru to Melbourne, Brisbane, Pohnpei, Guam, Manila, Fiji and

Kiribati. Nauru has two hotels: the government owned Menen Hotel, and the privately owned Od'n Hotel. The Department of Culture and Tourism handle matters relating to tourism and visitor information.

1.5.6 Transport

The Government of Nauru for a number of years operated "Air Nauru" as a government airline, however under this mode of operation the airline was servicing non-viable destinations and was accumulating significant operating losses ($20 million per annum). In July 1996 "Air Nauru" was corporatised. The airline still remains 100% government owned but now is operated as a commercial operation with the new objective of providing a financially viable air service. Current indications are that this object is being achieved (reduced operating loss down to $2.6 million [financial year 97/98] break even or a small profit [financial year 98/99].

The road infrastructure around Nauru totals 40 km. This comprises of 29 km of sealed roads, of which 17 km is the distance around the perimeter of the island. There is another 12 kms (approximate) of unsealed roads that are mainly on the "Topside" and used for the phosphate mining operations; this varies with the location of the mining operation.

A narrow-gauge rail system for transporting the mined phosphate links a tip head located near the middle of the Topside area to the Phosphate Refinery situated in Aiwo and is 4 km in length.

There is no public transport system and most families own one or more cars or motor cycles. The total numbers of registered motor vehicles and motor cycles on Nauru as recorded in the 1992 census are provided in the table below. What is of particular interest is that approximately a third of all Nauruan households may have at least one motor car (38%), a land rover (35.5%) or a motorbike (33.1%).

Vehicle / Boat	Total[4]	h/holds with one	% of h/hold responses	h/holds with two	% of h/hold responses
Motor Car	370	260	38.0%	78	11.4%
Land Rover	307	243	35.5%	50	7.3%
Truck/Van/Minibus	103	93	13.6%	7	10.25%
Motorbike	315	227	33.1%	62	9.1%
Bicycle	294	139	20.3%	74	10.8%
Motor Boat	99	84	12.3%	11	1.6%
Canoe	21	16	2.3%	4	0.6%
Sail Boat	3	2	0.2%	1	0.2%

[4] Information extracted from the Republic of Nauru 1992 Census

Sea transport is limited to a range of small to medium-sized outboard motor boats, which are used predominantly for subsistence fishing. Fishing for domestic consumption is often carried out from traditional wooden dugout canoes. From the 1992 census it was calculated that over 12% of households own a motor boat, compared to 2.3% that own a dugout canoe.

The regular ocean-going shipping that services the island and the phosphate ships all add to the potential detrimental impacts to the environment from oil spills and general ship's pollution. The plumes of phosphate dust drifting freely over both the land and ocean during the loading of phosphate for export, the plumes remain a concern. Unfortunately there does not appear to be an easy solution to this.

1.6 Energy Sector

1.6.1 Introduction

The Nauru Phosphate Corporation (NPC) is wholly government owned and is the sole power provider on Nauru. The NPC was traditionally established for the primary purpose of mining. In addition to the provision of electricity for the entire island NPC is also responsible for the water supply (pumped / imported and through desalination) for distribution through water tankers to the meet the domestic, hotel and commercial requirements.

The whole population on Nauru has access to electricity, and there are a number of stand-alone generators that are used for standby purposes.

Limited use is made of solar photovoltaic or solar hot-water systems, although with Nauru situated almost on the equator the climate and long hours of solar radiation lend themselves to this alternate form of renewable energy.

Diesel generators have been the traditional source of electrical energy for Nauru since the establishment of the mining activities. The NPC has an installed capacity of 15 MW (derated to 11.1 MW) with approximately 43% of the energy generated by NPC being used by the mining operation.

There is limited use of LPG on Nauru, in particular in the domestic sector. However, hotels and restaurants use LPG for cooking purposes. This situation has arisen due to the long-term reliance on electricity as an energy source, which in the earlier days of the mining operation (pre 1990s) was free.

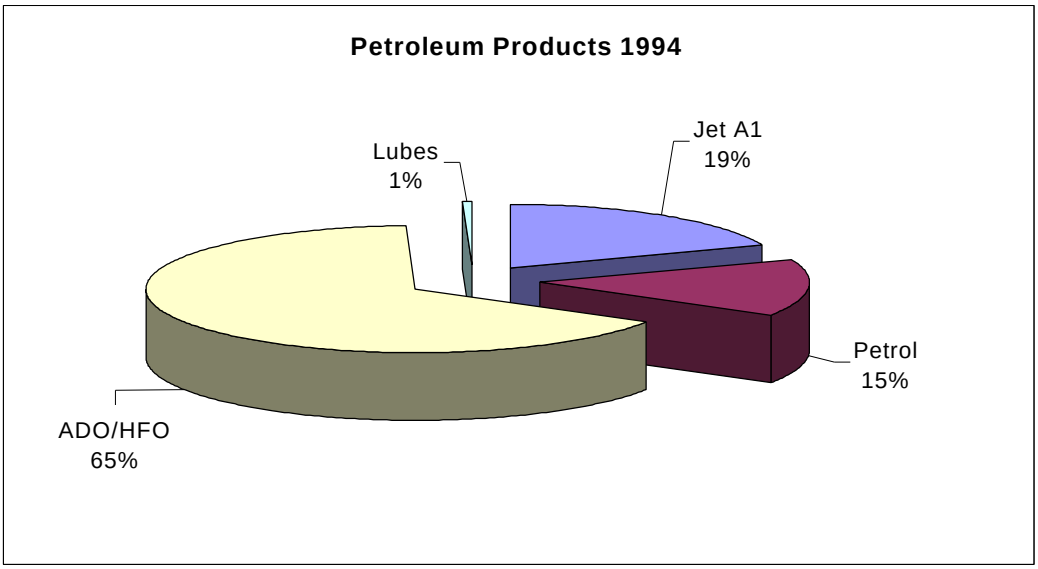
Opportunities abound for the introduction of demand side management and energy efficiency in Nauru, in particular in the government and domestic sectors where there is a high use of air conditioners, electric water heaters, electric water pumps and electrical appliances.

The installation of a desalination plant (design capacity 1200 tonnes per day with an actual output 1150 tonnes per day) in 1994 utilises the waste heat from the engine exhaust system of the NPC diesel generators. This source currently provides most of the island's clean water supply requirements. Most residents have their own water wells and small electric pumps. Limited use is made of the extensively available roof rainwater catchments.

1.6.2 Resources

Indigenous energy resources in Nauru are limited solely to solar radiation and a small amount of biomass. However, as the electricity is supplied from diesel generation and has been abundantly available over the past 80 years, these other renewable energy sources have not been extensively exploited. Due to Nauru's limited biomass resources it is unlikely that this could be considered to be a sustainable energy resource for the future. Solar energy offers the best alternative, but considering the high usage of electrical appliances, i.e. air conditioners, stoves, etc., the practicalities of adopting a solar-replacement policy would need to be carefully evaluated from an economic point of view. In addition, the environmental aspects of battery import and disposal may also create additional problems.

All other forms of energy (petroleum products, LPG, etc.) are imported into Nauru. The chart below shows the volumes of petroleum products imported in 1994.



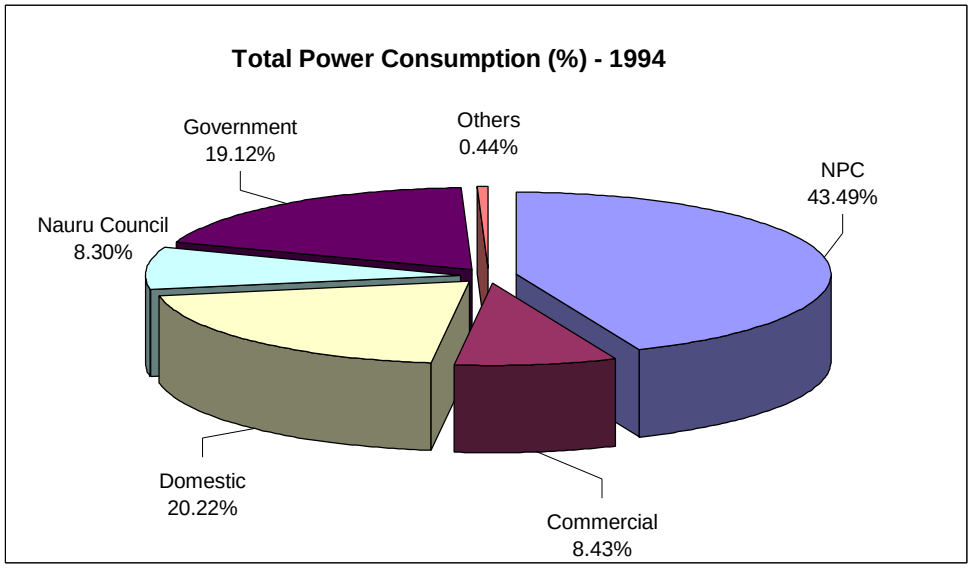
(Data from Nauru Phosphate Corporation)

1.6.3 Transformation

Energy transformation in Nauru is limited to the use of diesel fuel for the production of electricity. Consumption of diesel fuel has remained relatively consistent and is in the order of 16400 kilolitres per annum. This consumption is about 61% of all the petroleum products imported into Nauru.

1.6.4 Demand

Current demand in Nauru peaks around 8 MW. As the generating plant operated by NPC is relatively old, there is an immediate need to consider either an upgrade of a number of the diesel generators or alternately to actively support and implement with the government a demand side management (DSM) and energy efficiency programme. The focus of this would be on conservation programmes, alternate fuels such as LPG and the utilisation of solar energy. The introduction of a tariff structure that reflects the true cost of electricity generation will also assist in ensuring the optimal and efficient use of electricity through pricing.



(Data from Nauru Phosphate Corporation)

Chapter Two

Nauru's Climate Change

2.0 Introduction

Nauru could be considered to be in a far better position with respect to climate change and sea-level rise than a number of its Pacific island neighbours who have substantially larger land areas.

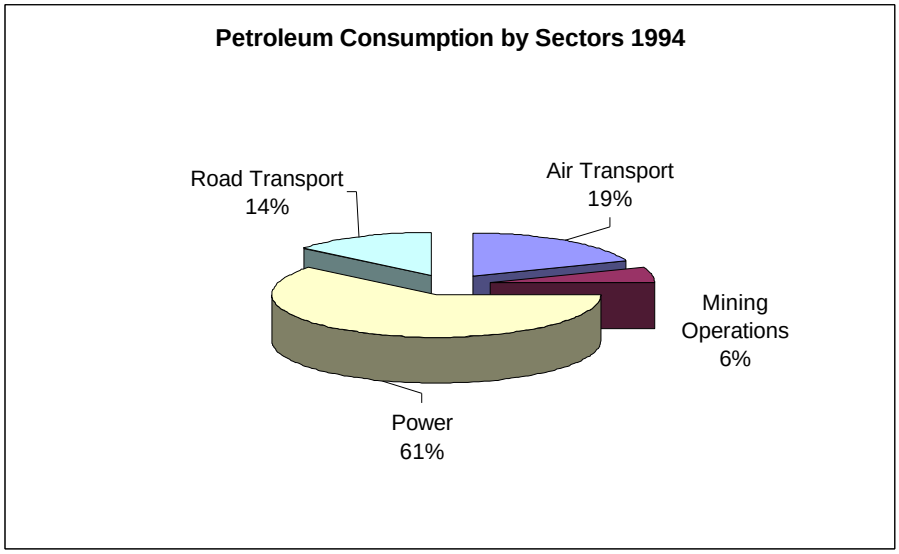
Nauru aside from its coastal perimeter being at sea-level, still has at least 80% of its land area well elevated. However, this is not the case for a number of its neighbouring countries which are predominantly low-lying coral atolls and vulnerable in respect to any future sea-level rise.

However, until proven otherwise, it is very likely that Nauru will to some degree be vulnerable to climate change, but to what degree, is currently difficult to predict. The vulnerability and assessment study carried out for Nauru[5] has identified that future activities would influence Nauru's sensitivity to future change. In particular, the coral reef and marine environment; coastal erosion; water resources; vegetation; and human health.

The levels of carbon dioxide (CO_2) emissions from Nauru are relatively small and are easily identifiable with respect to their source, predominantly the energy sector (61%), international air transport (19%) and road transport (14%). Aside from the impact of climate change there will also be implications of introducing adaptation or mitigation options for Nauru which will obviously have an impact. These are discussed in detail in Chapter Four of this report.

As estimated for 1994, 70% of Nauru's greenhouse gas emissions can be attributed to energy production and the phosphate mining activities. Nauru's consumption of petroleum products by sectors is provided in the chart below.

