National Tidal Facility

South Pacific Regional Environment Programme

The South Pacific Sea Level and Climate Change Newsletter

ISSN: 1026-4124
Quarterly Newsletter Vol. 3, No. 3, July 1998

Project Update

So far the project has produced 12 Quarterly Newsletters and 36 Monthly Reports as part of the programme's Information and Training Component. These newsletters and reports target technical personnel, policy-makers, teachers, high school children and the general community of this region, contributing to international discussions and understanding of sea-level rise and climate change.

Project comes under the microscope

During the month of May, the South Pacific Sea Level & Climate Monitoring Project (SPSL&CMP) came under the microscope of the *AusAID* Review Team. The review and general evaluation of the SPSL&CMP is part of the terms of reference of the Australian Government (*AusAID*). It aims to oversee the project implementers (National Tidal Facility, Flinders University) and ensure they are producing the required outputs for the Forum countries in a timely manner.

The *AusAID* Review Team consisted of Dr Luca Tacconi (Team Leader), Dr John Mottram (Consultant), Dr Bill Kinimonth (Australian Bureau of Meteorology, Melbourne) and Prof. John Hay (Auckland University, New Zealand). Prof. Hay did not travel with the team due to his other commitments but contributed meaningfully from his university. The rest of the team first visited the National Tidal Facility in Adelaide from 11–12 May and then spent the whole of May visiting and consulting the Governments of Fiji, Samoa, Tuvalu and Kiribati. The Pacific leg of the trip was coordinated by Dr Chalapan Kaluwin, the project's Climate Change Officer.

It is anticipated that the final report from the Review Team will be made public in August 1998.

Contents

Published by the South Pacific Regional Environment Programme (SPREP) and the National Tidal Facility (NTF) with financial assistance from AusAID

AusAID

Promotion of Climate Change and Sea-level Rise Curriculum in the region

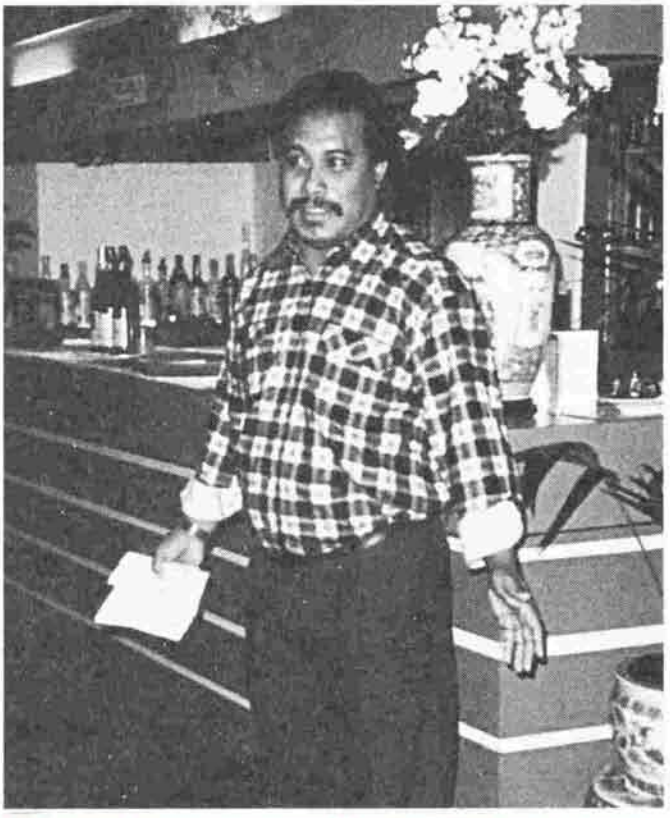
After nearly two years the project staff, in consultation with Forum island curriculum teachers, have produced a textbook on the climate change and sea-level rise curriculum targeting teachers and students of the Pacific region. The textbook, Curriculum Modules for the Pacific Schools, appears in two volumes: Part One, Physical Science and Part Two, Social Science.

The project management is very grateful to *AusAID* for providing the funding for the books' development, and to the US Government (Atmospheric Radiation Measurement (ARM) and Schools of the Pacific area Rainfall and Climate Experiment (SPaRCE) Projects) for providing resource people. The books have been promoted throughout the region, as follows:

- Soon after the project review, Information and Training Officer, Dr T H Aung, Computing System Officer, Mr G.J. Musiela and Prof. G.W. Lennon took part in the South Australia Geography Teachers' Conference to promote the newly-released curriculum modules. Although the modules are produced for the Pacific region, the fundamental concepts of climate change and sea level are essentially the same everywhere. During the conference, project representatives set up a display, gave an oral presentation on climate change and sea level rise and distributed curriculum modules.

- The curriculum modules were officially launched in Fiji by the Australian Ambassador for the Environment, Ms Meg McDonald. This took place during the Pacific Regional Conference for Environmental Education and Training (29 June–3 July 1998) co-hosted by SPREP, USP and the Pacific Resources for Education and Learning (PREL), at the University of the South Pacific, Suva. The Ambassador was accompanied by Ms Anne Plunkett, the Deputy High Commissioner; Counsellor Mr John Davidson, *AusAID* Representative in Fiji; Dr Chris Mitchell, Coordinator for the Commonwealth Scientific and Industrial Research Organisation's Division of Atmospheric Research; and Ms Debbie Thiele of the Wildlife and Marine Management Section at Environment Australia. The books were well received by more than 150 educators from the SPREP countries.

The Pacific Project was represented by two of the editors of the curriculum modules, Climate Change Officer, Dr Chalapan Kaluwin and Training Coordinator, Dr Than Aung. The NTF Computing Systems Officer, Mr Greg Musiela and Marshall Islands Environmental Education Officer, Mr Karness Kusto, also attended. They both were deeply involved in the production and completion of the books. In addition to the book launch, they each presented individual educational papers during the conference. Among them, selected practical demonstrations from the curriculum modules, conducted by Mr Karness Kusto, attracted the attention of many science teachers from the Pacific region.



Mr Karness Kusto, Environmental Education Officer for the Marshall Islands delivering a speech on behalf of Pacific island delegates.

Approximately 200 copies of both Part One and Part Two were distributed to the conference participants from 22 Pacific island countries and approximately a dozen organisations involved in the educational activities of the Pacific region. In addition 100 copies of the books were donated to the Education Department of Fiji for further distribution and use in Fijian schools. Some copies of the books were donated to the library of the University of the South Pacific and to SOPAC (South Pacific Applied Geoscience Commission) in Suva.

Other project products, such as the *Monthly Data Reports*, *Quarterly Newsletters*, *Fact Sheets*, *Tidal Predictions Booklets* and *Tidal Predictions Calendars* were also widely distributed from the project's display booth during the conference.

Having launched the books officially, both volumes are now ready for further distribution in the Pacific region. If anyone wishes to obtain a sample copy for comment or for either office or personal use, please let us know directly. As usual, our contact details are provided at the end of this report. You may also contact SPREP's Climate Change Officer, Dr Chalapan Kaluwin, if this is more convenient.

Forum Governments trained at Flinders University

June 1998 became another busy month for the National Tidal Facility at Flinders University, as the staff prepared and organised training courses for 13 participants from the Forum member countries. The training attachment involved a 15-member resource team from NTF, SPREP, Australian Defence Force Academy, University of Adelaide and the School of Earth Sciences (Flinders University).

This training course was yet another special effort from the Information and Training Component of the South Pacific Sea Level and Climate Monitoring Project. Its aim is to enhance the scientific and practical knowledge of meteorologists, environmentalists, surveyors, hydrographers and engineers from Pacific island countries. It is one of the aims of the project to transfer technology and improve capacity building and confidence in the Pacific region. The training attachment was conducted in the conference room of the NTF in Adelaide, South Australia.

The State Director of *AusAID*, Ms Carol MacLeod, welcomed the Forum governments' participants to Adelaide and officially opened the training attachment course. In addition the Facility's Office Manager, Ms Heather Westrup, provided the traditional opening Words of Prayer. The Acting Director of NTF, Mr W.M. Mitchell, as well as the SPREP Climate Change Officer and the Training Coordinator of the project, each addressed the group during the opening ceremony on behalf of the project management.