[5] National Statement on Vulnerability and Adaptation to Climate Change and Sea-level Change in Nauru, Nodel Neneiya and Taralyn Adam, PICCAP, V&A Trainees, IDI.



(Data from Nauru Phosphate Corporation)

2.1 Climate Change – Predictions and Methodology

Currently there is relatively limited detailed information on climate change in Nauru, and like a number of its small Pacific Island neighbors Nauru reacts to situations such as water shortages when they occur. As a small island state (SIS), Nauru has limited resilience to climatic change and therefore the impacts tend to be more severe due to the lack of this natural ability to diversify. Longer-term detailed information is limited for most sectors and because the focus for the past century has been on the phosphate mining industry, other sector activities have as a rule been very limited. Acknowledging that the phosphate mining cannot be carried on in a sustainable manner forever has led Nauru to take steps through the current proposed rehabilitation plan to develop a way to ensure that an economy will exist for the future.

- Predictions

Due to this limited level of information, quantifiable predictions have not been made although the ability to match regional trends and changes with events in Nauru provides a mechanism whereby the prediction of future events will enable Nauru to be at least a little better prepared to handle these occurrences and episodes.

- Methodology

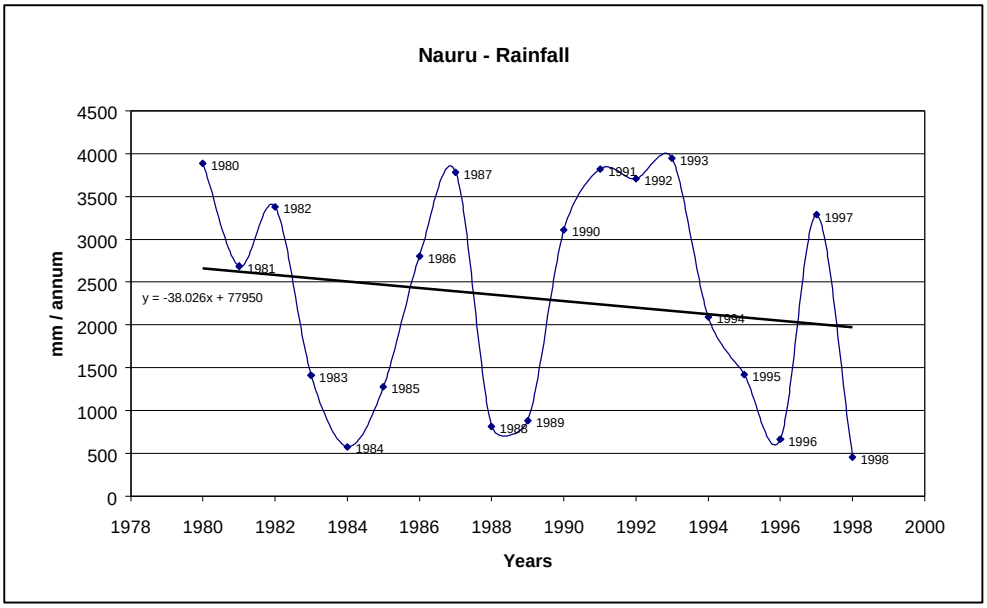
The methodology used in establishing a prediction of the effect of climate change has been limited to the analysis and reference to the wider regional predictions in respect to climate change. As Nauru's data collection and management systems are relatively immature and still being developed, it has not been possible to fully quantify the predictions as noted above. As the length of records increase, Nauru will be in a better position to predict, as opposed to currently reflect on historic trends. This also carries with it the need for the development of analytical skills and technical training in data collection and management which is currently being provide a through a number of regional programmes and activities.

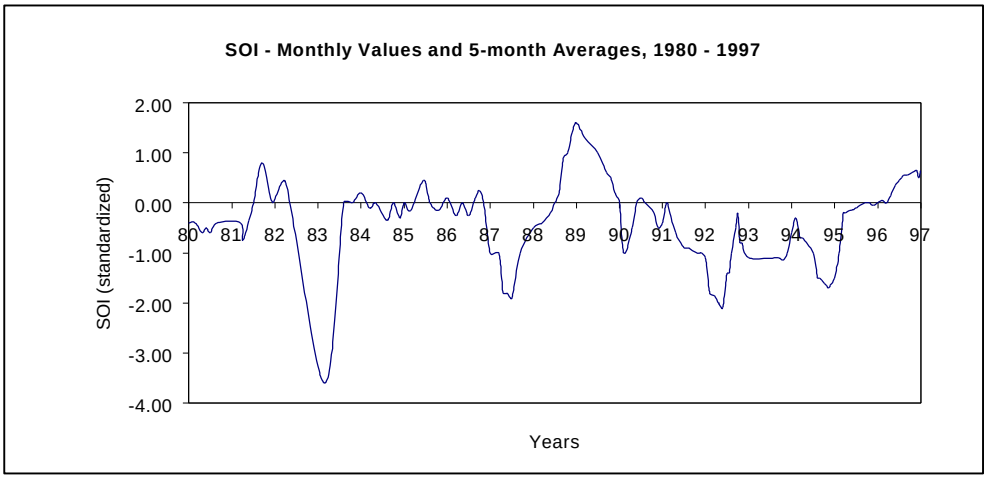
2.2 Climate Summary

Weather patterns throughout the region are now described with reference to and in terms of the El Niño – Southern Oscillation (ENSO), which is cited as a natural oscillation of the Earth's climate, and La Niña. The main effects are to alter the global patterns of cloudiness and rainfall, especially in the tropics.

Extremes of ENSO oscillation occur every few years, about 3-7 years apart. The last four events were 1982-83, 1986-87, 1991-94 and 1997-98. Currently the region is now in a La Niña episode after experiencing a relatively strong El Niño in 1997-98. For Nauru this is evidenced by lower than average rainfall recorded for 1998 and an interesting declining trend line that obviously will have longer-term implications.

Between El Niño events, La Niña events occur which have the opposite effect on the ENSO. Refer to ANNEX 4 for a description of the Anomalous Pacific Conditions: El Niño and La Niña.





A plot of the Southern Oscillation Index (SOI) with Nauru's rainfall record is provided as a comparison.

The SOI is based on the differences in atmospheric surface pressure between Tahiti and Darwin. The SOI gives information on the strength or weakness of normal easterly surface wind patterns in the tropical Pacific compared to the long term average. The negative values of SOI are associated with El Niño or ENSO warm events, and a weakening or reversal of normal wind patterns, while the positive values of SOI are associated with La Niña cold events and stronger than normal easterly winds in the region.

The effects of the La Niña and El Niño events are described briefly below in the context of Nauru.

2.2.1 Rainfall

Rainfall for Nauru during an El Niño episode will generally result in a wetter than average period. This period of maximum effect is from November to April and usually sees dramatic increases in normally dry areas along the equator and generally decreased rainfalls South West of the merged zone (Fiji). As noted above the pattern of change of El Niño is not fixed throughout the episode, but varies from month to month.

Tropical cyclones require specific oceanic and atmospheric conditions for initiation and maintenance and therefore occur only in certain parts of the globe. In the South Pacific, these conditions are associated with the major rainfall zones, and therefore during El Niño years they tend to shift Eastward as do the shifts in rainfall zones. Hence in an El Niño year/s the incidence of tropical cyclones is higher. To date Nauru has not been significantly affected by cyclones. However rough to severe weather conditions have been known to occur on occasions (e.g. 1983).

2.2.2 Weather

Weather in general sees a weakening of the Easterly winds along the equator, sometimes accompanied by strong Westerly outbursts with high waves and hence coastal damage which has been noted in Nauru, Western Kiribati and Northern Tuvalu.

Sea temperatures produce a fundamental oceanic signature of ENSO in a fan-shaped area where sea surface temperatures are significantly higher than normal. This extends Eastwards from the dateline (180^{th} meridian) along the equator and fans out to the coastline of the Americas. High surface temperatures are known to stress corals and affect fisheries, and this is significant for Nauru.

2.2.3 Sea-level

Sea-level during an ENSO episode is sometimes seen to fall, especially in the Western Pacific. This is due to the Eastward release of warm tropical water built up in the western Pacific by the strong Easterly trade winds in the years between events. Such depressions of sea-level can cause reefs to be exposed, and higher temperatures in lagoons leading to coral and near-shore damage.

Records for Nauru have been taken from the South Pacific Sea-level and Climate Monitoring Project - SEAFRAME Data. In the Monthly Data Report No 46, April 1999, sea-level trends for Nauru have been reproduced from Figure 15 of the publication and shows “Sea-level Trends through January 1999” (mm/year) from the time of the project commencing in 1994. The current trend is a fall in sea-level of an estimated 27.5 mm over this period. As the record is considered to be relatively short no projections are possible. However, compared to the SOI it can be seen that the trends in 1995 and 1997 coincide with the El Niño and La Niña episodes.

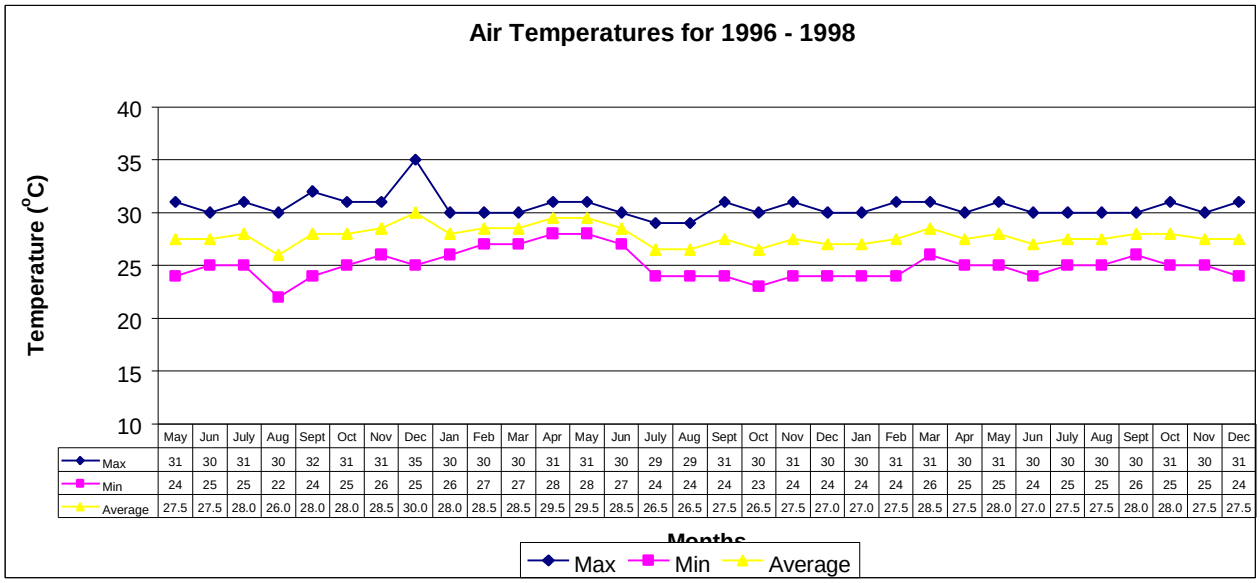
In addition to these indicative sea-level trends and other regional claims that the sea-level is in-fact rising it is important for Nauru not to loose sight of these claims and long term predictions. Since at least 95% of Naurus population live on the coastal perimeter of the island and the Topside area is currently uninhabitable they are literally “with their backs to the wall”, hence, could be particularly vulnerable to climate change and sea-level rise.

Temperature records for Nauru have been taken from the South Pacific Sea-level and Climate Monitoring Project - SEAFRAME Data. These records provide both sea and air temperatures; plots of these have been provided below for information. Nauru, being located at the equator does not have substantial variations in either sea or air temperature throughout the year. Hence any variations that are recorded do not need to be interpreted as do climate variations from countries closer to the polar regions that have significant seasonal changes from winter to summer.