The project management is grateful for the continued assistance of the Bureau of Meteorology, LADS (Laser Airborne Depth Sounding), Department of Coastal Protection, Ministry of the Environment of South Australia and the Airborne Meteorology Group of the School of Earth Sciences. Each of these institutions was involved in the training attachment, where they explained and demonstrated their activities to the Pacific visitors. Many thanks are due to all these institutions.

The training attachment focused on project data interpretation, use of computer software, integrated coastal zone management, simple treatment on tides, climate change and ocean circulation, and impact analysis and vulnerability assessment with respect to sea level and climate change. It also covered a few other related topics and practical activities based upon the background of the participants.

All the activities of the three-week course were provided and organised by NTF staff members, including travel arrangements, accommodation, hospitality, administrative assistance, clerical support, transport and other social events. The entire financial support was provided by *AusAID*, under the South Pacific Sea Level and Climate Monitoring Project through the National Tidal Facility. Most of the resource materials for the course were provided by NTF, SPREP and the Flinders University of South Australia.

Top: NTF Director Designate Dr Wolfgang Scherer greeting Mr Joseph Cain of Nauru during the training course.

Bottom: Opening address by South Australia Director of AusAID, Ms Carol MacLeod.

The participants (12 male and one female) mostly came from meteorological services, surveying, engineering and environmental sciences backgrounds. Although these backgrounds are diverse, the Pacific participants' interest in climate change and sea-level issues was unanimous.

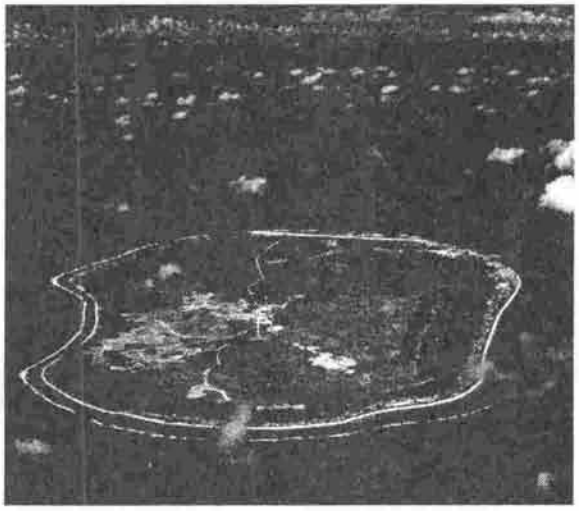
On the final day of the course, the State Programme Manager of *AusAID*, Mr Bill Trewartha, delivered the closing address and presented the course completion certificates to the participants. The Director-Designate of NTF, Dr Wolfgang Scherer, officially closed the training attachment after giving presents and having a few words of discussion with the participants about their plans for the future. It was evident that the participants not only acquired a lot of new knowledge from the training attachment, but also enjoyed their stay in Adelaide. The Organising Committee of the training attachment was elated to see its success, and we hope to have an equally successful one in October 1998.

News and views from South Pacific Forum governments

The following articles were contributed by representatives of Forum governments following their training attachment at the National Tidal Facility, Flinders University, and also as a response to the Quarterly Newsletter and Monthly Reports which helped to increase their understanding of climate change issues.

Some features of project data: Possible human cause behind strange fluctuations in Nauru's water temperatures

by J Cain



Have you ever noticed that, when you're boiling water, within minutes the metal kettle is hotter than the water inside? The thermal capacity of water is relatively high; water requires lots of heat energy to raise its temperature, and it can store more heat energy than other substances such as metal. Accordingly it takes time to change water temperature.

It has been observed for the past several months that the water temperature at Nauru is changing several times a day. However, if we look at figure 1 (water temperature data of January 1998), water temperatures at other stations are quite stable and there are very few daily fluctuations. In fact, after checking old water temperature data, the rapid fluctuations in Nauru's seawater temperature seem to be relatively new. When we examined the data set of May 1998 in figure 2, water temperature fluctuation in Nauru was reduced. This seems to indicate that the cause may not be the malfunction of the instrument. Perhaps something has changed on-site from time to time.

However, we cannot ignore that fact that the hourly water temperature records from the Nauru SEAFRAME station have been shown to exhibit abnormal fluctuations. As we can see from figure 1, the daily water temperatures often show two highs and two lows as semi-diurnal tides. Perhaps there is some explanation for this.

Foremost, the problem may be due to the location of the tide gauge itself, which is situated within the boat harbour enclave. The Nauru Phosphate Corporation (NPC) has been drawing sea water directly from the boat harbour, which is pumped to the power station for cooling. There is a strong possibility that the reticulated sea water that is heated after use by the power station and deposited back into the harbour could be a critical factor.

A modern desalination plant has recently been commissioned by NPC, using the waste heat generated from the power station. The outlet pipes are located about 50 metres outside the boat harbour enclave and discharge or brine from the desalination plant which is quite warm could be another factor in the temperature fluctuation.

The mouth of the boat harbour enclave, which is approximately 50 metres wide, is relatively small to accommodate these activities. The harbour has constantly been used for the activity of fishing boats and the NPC barges either at night (from 6:00pm to 10:00pm) or any time during the day. It is possible that heat from the outboard engines could be another factor.

The above explanations would need further studies to ascertain the valid reason for the abnormal fluctuation of the water temperature. Whatever the cause, these water temperature records from the SEAFRAME station do not represent the general water temperature of Nauruan waters for research purposes due to its close vicinity to human activities.

Note: *The article was written by Mr Joseph Cain while he was taking a short-term training course at NTF during June 1998. He is a Senior Project Officer at the Environment Unit of the Department of Island Development and Industry, Nauru. Many thanks are due to Dr T H Aung for his help and encouragement, which made this contribution a reality.*