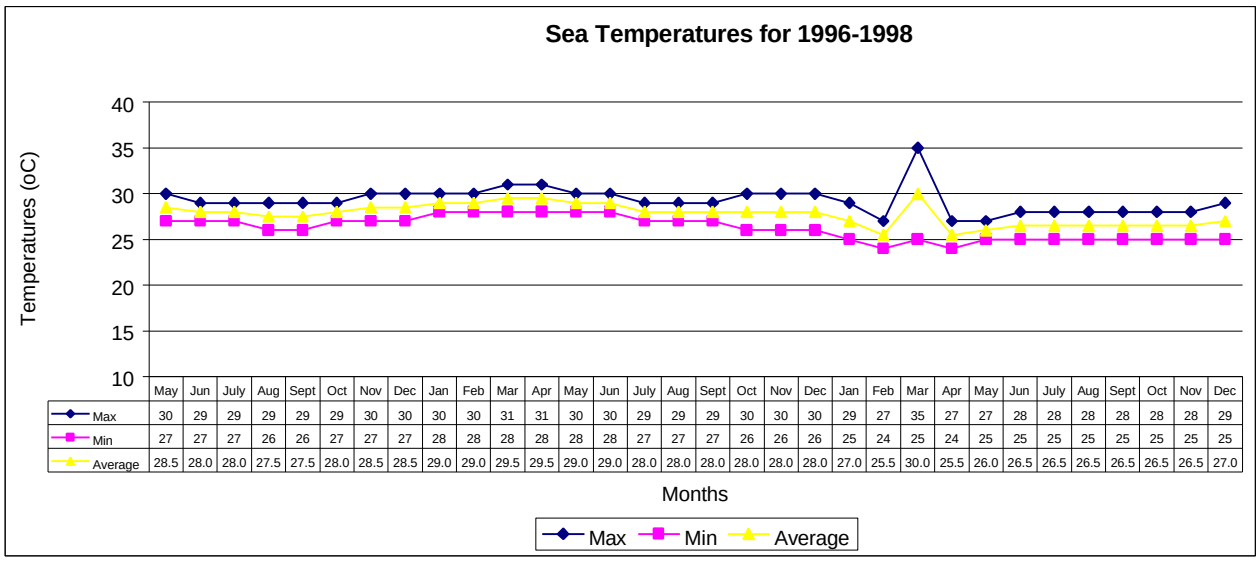
The figures provided below represent the minimum and maximum figures recorded. However, in both the air and sea temperature plots there are two outlier figures (not consistent with the record trend before and after) which can be treated with suspicion and for continuity of record have been neglected in this case.

Air Temperatures	Min	22	^{o}C	Max	32	^{o}C
Sea Temperatures	Min	24	^{o}C	Max	31	^{o}C

Note: Information / Data extracted from South Pacific Sea-level and Climate Monitoring Project - SEAFRAME Data – Monthly Data Reports.



	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Max	31	30	31	30	32	31	31	35	30	30	30	31	31	30	29	29	31	30	31	30	30	31	31	30	31	30	30	30	30	31	30	31
Min	24	25	25	22	24	25	26	25	26	27	27	28	28	27	24	24	24	23	24	24	24	24	26	25	25	24	25	25	26	25	25	24
Average	27.5	27.5	28.0	26.0	28.0	28.0	28.5	30.0	28.0	28.5	28.5	29.5	29.5	28.5	26.5	26.5	27.5	26.5	27.5	27.0	27.0	27.5	28.5	27.5	28.0	27.0	27.5	27.5	28.0	28.0	27.5	27.5



	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Max	30	29	29	29	29	29	30	30	30	30	31	31	30	30	29	29	29	30	30	30	29	27	35	27	27	28	28	28	28	28	28	29
Min	27	27	27	26	26	27	27	27	28	28	28	28	28	28	27	27	27	26	26	26	25	24	25	24	25	25	25	25	25	25	25	25
Average	28.5	28.0	28.0	27.5	27.5	28.0	28.5	28.5	29.0	29.0	29.5	29.5	29.0	29.0	28.0	28.0	28.0	28.0	28.0	28.0	27.0	25.5	30.0	25.5	26.0	26.5	26.5	26.5	26.5	26.5	26.5	27.0

2.3 Impacts – Natural Ecosystems and Socio-economic

The following section provides a brief summary of the impacts that can be expected to affect natural ecosystems and the socio-economic component of a country. These are detailed further in Chapter Four - Vulnerability and Adaptation to Climate and Sea-level Change.

2.3.1 Water Supplies

Most Pacific island water supplies are vulnerable to fluctuations in rainfall. The effect may be wide and varied, including the need to introduce desalination as has been the case for Nauru. Examples of externalities are, the need to truck / import water, increase of health risks, poor crops, etc. In Nauru brackish water is commonly used for sanitary purposes in homes and the two Hotels.

2.3.2 Agriculture and Fisheries

The agricultural and fisheries sectors can both be affected when rainfall averages and sea temperatures rise or fall significantly. The effects are often difficult to determine and have specific considerations for either domestic sector or the commercial / industrial sectors.

2.3.3 Fire

The risk of fire increases during drought periods, which are associated with the ENSO episodes. For Nauru this risk could be considered to be high considering the limited fresh water resource immediately available and the limited number of suitable points of access to the ocean for pumping seawater.

2.3.4 Health

Health is mainly affected through the lack of adequate freshwater supplies. This generally leads to the higher incidence of water-borne infectious diseases such as typhoid and diarrhoea, of which a number of cases have been reported on the island. In Nauru brackish water and seawater is commonly used for sanitary purposes especially in hotels and private housing.

2.3.5 Environment

The environment can be affected during an ENSO episode through stressing a range of areas, groundwater resources, temperature and stress levels in lagoon, and unusual wave action on coastal zones and on coastal infrastructure.

2.3.6 Unexpected Effects

Climatic, environmental and social factors can interact in a number of unexpected ways. These are yet to be assessed.

2.3.7 National Economies

A cyclone, drought or flood may affect most of if not all of a small country. Extreme events that occur as a result of ENSO episodes may affect a significant component of the country's GDP.

Chapter Three

Nauru's National Greenhouse Gas Inventory

3.0 Introduction

This section of the National Communication has been reproduced from the first Greenhouse Gas Inventory (GHG) prepared for the Republic of Nauru[6]. This detailed report adopted the "Reference Approach" for the calculation of Nauru's Greenhouse Gas Inventory and was in accord with the Revised (1996) Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (Revised 1996). The inventory was prepared by the Department of Islands Development and Industry in conjunction with assistance from the Energy Unit of the South Pacific Applied Geoscience Commission (SOPAC) The presentation generally adopts the IPPC reporting layout, aside from the Executive Summary that has been integrated into the main communication's summary and the omission of duplicated sections on "present conditions in Nauru", and the detailed GHG inventory worksheets. The remainder of the report has been cited here for continuity and completeness, with summary tables provided where appropriate.

Greenhouse Gas Emissions and Sinks

Greenhouse gas emissions in Nauru in 1994 totalled 19.265 Gg of carbon dioxide.

As this is Nauru's first Greenhouse Gas Inventory a comparison of emission trends has not been possible. However, as the once predominant phosphate mining activity has been

[6] "Greenhouse Gas Inventory Report - 1994" prepared by Mr Tyrone Deiye, Project Officer, Mr Ditrone Tom, GHG Trainee, Department of Island Development and Industry (IDI), Republic of Nauru

gradually decreasing since 1993 it can be expected that the levels of greenhouse gas emissions for Nauru will also have been decreasing over recent years.

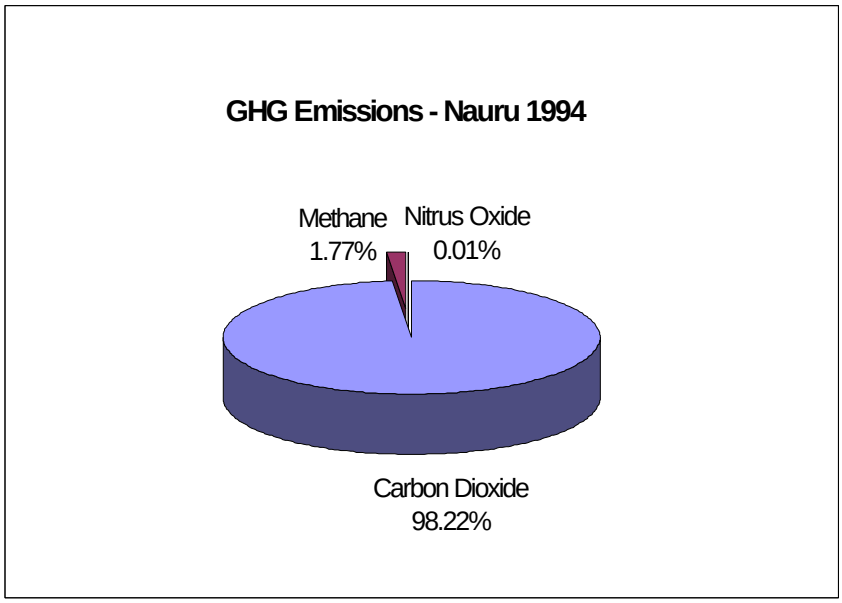
It is acknowledged that in the future there are likely to be modifications to the inventory, once the process of determining greenhouse gas emissions is better understood, in particular, appropriate conversion figures for industrial processes such as phosphate extraction and processing which are particularly relevant to Nauru's situation. Due to Nauru's relatively uncomplicated situation the greenhouse gas emissions have focused predominantly around activities associated with the phosphate mining operation and the transport sector.

The Greenhouse Gas Inventory, prepared as a separate report, elaborates on the assumptions made and the constraints encountered in the preparation of this first Greenhouse Gas Inventory for Nauru.

National Greenhouse Gas Inventory						
Greenhouse gas source and sink categories	***CO_2***		***CH_4***		***N_2O***	
	Gg	%	Gg	%	Gg	%
1. All Energy (incl. transport)	**41.416**					
A. Fuel combustion	28.318	68.37				
B. International bunkers 1	13.098	31.63				
2. Industrial processes	**NE**		**NE**		**NE**	
3. Solvents	**NE**		**NE**		**NE**	
4. Agriculture			**0.234**	**67.55**		
A. Enteric Fermentation			0.011	3.18		
B. Animal Wastes			0.223	64.38		
5. Land use Change & Forestry 2	**-9.053**	**21.86**				
6. Waste			**0.1124**	**32.45**	**0.001**	**100.00**

1. Not included in Nett National Total
2. Uptake (sink) not deducted from "All Energy" and taken as a percentage of "All Energy"

NE = Not Estimated



3.1 Methodology

The approach used for the calculation of Nauru's first Greenhouse Gas Inventory is in accord with the Revised (1996) Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (Revised 1996)[7]. For Nauru the "Reference Approach" or the "Top-down Approach" was adopted and is as detailed in the IPCC Guidelines for National Greenhouse Gas Inventories.

This approach was deemed to be the most appropriate considering Nauru's physical and geographical status within the Pacific and, due to its size, the actual sources of greenhouse gas emissions. In addition, the availability of information for the compilation of Nauru's greenhouse gas inventory was relatively limited and this was a significant constraint. In light of this lack of information the Department of Island Development and Industry (IDI) has now placed a high priority on the collection and compilation of data in the comprehensive energy database earlier established by the Energy Unit of the South Pacific Applied Geoscience Commission (SOPAC). The continued regular management of this database will also assist the IDI to design and establish projects for the reduction of energy consumption on Nauru.

[7] Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (Revision 1996)

Volume 1 – Greenhouse Gas Inventory Reporting Instructions

Volume 2. – Greenhouse Gas Inventory Workbook

Volume 3. – Greenhouse Gas Inventory Reference Manual

In the preparation of this inventory, information and data required relating to climate, statistics (GDP, imports/exports, population etc) and the energy sector has been obtained predominantly either from the Bureau of Statistics or the Nauru Phosphate Corporation (NPC). However, there are still various levels of uncertainty associated with different sections of the inventory. In particular, information and data from other sectors contributing greenhouse gases are not well documented and hence to accurately quantify these has been difficult. Specific reference is made in the body of the report to the assumptions made and constraints with respect to the preparation of this, Nauru's first greenhouse gas inventory. These need to be addressed when preparing subsequent inventory reports.

3.2 Specific Sector Information Relating to Nauru's Situation

The NPC currently holds the longest and most appropriate data source for the energy sector through their role in phosphate extraction and processing activities. The NPC is also responsible for the island's fuel supply, management of the fuel storage tank farm, electric power generation, and water supply and sewage disposal. In addition to the NPC, the Government's Bureau of Statistics has provided more recent statistical information/data and reports which has enabled some short term trends to be established. However, this is relatively limited as the Bureau of Statistics was only established formally in 1996. The Department of Island Development and Industry have also proven to be a useful source of information required for the preparation of the greenhouse gas inventory.

3.3 Energy

3.3.1 Petroleum Fuel

The NPC is responsible for the bulk importation of all petroleum fuel and products to Nauru, and supplies all petroleum fuel for domestic use such as diesel oil (ADO), petrol, dual-purpose kerosene (DPK), lubricants, solvents and LPG. A number of small businesses individually also import lubricants, solvents and small amounts of LPG for which records were not readily available. As and when required, the Nauru Public Works Department imports bitumen.