Figure 1: Hourly water temperatures from SEAFRAME stations (deg C), January 1998

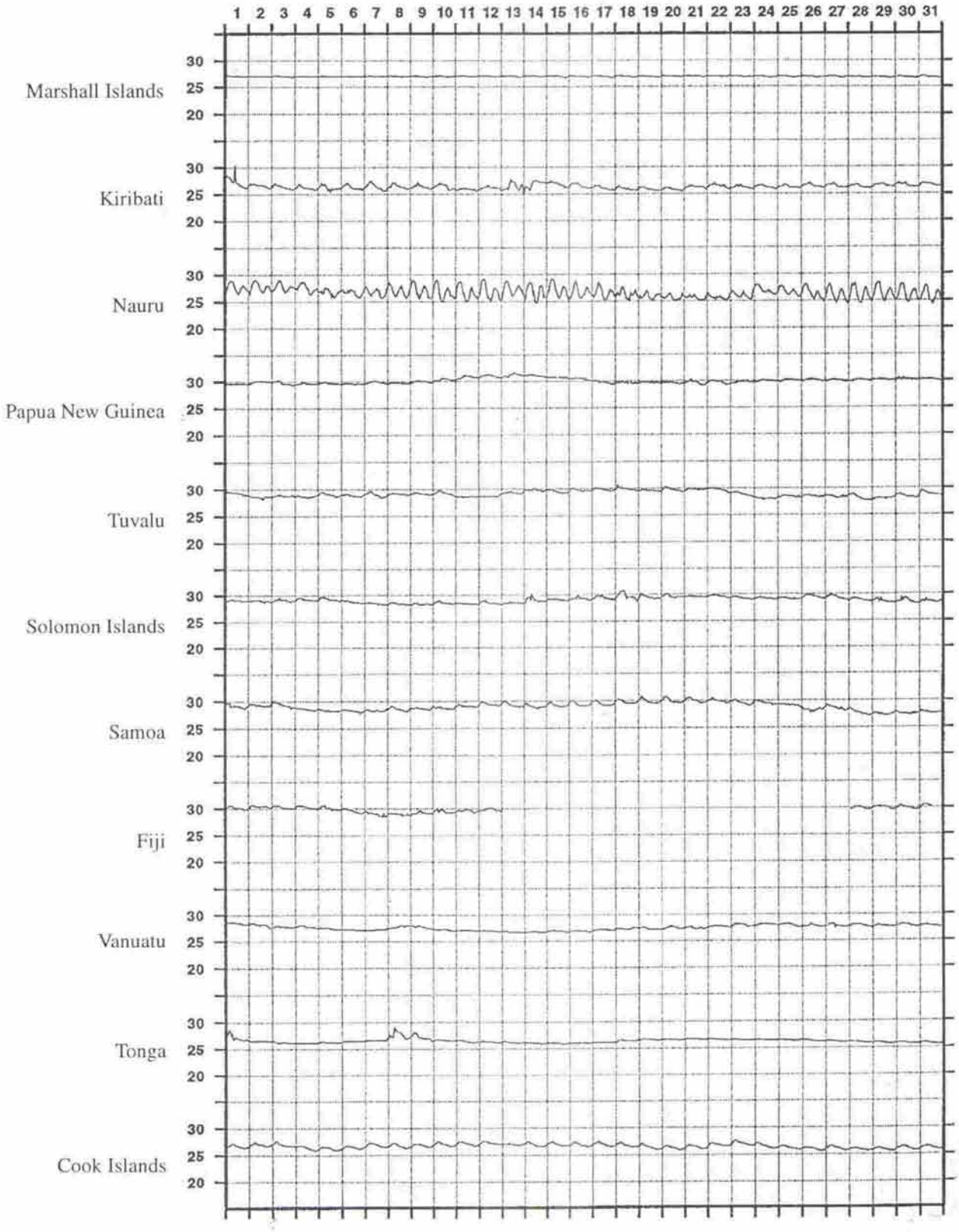
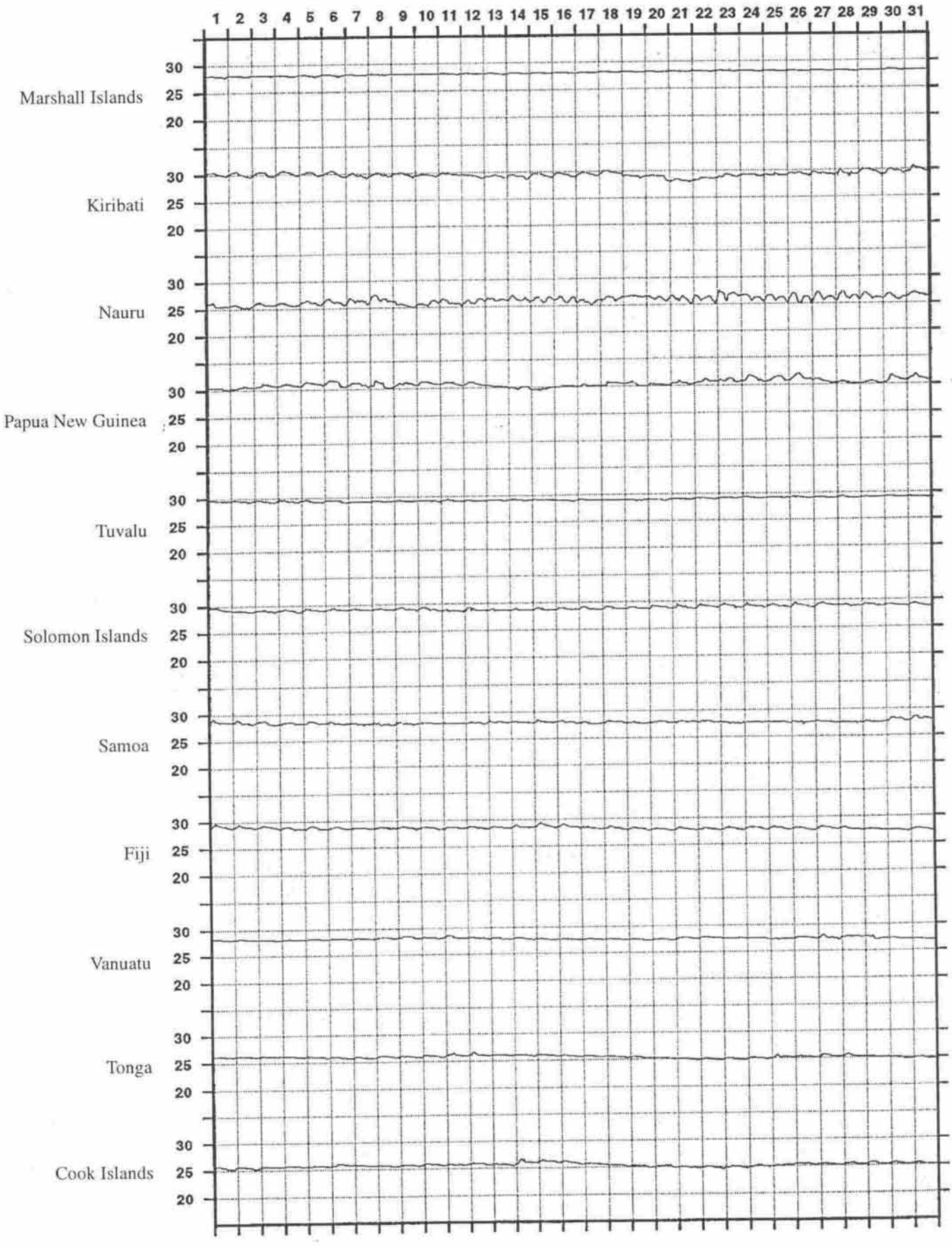


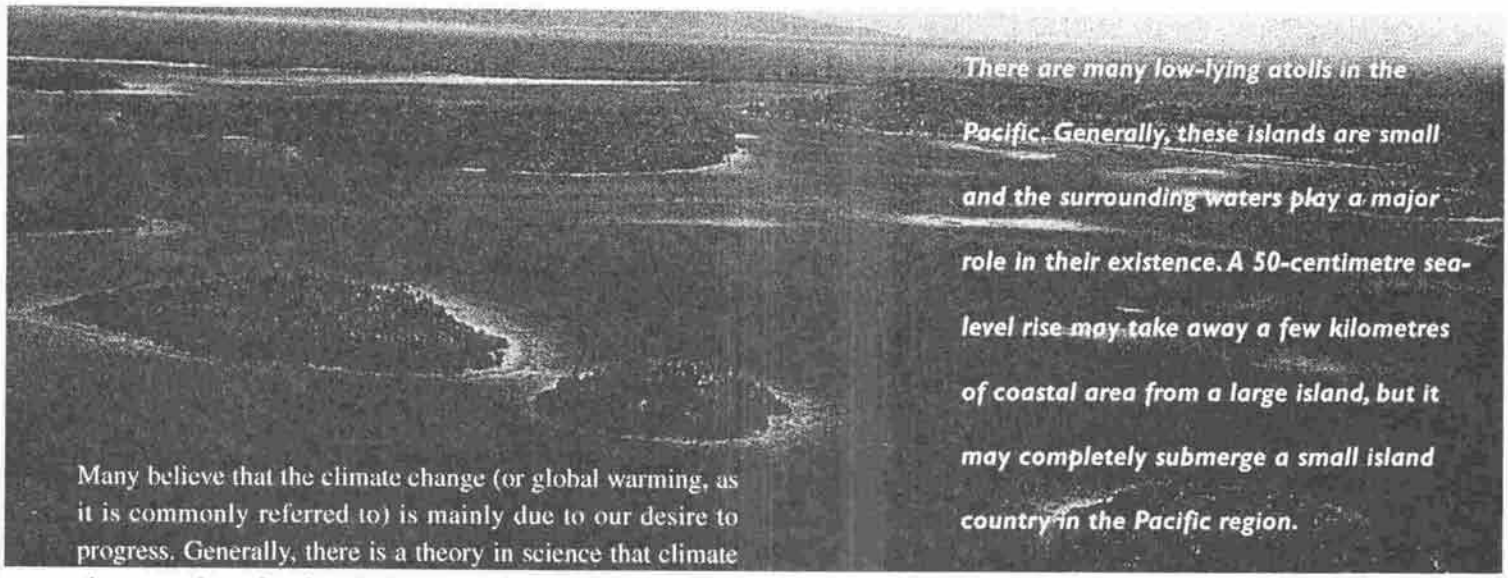
Figure 2: Hourly water temperatures from SEAFRAME stations (deg C), May 1998