Nauru Air Corporation purchases its own supply of aviation fuel (Avgas), but NPC stores and handles the fuel.

Information on product imports is relatively well documented, however the end-user information for the bulk of the petroleum products is limited to transport, mining and power generation. The sectors other than power generation (requirements ADO and lubes) are not well documented. As NPC has been responsible for nearly all the island's fuel supply it has maintained the only records of fuel imports and consumption. Unfortunately with the change in staff and operational arrangements (introduction of computers) within NPC, a number of the more historic records have been mislaid. For the other, smaller volumes of products that are imported, such at lube oils, solvents and LPG, these have generally been handled through NPC's stores system pretty much in the form of consumables and hence historical statistics on these products was also limited.

In compiling the inventory all the aviation fuel has been treated as international bunkers.

The use of dual purpose kerosene (DPK) on Nauru is very small and this has not been distinguished in the petroleum product volumes splits or usage.

Although records of petroleum product use are currently well documented in NPC's powerhouse daily operating records, a detailed breakdown for the past (1994) was not available. However, records for 1996 were available for the powerhouse and these were used along with the transfer records from the Tank Farm to the powerhouse as a basis for calculating annual consumption to establish the powerhouse consumption. The volume of lubricants consumed in the powerhouse for power generation (transformation sector) was also calculated on a similar basis. Power generation, mining and international air transport are the three largest consumption sectors for Nauru and dominate Nauru's fuel consumption picture. The other sectors are less significant. In a number of the areas considered, due to insufficient detailed information on consumption, the assumption has been applied that supply equals demand.

3.3.2 Biomass Burned for Energy

Nauru's major biomass resources comprise coconut-husk, shell and fronds, and a variety of other wood types. Nauru's use of biomass for domestic / household consumption has been very limited.

This is attributed to two main factors:

i) since the establishment of the phosphate mining operation and infrastructure the NPC has been the sole supplier of electricity for both the phosphate industry and domestic consumption. This electricity supply being without charge up until recently still remains the predominant energy source for cooking and heating; and

ii) with the phosphate mining operation progressively stripping Nauru of nearly all its natural vegetation and trees, there has never been a strong reliance on the use of this very limited biomass resource for cooking and heating.

Biomass use on Nauru is therefore relatively small and is considered as insignificant in the overall energy balance. It therefore has not been included as a contributor to the overall energy picture. With the longer-term plan for rehabilitation and replanting of trees, etc., and the possible increases in power tariffs as a means of enforcing energy conservation, measures to reduce the reliance on and consumption of fossil fuels and the use and importance of biomass may again increase.

To date there have been no household energy consumption surveys carried out on Nauru therefore the actual energy consumption balances are not available.

3.3.3 Solar Hot Water Systems and Solar Photovoltaics

As all energy on Nauru is provided from predominantly fossil fuels (electricity generation) there has only been a limited interest shown in solar applications.

Nauru being located nearly on the equator limits the need for hot water for domestic applications. Since NPC have traditionally provided electricity at no cost up until recently, any hot water requirements have been met from electric water heaters. There are only a small number of solar hot-water systems on the island, most of which are in need of substantial maintenance.

Solar photovoltaics have not been used as an energy source on Nauru as the island is 100% electrified by grid-distributed power. However, the government still continues to consider the use of the sun and solar photovoltaics as an energy source, and originally indicated this at the 1995 South Pacific Forum Meeting.

3.3.4 Liquid Propane Gas (LPG)

A very small amount of LPG is used in the domestic and commercial sectors. This is mainly for cooking and is imported in 45 kg bottles. The supply is limited and therefore this has also

limited the expansion of the use of LPG. There are significant opportunities for the expansion of the use of LPG into the domestic sector, which is currently nearly totally dependent on electricity for cooking.

3.4 Industrial Processes

The production of phosphate on Nauru is the only significant industrial process. The production of Nauru's phosphate does not include chemical transformation, therefore there is no direct production of greenhouse gases from this industrial process. The energy used for the extraction and physical phases (grinding of the phosphate) are accounted for in the transformation process of generating electricity (diesel fuel) and heating (heavy fuel oils) to achieve the correct moisture content for export.

3.5 Solvent and Other Product Uses

Information was not available for this sector. Current information from the Bureau of Statistics, which was established only three years ago, indicated relatively small volumes being imported since 1994, and therefore this has been considered as negligible in this first estimate of greenhouse gas emissions.

3.6 Agriculture and Livestock

Agricultural activity on Nauru is very limited due to the small amount of land available and also, more importantly, the scarcity of water. Nauru is quite unique compared to other Pacific island countries in terms of land-use structure, as it has only a relatively narrow outer coastal rim where the greater percentage of the population resides. The "Topside" or middle of the island has been exposed to open-cast mining for phosphate and only the residual rough pinnacle formation remains, which is currently not conducive to agriculture. The proposed rehabilitation of these earlier mined areas is planned, which in the longer term will provide the opportunity for agriculture and also revegetation.

Livestock on Nauru is limited to pigs and chickens due to this inavailability of pastures and free range / grazing land areas. The pigs and chickens (eggs) provide the only locally produced food stocks aside from the odd local garden and tropical fruit trees. Endemic species such as the noddy birds have not been included in this sector.

IDI have successfully developed a small commercial market for the sale of eggs. However, the product quality (pale yolk colour) has seen the production of these eggs substantially exceed the demand. There are a number of pigs and chickens, which tend to be free range and used for domestic consumption only.

The emissions from pigs and chickens have been calculated and included in the inventory. The combined emissions were found to produce 0.223 Gg of methane (CH_4).

3.7 Land Use Change and Forestry

Due to the long period of open cast mining on Nauru there have been a number of changes in the land use and fauna over this time. Unfortunately detailed historic data of these changes are not readily available, although the current situation is well documented in Nauru's "National Environmental Management Strategy and National Environmental Action Plan" (NEMS).

On a global scale the impact and changes are minimal, but within the overall balance for Nauru it can be considered important for the following reasons. During the earlier periods of the mining operations the naturally occurring vegetation was progressively stripped from most of the island, reducing any benefits of CO_2 uptake. However, there has been limited revegetation during this period and under the current initiative to rehabilitate the mined pinnacle areas through levelling. The proposed replanting, land use change and management practice and reduced mining activities should therefore result in reduced CO_2 emissions. Therefore the current natural revegetation on the topside and the remaining natural vegetation have been used as a basis for determining the current situation, which will provide a baseline from which to determine future benefits from the proposed rehabilitation, and to specifically quantify the land use change.

An uptake or sink of 9.035 Gg of carbon dioxide (CO_2) has been estimated, based on the remaining 68 ha of very tall closed forest (natural vegetation), the reported 1366 ha of

regenerated vegetation after mining and the calculated area of 200 ha as a provision for the coastal perimeter.

3.8 Waste

3.8.1 Solid Waste Disposal

Controlled land filling is currently not practised on Nauru. Instead, open dumping is the most common way of disposing of solid wastes. This has been carried out mainly in designated areas above the main town centre and in an area previously mined of phosphate. The current waste-collection system is ineffective and not integrated, which leads also to indiscriminate dumping. This lack of solid-waste management including hospital waste, quarantine waste, metal waste and the municipal waste, leads to future potential environmental and health risks, some of which already exist.

To determine the emissions from these open land-fill areas it has been assumed that the organic waste decomposes aerobically (in the presence of oxygen) and is then attacked by anaerobic non-methanogenic bacteria. On Nauru the total amount of methane (CH_4) estimated to be generated from these land-fill areas is 0.101 Gg.

3.8.2 Wastewater Treatment

On Nauru the domestic and commercial wastewater and sewage are collected by large tanker trucks from septic and wastewater storage tanks and along with NPC's wastewater is disposed of through a seawater pipe outfall close to the edge of the reef. There is no alternate domestic, commercial or industrial wastewater treatment available on Nauru. This lack of primary treatment for liquid wastes provides potential environmental and health risks.

The estimated amount of methane produced from the wastewater collection and disposal process is 0.0113 Gg.

Chapter Four

Vulnerability and Adaptation to Climate and Sea-level Change

4.0 Introduction

The foundation for this section of the National Communication has been obtained from an initial report on Vulnerability and Adaptation for Nauru prepared by the V&A Trainees[8] as part of the overall PICCAP Programme. This detailed report provided the basis for this synthesis and was prepared through technical[9] assistance. Except for the Executive Summary that has been integrated into the main communication's summary, and the omission of duplicated sections on "present conditions in Nauru, and environment and social situation", the report has been cited here for continuity and completeness.

4.1 Sensitivity of Nauru to Climate and Sea-level Changes

Given that Nauru is a single small island, it is appropriate to consider the sensitivity of the island as a whole to climate and sea-level change. The sensitivity of the island can be characterised by possible effects in several important areas.

4.1.1 Coral Reef System

The productivity of the fringing reef and the reef slope of Nauru are already in decline as a consequence of the industrial, infrastructure and residential developments in the coastal zone, as outlined in the previous section. The health of this system is vital, not only as a food resource, but also for protection of the shoreline. Coral reefs are sensitive to variations in ocean temperature and sea-level. Thus, it is likely that the ability of the coral reefs to adjust to these variations have already diminished.

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[8] Ms Taralyn Adam and Mr Nodeal Neneiya, PICCAP V&A Trainee, IDI, Nauru Energy Unit – Vulnerability and Adaptation Assessment for the Republic of Nauru.

[9] Gavin Kenny and Neil de Wet, International Global Change Institute (IGCI), University of Waikato, Hamilton, New Zealand.

4.1.2 Coastal Erosion and Flooding

Coastal erosion is already evident in many areas in Nauru, and can be directly linked to a decline in health of the reef system as also can activities such as removal of coastal vegetation, the blasting of reef channels and poorly constructed sea walls. Many of these problems have arisen because of the lack of an effective EIA process. Lack of an effective water drainage system is also contributing to erosion of land from surface water runoff. In some areas of the coastal plain there are low-lying areas behind the beach ridge which are prone to flooding from overtopping in storms. In addition, there are areas of intensive infrastructure development with poor water drainage systems that are prone to flooding during rainstorms. These factors, in combination, make the Nauru coastline increasingly sensitive to variations in sea-level, and to storm events.

4.1.3 Water Resource

There are no potable surface water resources in Nauru. At present, the two main sources of water are groundwater and the desalination plant. Availability and use of groundwater is limited to the coastal plain. Because of the current salinity and high bacterial levels the use of this water is limited to non-drinking purposes. The sustainability of the groundwater is dependent on adequate recharge from rainfall in relation to the demand. Compaction of surfaces and infrastructural development have led to increased runoff and flooding, and decreased recharge. The high costs of desalination, which will become even less sustainable after the closing of the phosphate mine, combined with decreased quantity and quality of groundwater, have made the water resource of Nauru increasingly sensitive to rainfall variations, in particular drought events such as that of 1997. An as yet unexploited water resource is the groundwater of the Topside.

4.1.4 Vegetation

The natural vegetation of Nauru has been significantly reduced as a consequence of phosphate mining. This loss of vegetative cover, combined with the intensive development activities in the coastal plain, has placed the remaining vegetation increasingly at risk from climate extremes, in particular drought. In the past droughts have had severe effects on vegetation, including death of coconut palms, breadfruit and other important trees.

4.1.5 Human Health

In the past the health and well being of Nauruans was assured by the healthy and productive environment in which they lived. With rapid development and associated changes in lifestyles and diet, diseases such as diabetes, obesity and high blood pressure have become increasingly prevalent. In addition, there are high levels of diseases which are associated with scarce water resources, overcrowding and poor environmental hygiene, such as

diarrhoea and skin diseases.

4.2 Climate and Sea-level Scenarios for Nauru

Nauru has historically been subject to extremes of temperature and rainfall, and interannual variations in sea-level. It is likely that these extremes and variations will continue into the future. However, it is uncertain as to exactly how these local fluctuations will be affected as a consequence of global changes in climate and sea-level arising from the enhanced greenhouse effect. While advances in global climate models are being made, it is unlikely that they will ever be able to provide detailed information for the locale of Nauru. However, it is important for Nauru to have access to the best currently available information derived from global models that is as locally relevant as possible. The use of such information, as presented below, must be qualified by the high uncertainties, particularly in relation to the direction and magnitude of future rainfall changes, and how sea-level will change in Nauru relative to projected global changes.

4.2.1 Climate Scenarios

Scenarios of temperature and rainfall change in Nauru are presented below, for the years 2020, 2050 and 2100. These are based on information in the SCENGEN[10] model, for the locale of Nauru. Results from two general circulation models (GCMs) are presented, and are for an Intergovernmental Panel on Climate Change (IPCC) best-guess scenario of greenhouse gas emissions. Both sets of results show temperature and rainfall increases for Nauru, although the CSIRO9M2 results show lower temperature increases and relatively small increases in rainfall. Although both show rainfall increases, it is not beyond the realm of possibility that Nauru could experience more-extreme interannual variations in rainfall, such as wetter wet years and drier dry years.

GCM Pattern	**2020**		**2050**		**2100**	
	Temp. (^{o}C)	**Rainfall (%)**	**Temp. (^{o}C)**	**Rainfall (%)**	**Temp. (^{o}C)**	**Rainfall (%)**
HADCM2	0.7	5.3	1.5	10.9	2.8	19.9
CSIRO9M2	0.4	1.2	0.9	2.4	1.6	4.3

4.2.2 Sea-level Scenarios

The only scenarios of sea-level change for Nauru are the current global projections. Those based on the IPCC, 1995 assessment are presented below, for a best guess and high estimate of greenhouse gas emissions. Both show significant increases in global sea level over the next century, however there is still considerable uncertainty in the projections obtained from these models.

	2020	2050	2100
IS92a (best guess)	8 cm	20 cm	49 cm
IS92e (high)	16 cm	40 cm	94 cm

4.3 Environmental and Socio-economic Scenarios

The assessment of effects of climate and sea-level change in Nauru must take account of concurrent non-climatic changes. Scenarios of population growth and socio-economic and environmental change are presented below.

4.3.1 Population Growth

According to the 1992 population census the total population of Nauru was 9919. Developing long term population projections is extremely difficult, and for Nauru this is complicated by the fact that the population is very small in absolute terms. Furthermore, nearly a third of this population (3088) are non-Nauruans, many of whom are presently involved in activities related to phosphate mining and can not be considered long term residents. Consequently, projections of total population have been developed for the indigenous Nauruan population alone. Given that this population is youthful (48.1 % under the age of 15), population growth has considerable momentum. If the total fertility rate of 4.4, as determined by the 1992 census, were maintained Nauru would have a population of nearly 80 000 by the year 2100. Clearly this would be untenable and therefore the three projections provided are very conservative, and all assume significant decreases in the total fertility rate.

As with the other projections made in this synopsis, it should also be noted that population projections are rarely accurate or reliable beyond 25 years. In addition, and due to Nauru's

[10] SCENGEN is a computer software system for generation of climate change scenarios, developed by the Climatic Research Unit (CRU).

relatively small population, long term projections become difficult, as assumptions of population dynamics and statistical averages and trends on which the projections are based are less meaningful and have higher degrees of error.

Projections of total population for Nauru (Indigenous Nauruans only – 1992 Census)				
Projection	**1992 (census)**	**2027**	**2052**	**2097**
Low	6831	12000	13900	14000
Medium	6831	13900	18400	22400
High	6831	14600	20600	29000

4.3.2 Environmental and Socio-economic Scenarios

The two most important factors determining the future environmental, social and economic scenarios for Nauru will be the cessation of phosphate mining, and subsequent implementation of the National Environmental Action Plan (NEAP) and the Rehabilitation Master Land-use Plan (RMLP) along with other sustainable development objectives. Failure to implement the NEAP and RMLP successfully would lead to continued breakdown of the physical environment of Nauru, as well as the social and economic well being of the people through continued exploitation of remaining resources.

Two possible scenarios of future socio-economic development and environmental change are presented:

1. Failure to implement the NEAP and RMLP successfully would be associated with ongoing exploitation of land and marine resources and continued social and economic breakdown. Such an outcome will limit the potential for an environmentally and economically sustainable future for Nauruans.

2. Successful implementation of the NEAP and RMLP would result in rehabilitation of mined land, increased protection and enhanced productivity of renewable natural resources and enhanced social and economic well being. Such an outcome will provide Nauruans with an environmentally, socially and economically sustainable future.

4.4 Assessment of Effects of Climate and Sea-level Change in Nauru

Given the over-riding environmental and socio-economic problems that have arisen from the phosphate mining of the last 90 years, effects of climate and sea-level change must implicitly take into account the environmental sensitivities which have resulted from these changes, and how these may be modified in the future. This assessment of effects of climate and sea-level change has been undertaken in the context of the first environmental and economic scenario, which assumes ongoing unsustainable exploitation of resources and environmental degradation. Almost all the effects of climate and sea-level change described below will be worsened by the pressures and demands of a growing population.

4.4.1 Coral Reef System

Coral reefs in Nauru presently survive near the limits of their temperature tolerance of 25^{o}C to 29^{o}C. Any increase in sea surface temperature may result in coral bleaching and loss of coral species, reef habitat and reef building processes. In the absence of the adverse effects of temperature change, sea-level rise may lead to renewed coral growth on the reef flat which is presently exposed at low tide.

Local people have already observed a decrease in the vitality of the reef systems, for example examples of coral bleaching, and consider this to be a climate-related effect. While this may indeed be the case, it is likely to be linked to the decline in reef health as a result of over-fishing, uncontrolled pollution and destructive effects of developments and some fishing methods. As loss of reef vitality decreases the ability of the reef system to cope with other environmental stresses, any adverse effects of climate change will be worsened by such ongoing exploitation and destructive practices.

4.4.2 Coastal Erosion and Flooding

As highlighted in section 4.0, the coastline of Nauru has become increasingly prone to erosion through damage to the reef flat and coral species, removal of coastal vegetation and intensive development of infrastructure and housing. Given this situation, any relative increase in sea-level in Nauru will result in a worsening of the erosion problems. Increased sea-level rise, even with no change in storm frequency, would increase the potential for wave overtopping and flooding of the low-lying areas of the coastal plain. Additionally, a scenario of increased rainfall, particularly if it resulted in more intense or more frequent rainfall events, will add to the erosion and flooding problems related to surface runoff. Further development which continues existing trends in the coastal zone could accelerate the problems of erosion associated with sea-level rise, lead to loss of land area and place an increasing amount of infrastructure and people at risk.

4.4.3 Water Resources

The groundwater resources of the coastal area are already being used in an unsustainable manner and are subject to both salt-water intrusion and pollution. Any rise in sea-level, combined with loss of land area from erosion, would lead to the potential for increased salt-water intrusion. Continued compaction and sealing of surfaces through development, and the associated increased runoff, would contribute to this problem by decreasing recharge. The effects of a decrease in freshwater yield of this resource would be made worse by continued increasing levels of bacteriological and chemical pollution. While the desalination plant meets the present demand for potable water, it will be less economically viable after the closure of the phosphate mine. The groundwater reserves of Topside will become increasingly important, but also become increasingly at risk of pollution from further exploitation and degradation of this area.

4.4.4 Vegetation

The effects of climate and sea-level change on the vegetation of Nauru can be described in terms of effects in the coastal plain and effects in Topside. In the coastal plain, the remaining vegetation, in the absence of any future re-vegetation programme, is likely to be increasingly prone to the effects of coastal erosion as well as salt-water intrusion of the groundwater lens as described above. Further loss of coastal vegetation would potentially accelerate erosion processes. Continued withdrawal of coastal groundwater, together with continuation or intensification of drought events, would contribute to these adverse effects. In Topside the potential for pumping of the groundwater for human use could increase the drought sensitivity of remaining vegetation. This would depend on the rate of withdrawal and the potential rate of recharge associated with future rainfall, the magnitude and interannual distribution of which remains uncertain.

4.4.5 Human Health

The scenario of continued environmental and social degradation, combined with the effects described above, would lead to a continuation and possible worsening of the existing health problems in Nauru. In particular, those conditions related to scarce water resources, overcrowding and poor environmental hygiene would be likely to increase. In addition, marine resources which have always been vital to the health and wellbeing of the people of Nauru may become increasingly less productive, as both direct and an indirect consequence of climate and sea-level change. As climate change is likely to result in an increase in the prevalence of dengue fever in the region, this may become an additional public health risk for Nauruans.

4.5 Adaptation and Vulnerability

It is evident that because Nauru is a single small island, the effects of climate and sea-level change will be highly inter-related and conditioned by the environmental and social changes that occur in the future. This, combined with the uncertainties relating to present sensitivities and climate and sea-level change scenarios for Nauru, as well as the uncertainties in determining cumulative and integrated effects, suggests that the best adaptation strategy in Nauru would be a 'no-regrets' approach. This approach emphasises adaptation measures which are consistent with the goals of environmentally, socially and economically sustainable development as outlined in the second environmental and socio-economic scenario (Section 6.0).

This adaptation strategy should be founded on the NEAP in conjunction with the Rehabilitation Master Land-use Plan, with particular emphasis on, but not limited to, the following NEAP objectives:

- Objective 1: Land rehabilitation and protection
- Objective 2: Strengthening environmental education
- Objective 3: Strengthening environmental institutions and legislation
- Objective 4: Conservation of biodiversity
- Objective 5: Promotion of the sustainable use of marine resources
- Objective 7: Pollution and waste management
- Objective 8: Control of population and urban growth
- Objective 11: Appropriate infrastructural development

The NEAP presently contains an Objective 12 aimed at addressing and preparing for global climate change and sea-level rise, incorporating programmes on integrated coastal-zone management (ICZM) and coastal protection (Programme 12.2) and coastal forest protection and reforestation (Programme 12.3). However, it is suggested that all of the above objectives, and in particular these two programmes of Objective 12, are integral to effective implementation of a no-regrets adaptation approach in Nauru. A summary appraisal of these NEAP objectives in terms of adaptation to climate and sea-level change is presented in the table below. Given the importance of an ICZM to effective coastal protection, it could be expanded as a separate Objective in the NEAP, which has adaptation considerations as a key priority.

NEAP Objective	Key priorities and benefits in terms of adaptation to effects of climate and sea-level change
Objective 1: Land rehabilitation and protection	Rehabilitation and re-settlement of mined areas will decrease pressure on the coastal plain and facilitate development of infrastructure in a less vulnerable location.
Objective 2: Strengthening environmental education	For the NEAP to successfully achieve adaptation goals, there needs to be an increase in public awareness and local expertise in terms of climate and sea-level change and its possible effects in Nauru.
Objective 3: Strengthening environmental institutions and legislation	Climate and sea-level change considerations should be directly incorporated into the proposed EIA process, land-use planning process, environmental baseline studies and new environmental legislation.
Objective 4: Conservation of biodiversity	Biodiversity plays a key role in increasing the resilience of natural systems to environmental stresses. Biodiversity objectives should include the coastal forest protection and re-forestation programme from Objective 12. This programme could be re-named as the 'Re-forestation and conservation of terrestrial biodiversity programme.'
Objective 5: Promotion of the sustainable use of marine resources	The marine resources objective needs to be enhanced by a programme on protection of Nauru's coral reef systems which are vital for the island. This objective could be renamed 'Promotion of the sustainable management of coral reefs and marine resources.'
Objective 7: Pollution and waste management	Achieving the goals of this objective is vital to the health of the coral reef and marine system and groundwater and would therefore decrease the vulnerability of these systems, the coast and associated infrastructure and communities.
Objective 8: Control of population and urban growth	It is clear that the key to both a sustainable future and reducing vulnerability of Nauru to climate and sea-level change would be an early stabilisation of the Nauruan population. In addition the shift of urban growth from the coast to Topside would reduce vulnerability.
Objective 11: Appropriate infrastructural development	Implementation of programme for the integrated water conservation and supply management and also programme for the development of storm-water collection and disposal system for re-use, are critical in terms of adaptation. Objective 11 could be revised to incorporate the possible effects of climate and sea-level change on the infrastructure itself, the effects of infrastructure on sensitive systems and potential modifications of specific value for adaptation.

4.5.1 Vulnerability of Nauru to Climate and Sea-level Change

The vulnerability of Nauru to climate and sea-level change will be determined by four main factors:

1. The magnitude and rate of global climate and sea-level change and how they manifest in Nauru;
2. The effectiveness with which population is stabilised at a sustainable level within the next fifty years;
3. The effective implementation of the Rehabilitation Master Land-use Plan over the next 50-100 years;
4. The effective implementation of the NEAP, in particular those objectives that are directly related to a no-regrets adaptation approach as outlined above.

In the physical environment of Nauru, the coastal zone and groundwater resources in particular are likely to be those most vulnerable. Adaptation measures, such as an ICZM plan and a water resource management plan, could significantly reduce the vulnerability. However other measures, such as phase out of settlement and important infrastructure on the coastal plain, may become necessary over the next 50-100 years. This possibility highlights the important of the rehabilitation programme in reducing vulnerability.

4.6 Conclusion - Identifying Gaps and Priority Needs

From the preceding discussion it is clear that there are significant gaps in information and knowledge. These are identified, and provide a basis for establishing priority needs.

4.6.1 Information and Knowledge Gaps

The following are the key information and knowledge gaps in Nauru relating to improved understanding of the effects of climate and sea-level change:

- There continue to be high uncertainties relating to projected climate and sea-level change and how this will manifest in Nauru. Of particular importance is how rainfall might change in the future, and the magnitude and rate of sea-level rise;

- While it is clear that erosion is occurring in many parts of the Nauru coastline, it is not known how the many coastal developments (including sea walls, reef channels, groynes,

coastal infrastructure such as the airport extension, and vegetation removal) have affected, and are affecting coastal erosion;

While it is certain that the discharge of a wide range of pollutants (including sewage, industrial chemicals, thermal waste water, and solid waste) into the ocean has negatively affected the coral reef environment, it is not known what the effects have been on the coral reef ecosystem and the marine environment in general. Additionally, it is not known how these activities will affect the ability of the reef to adjust to future increases in ocean temperatures and sea-level;

- There is presently limited knowledge of the relationship between vegetation on topside and at the coast and the ground-water, and how existing vegetation and future re-vegetation might be affected by human use of this water resource;

- There has been no evaluation of the possible implications of climate and sea-level change for the rehabilitation programme. This is of particular importance given that the time-scale of the programme is the same for future climate and sea-level change projections (i.e. 50-100 years).

4.6.2 Priority Needs

While the process of assessing the effects of climate and sea-level change and developing appropriate adaptation responses in Nauru will be on-going and involve a wide range of measures, the following have been identified as key priority needs on which a response strategy should be founded:

- **Education and Training.** A basic pre-requisite for both the development and effective implementation of an adaptation response strategy is the development and enhancement of local expertise and skills. This should encompass both traditional local knowledge in combination with secondary and tertiary education and training, particularly with respect to environmental management from both a physical and social perspective;

- **Institutional Strengthening.** Closely tied to the need for education and training is the need for institutional strengthening. A key part of this priority need is a strengthening of the Department of 1131, or an appropriate organisation, which will have a lead role in facilitating implementation of adaptation through the NEAP objectives and the Rehabilitation Master Land-use Plan, in particular the EIA process, the land-use planning process, and new environmental legislation;

- **Monitoring of Important Baselines.** There are key gaps in present knowledge of important baselines, as identified above. Addressing these will require the establishment of baseline studies and on-going monitoring. These activities should be coordinated together with the Nauru Fisheries and Marine Resources Agency (NFMRA) and on-going monitoring programmes of other important baseline conditions, in particular ARM (sea surface temperature), NOAA and SHLCM (sea-level and climate change);

- **Evaluation of the Rehabilitation Master Land-use Plan and the NEAP.** The findings of this assessment suggest that high priority should be given to evaluation of the Rehabilitation Master Land-use Plan and the NEAP in terms of the possible effects of climate and sea-level change on the proposed activities, and how these might need to be modified to accommodate adaptation.

Chapter Five

Nauru's Policies and Measures

5.0 Introduction

As Nauru's greenhouse gas emissions are limited to a small number of well-defined sectors, the opportunities to reduce these emissions is relatively clear. However, although Nauru's emissions are relatively small, Nauru still remains very mindful of its vulnerability to climate change and the future potential effects predicted as a result of sea-level rise. In consideration of these future potential effects, Nauru has taken a positive approach towards improving its own situation as well as actively participating at both the regional and international levels.

As Nauru's first national communication, this establishes a baseline to work from in the future, and will assist Nauru in meeting its own national commitments and the commitments it has under the United Nations Framework Convention on Climate Change (UNFCCC).

Preparation of the communication is very timely for Nauru because of the recently adopted National Environmental Management Strategy and National Environment Action Plan (NEMS) in 1996, and the proposed rehabilitation of the previously mined topside area for phosphate. The rehabilitation currently being guided by the reports (seven) prepared under the "Nauru-Australian Cooperation "Rehabilitation and Development Feasibility Study".

5.1 Policies and Commitment

It is recorded that Nauru was the first signatory to the Climate Change Convention at Vienna in 1985. Since that time Nauru has officially shown concern for the environment, and sustainable development is high on Nauru's agenda. This is noted in its statement to AOSIS in 1994 where it tabled a protocol proposal. At this time, Nauru's President Bernard Dowiyogo stated that:

> . . development should be aimed at living our own preferred ways of life in a clean and sustainable environment. Development must not ride the cultural and spiritual integrity of our peoples we see development as a process of guided change directed toward

> our preferred goals. A healthy environment, which is our responsibility to our children, and ourselves, is also the cornerstone of the process of sustainable development.

At the Kyoto negotiations on 8th December 1997, His Excellency Kinza Clodumar, President and Minister for External Affairs stated that:

> "Nauru has long been deeply concerned about the effects of global warming and the special vulnerability of the world's poor to those effects. This led us to submit to the Alliance of Small Island States (AOSIS) in 1994 the draft protocol that has become known as the AOSIS protocol. As you know, that protocol calls for a 20% reduction in carbon dioxide emissions by the year 2000. The AOSIS protocol remains on the table as a signpost of our continuing concern.
>
> We have three points to make about the current state of negotiations as we enter the final and crucial ministerial segment. They are:
>
> - first, developed country Parties must take the lead in addressing climate change by pledging significant emission reductions
> - second, developing country Parties must do their part; and
> - third, we must all adopt a spirit of compromise if we are to attain the creative synthesis we all seek"

On the 14th September the Republic of Nauru became the 187th member of the United Nations. His Excellency the President of the Republic of Nauru, the Honourable Rene Harris, reiterated the concern voiced by many small islands states that the "immeasurable" threat of global climate change to the existence and survival of vulnerable islands like Nauru should be addressed by developed countries.

> "Although the economic benefits of global industrialisation has largely missed Nauru, it targets first and foremost, through global climate change, the destruction of small and extremely vulnerable island states like Nauru. These changes will, in the new millennium, add immeasurable threat to the very existence of small island countries like Nauru, and to the very survival of complete island cultures such as the people of Nauru."

From the 24th to the 26th of February 1999 Nauru convened a National Economic Summit entitled "Taking Nauru Beyond 2000". This summit was open to all Nauruans to consider and to contribute in respect to the main questions posed of how Nauru will "survive and thrive as a nation and to exercise its place responsibly and constructively in the region".

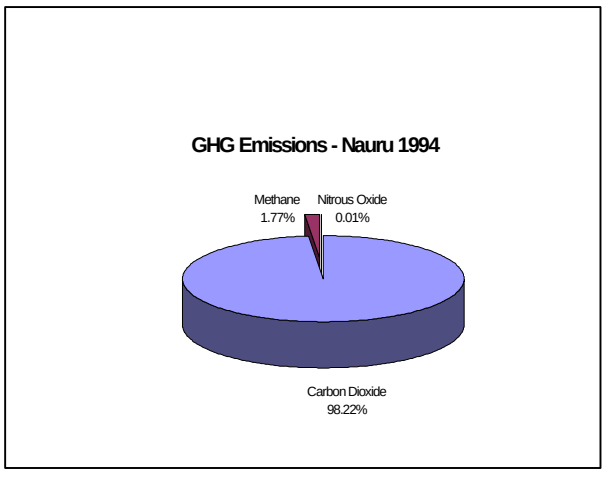
The need to "balance budgets" and to move away from the past "welfare" - style operations were clearly identified as policy priorities. From a practical aspect the following opportunities were identified:

- vigorously pursue economic and financial reform in order to achieve sustainable development;
- develop commercial fishing;
- develop tourism enabling greater employment and community activity;
- direction of NPC to change to secondary mining and also limestone mining;
- rehabilitation of the topside to produce productive land;
- establishment of service industries through training and development;
- expansion in Nauru of an offshore financial industry; and
- development of new industry products suitable for export.

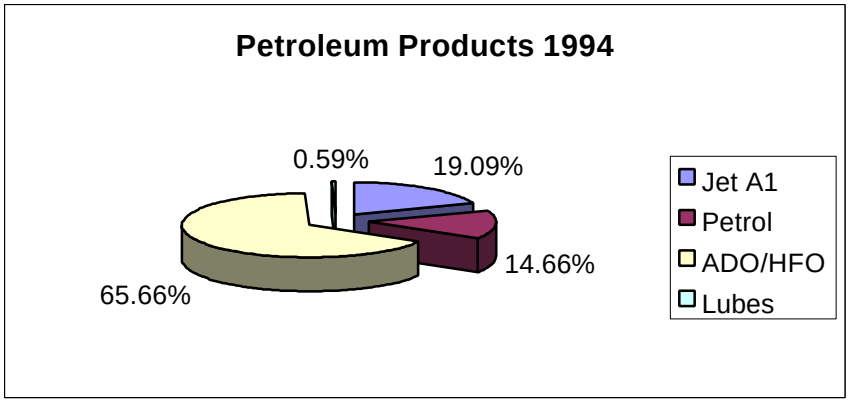
To achieve these aims requires education, a clean living environment, environmental protection, a healthy society, and the continuation of the public service reform.

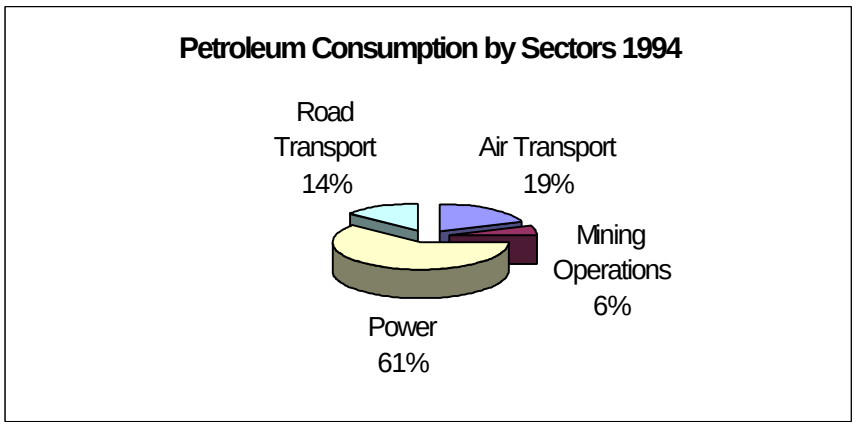
5.2 Emissions

The volumes of greenhouse gas emissions calculated for Nauru using the reference approach are limited to carbon dioxide, methane and nitrous oxide. The percentages of these gasses are 98.22%, 1.77% and 0.01% respectively.



Hence, carbon dioxide is by far the most predominant GHG that is emitted on Nauru. The individual product and sector emissions are provided below in the charts.



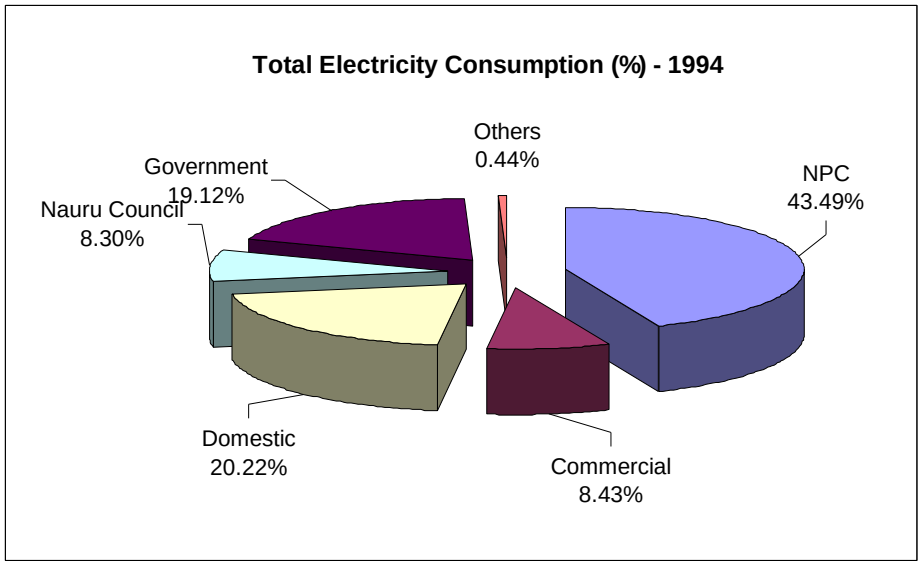


5.3 Opportunities

5.3.1 Carbon Dioxide (CO_2)

The generation of greenhouse gases on Nauru is from fossil fuels. The sectors in which these are consumed are defined in the chart above which provides both product and sector consumption.

The production of electricity or the transformation sector therefore is the most significant for Nauru, as the bulk of the CO_2 emissions are from power generation. Hence, opportunities must be considered as to how to reduce consumption in this sector. The split of electricity consumption is provided below.



5.3.2 Transformation

The improvement of efficiency in the transformation sector is limited to the efficiency of the power-generation plant and its maintenance. Historically, maintenance of the power-generating plant has been very good on Nauru; however, as the generating plant is now getting relatively old' the efficiency of the system is less than desirable. Maintenance and overhauls of the engines on a regular basis have assisted in delaying their replacement. Replacement cost is a deterrent, but new engines operate with a thermal efficiency of 42% to 45% and this could save up to 20% of the current fuel requirement. Also steam production from the exhaust gas boilers would be affected, as new engines operate with a higher exhaust-gas mass-flow rate, but at a lower exhaust-gas temperature. Hence the energy balance would indicate a lower rate of heat supply. Likewise the jacket water-cooling system's heat supply to the desalination-plant flash chamber would be marginally lower. Therefore the overall production of drinking water from the desalination plant would be affected. Unfortunately the trade off will have to be faced at some time in the future but will need to be carried out giving consideration to a total long term power plan and water supply.

5.3.3 Electricity Consumption

In the Government / Commercial Sectors savings can be made in implementing demand side management programmes, in particular the use of energy-efficient lighting and ensuring that lighting is used on an as-required basis. Where lighting is left on unnecessarily, there is a need to introduce timer or occupancy switches. A similar approach can be taken for air-conditioning, which has been proven to be a high-consumption area in most Pacific island countries.

For the Domestic Sector similar programmes on demand side management and energy efficiency for lighting, air-conditioners and electrical appliances (stoves / jugs / water heaters, etc.) are to be considered initially, as these are areas where the greatest savings can be achieved.

The successful implementation of these programmes will be reliant on their formal establishment and with the longer-term objectives clearly in mind. The commitment of the government and NPC (as the power provider) and involvement of local trade allies and tradesmen is noted as a requirement for the overall long-term success of any demand side management programme.

Identified focal areas of activity for these programmes are:

- introduction of LPG for cooking
- air-conditioner timers
- office equipment / photocopiers / computers
- energy efficient through appliance labelling
- minimum appliance performance standards
- education – users / purchasers
- taxes and duties
- full cost recovery of electricity generation
- energy audits / education
- energy building codes

5.3.4 Renewable Energy

The introduction and use of alternate energy, in the form of solar thermal energy for water heating and solar photovoltaic energy for lighting, has been limited on Nauru. Nauru appreciates that opportunities exist for the use of solar thermal energy in particular, at economic and affordable costs. However, considering that Nauru is 100% electrified and has a very high electrical-appliance usage, the financial and economic benefits are not achievable under the current subsidized electricity tariffs. It is also necessary to consider the level of service already being provided, and the ability and cost of introducing an economic alternate renewable form that will be acceptable and provide the same level of service. The extensive use of new and renewable energy technologies on Nauru is therefore under the current parameters seen as limited at the present time.

5.3.5 Transport Sector

5.3.5.1 Road

Nauru's roading infrastructure is limited to a total of 40 km comprising a 17 km sealed perimeter road around the island, an additional 11 km of sealed road primarily to the

petroleum tank farm and to the Buada District and 12 km of unsealed roads mainly providing access to the Topside for the phosphate mining. Fuel consumption in the road transport sector is 14% of total energy sector usage. Opportunities exist through a number of regulatory mechanisms to reduce the consumption of fuel in this sector. These include:

- increasing the price of fuel;
- import restrictions on vehicle size and capacity of vehicles;
- imposing fuel restrictions for domestic purposes; and
- introduction of bicycles (a significant number of small motorcycles are already used).

5.3.5.2 Rail

A narrow-gauge rail system for transporting the mined phosphate links a tip head located near the middle of the Topside to the Phosphate Refinery situated in Aiwo and is 4 km in length. Use of this rail system is totally dependent on the level of phosphate mining activity and detailed figures are not available, although energy consumption is estimated to be small in comparison to other mining related activities.

5.3.5.3 International Air

Fuel consumption in the international air transport sector, is 19% of total energy sector usage. Considering that international air transport provides the only regular link to the outside world for Nauru (aside from sea transport), and is now run on a fully commercial basis, it is difficult to realistically target this sector as one where significant reductions can be made, so long as the airline operation continues to be run so as to maximize its commercial operations with viable loadings and realistic routes and schedules.

5.3.6 Rehabilitation

The implementation of the rehabilitation programme will in the first instance increase the emissions from the increased use of heavy plant and equipment required for the pinnacle-levelling activities. Following the levelling, the development of green areas and plantations, etc., will have the effect of providing a sink, which will have a positive effect by decreasing the total emissions balance. Such activities within the rehabilitation programme have been strongly supported by the Nauru government.

5.3.7 Phosphate Mining

Export figures show the existing level of phosphate mining to be slowly declining, and so will the emissions from the fuel consumption directly related to this activity. However, with the proposal to establish secondary mining, it is expected that current levels of activity and emissions from this sector will remain relatively constant.

Opportunities to reduce energy consumption either through electricity consumption or the use of petroleum products in plant and equipment is a little limited in this sector, unless the generating plant and equipment is replaced, which may not be a totally economic proposition.

5.3.8 Methane (CH_4)

The amount of methane (1.77%) is relatively small and is generated from animal manure management and domestic solid-waste disposal. The overall balance is relatively insignificant however there is certainly opportunity to revise and improve on the solid-waste management. It is proposed that this will be addressed as part of the rehabilitation activities.

5.3.9 Nitrous Oxide (N_2O)

The nitrous-oxide emissions are generated from human sewage disposal and this small amount is considered to be insignificant. As for the methane emissions, the opportunity exists to improve the disposal method, which will in turn reduce the emissions. No specific policy or changes in current management practices are currently planned for this GHG emission.

5.4 The Future

Nauru is a signatory to many international environmental treaties (Annex 2), conventions and agreements, and has shown strong and continuing support for the efforts of the South Pacific Regional Environment Programme (SPREP) to achieve economies of scale in addressing environmental issues and strengthening environmental capacities in the Pacific Islands. The Government's deep interest and concern in this area will provide a guide for the development of internal policy in this regard.

The National Environmental Management Strategy (NEMS) and National Environmental Action Plan (NEAP) provide a comprehensive policy base for the environment, and along with the rehabilitation programme these two documents, if implemented in accord with government direction, will ensure that the environmental sector is managed properly. The NEMS also provides direction for the marine sector, which is of prime economic importance to Nauru.

The energy sector has been paid limited attention, and although a draft National Energy Policy Statement[11] has been prepared, this has not yet been adopted. It is important that the policy

[11] Nauru National Energy Policy Statement was prepared by the Nauru Government, Department of Island Development & Industry, with the assistance of the Forum Secretariat Energy Division, 1995. The Energy Division was transferred to the South Pacific Applied Geoscience Commission (SOPAC)

statement for the Energy Sector is adopted for Nauru, as this will provide a long term planning and implementation tool for the sector that has the highest emissions.

The rehabilitation activities planned for Nauru will have a significant impact on many of the areas that have been identified as greenhouse gas emitters. However, until the actual programme of activities and methodologies to be used has been defined, the impacts and changes will not be readily identifiable or quantifiable.

in January 1998. Assistance has continued to be provided by SOPAC in database development and policy formulation. Draft energy project proposals have been prepared for inclusion in Nauru's budget for 2000.

Chapter Six

Education and Information Activities

6.0 Introduction

Under the framework of the convention, emphasis is placed upon the role that education, public participation and public awareness will need to play in achieving an effective response to climate change, sea-level rise and global warming.

As outlined in the convention, activities include education and public awareness programmes on climate change, public access to information on climate change and its potential effects, and training of scientific, technical and managerial personnel.

Nauru has taken an active role internationally, regionally and nationally in climate change.

6.1 Projects and Programmes

Nauru has participated in the following projects and programmes that have been specifically established to assist in determining more scientifically and quantifiably the likely mechanisms, rates of change and impacts that climate change is likely to have for the region and in particular for Nauru.

6.1.1 Pacific Islands Climate Change Assistance Programme (PICCAP)

The Pacific Islands Climate Change Assistance Programme (PICCAP) run by the South Pacific Regional Environmental Programme (SPREP) has provided assistance in the preparation of national communications as required under article 12 of the United Nations Framework Convention on Climate Change (UNFCC).

The activities undertaken include:

- Preparation of a Greenhouse Gas (GHG) inventory;
- Identifying options as to how best to reduce GG emissions;
- Undertaking studies on the possible effects of climate change;
- Identifying options on how best to adapt to the effects of climate change; and
- Preparing national implementation strategies.

A “country team” approach was adopted for the delivery of the three-year programme, with emphasis being placed on the provision of support and training through:

- Overseeing analytical studies on climate-change issues;
- Drafting national implementation strategies and/or national communications;
- Coordinating and implementing national workshops and conferences which focus on training and awareness; and
- Training and organizing consultative meetings and public education, awareness and participation activities.

In particular for the Republic of Nauru, the activities have included technical training, policy-level workshops and participation at national and international conferences, and assisting with:

- the establishment of a training programme for the preparation of vulnerability and assessment studies;
- an understanding of climate change and the technical resources;
- a coordinating role between other Pacific island countries on climate change;
- guidance and assistance if required in the preparation of greenhouse gas inventories and national communications; and
- representation at the UN for climate change levels.

6.1.2 Climate Change Projects

Projects for the monitoring of climate change effects are:

- The South Pacific Sea-level and Climate Monitoring Project;
- Atmospheric Radiation Measurement Programme (ARM); and
- Nauru 99 Campaign

Details of these projects are provided below.

6.1.2.1 The South Pacific Sea-level and Climate Monitoring Project

Nauru has been involved in this programme since it commenced in 1991, with a monitoring station being installed in June 1993. The installation was completed by Kinhill Riedel & Byrne and a local contractor.

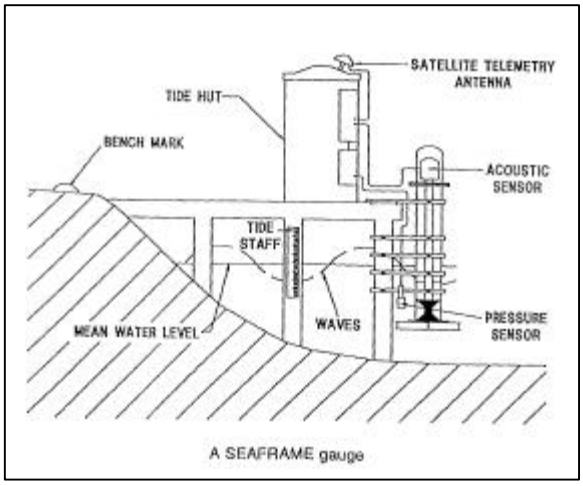
Training for the operation of the equipment was conducted at the National Tidal Facility in Adelaide. Since the original training there have been a number of other regional and sub-regional (1996) workshops convened in respect to the climate-monitoring project. In 1997 a

real-time display was installed at the Department of Islands Development and Industry allowing the staff to monitor the Sea-Frame remotely. The Sea-Frame is reviewed twice a year by a technical team from the National Tidal Facility. The visit provides regular maintenance checks and checks on the bench-mark levels.

The information provided from the Sea-Frame has been provided to the Nauru Fisheries and Marine Resources Authority, Nauru Phosphate Corporation, Marine Department, and the general media such as Nauru Television and 'Naoero' Bulletin.

It is proposed that in the long term the information recorded by the Sea-Frame will also be down loaded into computers that will be able to be accessed by secondary school students. The assistance to enable this educational value of the programmes to be realised has been through cooperation of the PICCAP and US ARM programmes.

From June 1993 to April 1999, 69 months of data have been collected.



Diagrammatic Installation

(Photo supplied by IDI)

Actual Installation

6.1.2.2 Atmospheric Radiation Measurement Programme (ARM)

Monitoring at the ARM project commenced in Nauru on 20th November 1998 and will assist in studying how the interactions of earth's oceans and its atmosphere cause global weather changes. The installation of the Nauru Climate Research Station (ARCS II) is part of the Tropical Western Pacific – field site that is located in the "Warm Pool". Nauru has been involved in the installation of the station and its operation. There are seven nationals working at the ARCS II site with an officer in-charge and three observers, including three security

officers. Training has been provided in Fiji for one of the observers, with opportunities for additional training of the other observers in the future.

The National Oceanic and Atmospheric Administration (NOAA) station is also manned by local staff in the form of an observer and a security officer, who are interchanged between the ARM and NOAA projects. The ARM and the NOAA projects complement each other in the information provided relating to climate change and future climate predictions. The technical information generated from the projects is available to the Department of Islands Development and Industry for use as appropriate.

ARM Project site and installed monitoring equipment.

(Photo supplied by IDI)

The station will provide information to assist the government in better understanding Nauru's environmental position and information on climate change. The facility in Nauru will complement the other two ARM installations, one of which is installed on Manus Island in Papua New Guinea and the other scheduled for installation on Kiritimati Island in Kiribati.

6.1.2.3 NAURU'99 – An ARM Campaign in the Tropical Western Pacific (TWP)

The Nauru'99 Campaign was carried out as a specific component of the United States Department of Energy's Atmospheric Radiation Measuring (ARM) programme as described above. The activities of the Nauru'99 Campaign were a special effort to collect specific data required to address scientific questions that cannot be addressed with the inter-island data alone. In particular this campaign was to determine the effects that the Island (Nauru) might have on the measurements being taken at the ARM site and to better understand the interactions between the ocean and the atmosphere.

6.2 Nauru Media Bureau

6.2.1 Publications and Bulletins

Publicity materials for all these projects have been prepared and distributed widely throughout Nauru.

6.2.2 Nauru Television

Nauru Television has run documentaries on the South Pacific Sea-level and Climate Monitoring Project, the Atmospheric Radiation Measurement Programme (ARM), on climate change in general and on coral reefs. It has also provided excellent coverage of the Nauru'99 ARM campaign in collaboration with New Zealand Television. The role of Nauru Television (NTV) has provided an effective media link to the public of Nauru, keeping them informed of the individual project developments.

6.2.3 Radio Nauru

Radio Nauru is government owned and has been in operation since Nauru became independent in 1968. Radio Nauru, like NTV, has provided an effective form of communication to the public. This in particular has provided the regular dissemination of information to the 46% of households that do not have television.

6.3 Training Programmes

IDI has participated in training provided through PICCAP in the Vulnerability and Assessment (V&A) programme established as part of the overall climate-change programme. The initial Vulnerability and Assessment training was carried out at the Waikato University in New Zealand during 1998. In 1999 the course was transferred to the University of the South Pacific (USP), Lacaula Bay Campus, Suva, Fiji. Two Nauruans participated in the initial New Zealand course and another two have participated in the Fiji course.

Additional training and assistance has been provided to Nauru in the preparation of their V&A Synopsis, the Greenhouse Gas Inventory and National Communication.

6.4 Meetings and Workshops

This programme provided the opportunity for Nauruan Nationals to participate at international meetings and fora and also to participate in regional training workshops.

All these activities have assisted in developing a better understanding of the climate mechanism, and provided a base for the development of the GHG Inventory and preparation of the Vulnerability and Assessment report for Nauru.

6.5 Climate Change Library

The Department of Island Development and Industry is developing a resource room for the use of school students, teachers and interested parties to access and research the extensive range of climate change documents, books, posters, etc., that have been collected.

6.6 Schools Education Programme

A schools education programme was convened based on the AusAID publications, Curriculum Modules for the Pacific Schools, Climate Change and Sea-level, Part One: Physical Science and Part Two: Social Science.

In conjunction with the Atmospheric Radiation Measuring (ARM) project, a development programme for schools was co-sponsored assisting with Science Curriculum Modules on Climate Change and Sea-level for the Pacific schools through teacher training and workshops. Technical teams continue to visit the schools and help them to join in SPaRCE (Schools of the Pacific Rainfall Climate Experiment). The programme is a school-based programme in tropical meteorology for high schools.

ANNEX 1

PACIFIC ISLANDS CLIMATE CHANGE ASSISTANCE PROGRAMME (PICCAP)
NATIONAL COMMITTEE MEMBERS as at 11th August 1999

Ms Julie Olsson (Chairperson) Secretary for Culture & Tourism Department of Works, Fisheries, Culture and Tourism
Mr Mathew Batsiua Acting Chief Secretary Department of the Chief Secretary
Ms Chitra Jeremiah Assistant Director for Regional Programmes Department of Foreign Affairs
Mr John Aremwa Assistant Secretary for Education Department of Education
Dr Kiki Thoma Vice Chairman Nauru Rehabilitation Corporation
Mr Terry Amram A/Executive Director Nauru Fisheries and Marine Resources Authority
Mr Robert Deidenang Chief Draftsman Nauru Rehabilitation Corporation
Ms Maria Gaiyabu Director University of the South Pacific - Nauru
Mr Nelson Tamakin President Nauru Environmental Association
Mr Joseph Cain Secretary Department of Island Development and Industry

NOTE: ***ANNEX 2*** provides the names of those that have also previously served on the PICCAP Committee but are currently not actively involved having completed their assigned terms or departed from Nauru.

ANNEX 2

COMMITTEE MEMBERS THAT HAVE COMPLETED THEIR ASSIGNED TERMS ON THE PICCAP NATIONAL COMMITTEE

Mr S.K Paltalwar Treasurer Nauru Islands Council
Mr Andrew Pitcher Senior Project Officer II Department of Island Development and Industry
Mr Charleston Deiye A/Executive Director Nauru Fisheries and Marine Resources Authority
Ms Pamela Scriven President Nauru National Womens Council

ANNEX 3.

TREATIES/CONVENTIONS/AGREEMENTS BETWEEN THE REPUBLIC OF NAURU AND INTERNATIONAL/REGIONAL ORGANISATIONS

1. Convention on Hazardous & Toxic Wastes (Waigani Convention)

Nauru became party to the Waigani Convention having signed the Convention on 16 September 1995 in Waigani, Papua New Guinea, during the South Pacific Forum. Nauru however has yet to ratify the Convention.

2. South Pacific Regional Environment Programme (SPREP Convention)

Nauru is a member of SPREP having signed the Convention in Apia, Samoa, on 16 June 1993, and ratified the same on 16 March 1994.

3. Convention for the Protection of the Natural Resources & Environment of the South Pacific Region & Related Protocol

Nauru signed the Convention on 15 April 1987 and ratified same on 28 August 1995. Nauru further signed and ratified the following on the same dates: (a) Protocol on Dumping & (b) Protocol on Pollution Emergencies.

4. United Nations Convention on Law of the Sea (UNCLOS)

Nauru is a State Party to the Convention, having signed the Convention on 10 December 1982, and ratified the same on 17 October 1995.

5. United Nations Convention on Rights of the Child

Nauru is a State Party to the Convention, having acceded to the Convention on 27 June 1993.

6. Agreement Establishing the South Pacific Forum Secretariat

Nauru signed the Agreement Establishing the South Pacific Forum Secretariat (formerly SPEC) in Pohnpei on 29 July 1991, and ratified the same on 21 October 1992.

7. Treaty on Cooperation in Fisheries Surveillance & Law Enforcement in the South Pacific Region (Niue Treaty)

Nauru became a party to the Niue Treaty, having signed the Treaty in Honiara on 9 July 1992, and ratified the same on 14 October 1992.

8. United Nations Convention on Biological Diversity

Nauru is a party to the Convention, having signed the Convention on 5 July 1992 in Nissan, Bahamas, and ratified the same on 11 November 1993.

9. Basic Agreement between Nauru and World Health Organization (WHO)

An agreement was signed between Nauru and WHO on 31 July 1995 in Nauru involving. Administrative & Technical Advisory Cooperation.

10. Asian-Pacific Postal Convention & General Regulations of the Asian-Pacific

Nauru is a party to the Convention, having signed the Convention in Rotorua, New Zealand, on 10 December 1990. Nauru ratified the Convention in May 1992.

11. Agreement for the Implementation of the Provisions of the UN Law of the Sea of 10 December 1982 Relating to the Conservation & Management of Straddling Fish Stocks & Highly Migratory Fish Stocks adopted on 4 August 1995 by the UN Conference on Straddling Fish Stocks & Migratory Fish Stocks

Nauru deposited its instrument of accession to the Agreement on 10 January 1997.

12. South Pacific Commission (SPC)

SPC was established in 1947. The Canberra Agreement that established SPC was signed in Canberra, Australia, on 6 February 1947. Nauru became a member of SPC, having signed the Agreement, in July 1969.

13. Forum Fisheries Agency (FFA) – Nauru Agreement

Nauru is a party and co-founder of the Nauru Agreement, which was signed in Nauru in October 1982.

14. Convention on the Prohibition for the Stockpiling, Transportation & Use of Chemical Weapons

Nauru is a state party to the Convention, having signed the Convention in Paris, France, on 13 February 1995. Nauru however has yet to ratify the Convention.

15. Treaty on Non-Proliferation of Nuclear Weapons (NPT)

Nauru is party to the NPT and fully supported and participated in the Conference on the Indefinite Extension of the Treaty with other States Parties in April/May 1995 in New York. Nauru was represented by Mr Kinza Glodumar as special envoy.

16. United Nations Educational, Scientific and Cultural Organization (UNESCO)

Nauru became a member state of UNESCO on signature of the constitution on 17 October 1996.

17. Vienna Conventions on Diplomatic Relations 1961 & Consular Relations 1963

Nauru is party to both Conventions, having acceded to the Conventions in 1968.

18. Forum Secretariat – South Pacific Regional Trade & Economic Co-operation Agreement

SPARTECA, which is a non-reciprocal trade agreement under which the two developed nations of the South Pacific Forum, Australia and New Zealand, offer duty-free and unrestricted concessional access for virtually all products originating from Forum Island Countries (FICs), was established on 1 January 1981 in Kiribati.

Nauru is a party to the Agreement, having signed the Agreement on 14 July 1980 in Tarawa.

19. South Pacific Nuclear Free Zone Treaty (SPNFZ)

Nauru signed the Treaty, which also became known as the "Rarotonga Treaty" in Rarotonga, Cook Islands, on 17 July 1986, and ratified same on 13 April 1987. The Treaty entered into force on 11 December 1986.

20. Convention of the Prohibition of Fishing with Long Driftnets in the South Pacific (Wellington Convention)

Nauru is a signatory to the Convention, having signed the Convention on 13 February 1990 in Wellington, New Zealand, Nauru ratified the Convention on 14 October 1992.

21. Multilateral Treaty on Fisheries between Government of certain Pacific Island Countries and the Government of the United States of America

Nauru deposited its Instrument of Acceptance of the Treaty on 4 June 1993 with the Government of PNG as the depositary of the Treaty.

22. Convention on the Prevention of Marine Pollution, Dumping of Wastes and other Matters (London Convention 1972)

Nauru is a contracting state of the Convention, having signed the Convention in 1972 in London, U.K.

23. United Nations Convention to Combat Desertification and Drought (CCDD)

Nauru acceded to the Convention to Combat Desertification on 22 September 1998, which was entered into force on 21 December 1998.

24. United Nations Framework Convention on Climate Change (UNFCCC) (1992)

Nauru became a signatory to the Convention on 08 June 1992 and ratified the Convention on 11 November 1993, which was entered into force on 21 March 1994.

ANNEX 4

Anomalous Pacific Conditions: El Niño and La Niña

Under normal conditions, the tropical Pacific Ocean is substantially cooler in the east than in the west. Trade winds flow consistently westwards across the Pacific from a semi-permanent region of high atmospheric pressure off the South American coast, bringing warm, moist air to the region of PNG, northern Australia and Indonesia. In that region the moist air rises to high altitudes over the warn ocean, generating thunderstorms and substantial rainfall as it does so, before returning eastwards at high altitudes.

The early stages of an El Niño episode are marked by the appearance of anomalously warm surface waters in the eastern tropical Pacific. As the El Niño develops, the area of anomalously warm surface waters spreads westward along the equator. At much the same time, the trade winds weaken right across the tropical Pacific, and may even turn westerly, especially west of the Date-Line (180th meridian). The region of rising air and thunderstorms moves eastwards from Indonesia/PNG into the central Pacific, bringing higher than usual rainfall there. High pressure and dry conditions develop over Indonisia, PNG, northern Australia and the Philippines. The monsoon rains over South East Asia are significantly diminished, and may fail altogether.

Fluctuations from normal conditions during La Niña episodes are the opposite of those that characterise El Niño. The trade winds strengthen, and the temperature gradient in the surface waters across the tropical Pacific from west to east increases. Wetter than usual conditions prevail during the southern summer across northern Australia, PNG, Indonesia, Malaysia and the Philippines, while dry conditions affect the central tropical Pacific. Warm, wetter conditions tend to prevail across eastern Australia, the western South Pacific and northern parts of New Zealand during the southern winter.

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