Climate change and sea level rise: A personal view from Fiji

by J Pahalad

Today, climate change and sea-level rise have become household topics, especially in the Pacific region. People are intrigued by these issues, but very few understand what all the fuss is about. Some wish to learn more but few are willing to combat the effects of such phenomena. Climate change and sea-level rise are so interrelated that one cannot talk about sea-level rise without explaining the reason for it. Sea level is a measurable quantity and it can be generally defined as the results of all influences such as daily tides, meteorological, oceanographical and geological effects. For example, climate change and the movement of the earth's crust can change the sea levels significantly.



There are many low-lying atolls in the Pacific. Generally, these islands are small and the surrounding waters play a major role in their existence. A 50-centimetre sea-level rise may take away a few kilometres of coastal area from a large island, but it may completely submerge a small island country in the Pacific region.

Many believe that the climate change (or global warming, as it is commonly referred to) is mainly due to our desire to progress. Generally, there is a theory in science that climate change and sea-level variation are natural phenomena that occur approximately every ten thousand years or so and something which cannot be avoided. However, our excessive contribution of greenhouse gases into the atmosphere (which did not previously take place) is one of the major factors contributing to global warming. Scientists claim that by the year 2100, expected global temperatures may rise by 1–4 °C and the subsequent sea-level rise may be approximately 50 centimetres, although this sea-level rise could be higher in the Pacific region. Research indicates that in the Pacific, temperature has been rising 0.1 °C per decade and that sea level has been rising by 2 millimetres per year. Recent data compiled from the NTF's 11 tide gauges in the Pacific show an accelerated sea-level rise of up to 25mm/yr—more than 10 times the global trend this century. This is thought to be related to El Niño-Southern Oscillation (ENSO) variations.

There are many low-lying atolls in the Pacific. Generally, these islands are small and the surrounding waters play a major role in their existence. A 50-centimetre sea-level rise may take away a few kilometres of coastal area from a large island, but it may completely submerge a small island country in the Pacific region. Long before that stage is reached, there may be greater loss of lives and infrastructure due to the enhanced impact of natural disasters such as tropical cyclones, storm surges, floods, tsunamis and so on. The economy of most of the Pacific island countries (PICs) is greatly dependent upon fisheries, agriculture, tourism and overseas aid, and most PICs are struggling to make ends meet.

Leaders of PICs are fully aware of sea-level rise and coastal erosion problems and they are badly in need of applicable advice on how to address the problems. Public awareness of the situation is also important, and this should be conducted in local languages. However, if we are told how to safeguard our coastlines or to reduce the emission of greenhouse gases, the question arises: who should pay the cost? If recent global warming is a man-made problem, PICs are micro-contributors of greenhouse gases yet they are likely to be affected most. Some larger nations have blatantly shown their lack of concern on these issues and they seem to believe that their economy and well-being are much more important than the survival of the people from PICs. This sounds inhumane to us. How can we make our voice heard? Are we over-reacting? One thing is for sure: we are vulnerable.

If climate change and sea-level variation have been natural phenomena in our planet, as suggested by the geological records, do we still need to do anything to protect our future generations? Obviously, this is a difficult question. When and how can we tell with some certainty if we are in danger of losing part or all our homeland? In the mean time, we have to focus upon capacity building for the Pacific community on these issues so we can catch up with current scientific information.

Note: *The author, Miss Janita Pahalad is a Senior Climatologist working at the Fiji Meteorological Services in Nadi, Fiji who visited NTF for three weeks in October 1997 to participate in the Short Term Attachment Workshop, Round III.*

Activities of the Cook Islands Marine Resources Ministry

by B Ponia

The Ministry of Marine Resources operates extensively throughout the Cook Islands with a mission statement to "ensure the sustainable development of the living and non-living marine resources of the Cook Islands for the benefit of the Cook Islands".

A major function is the environmental monitoring of the pearl culture industry. Pearl farming is presently limited to Manihiki and Tongareva atolls in the north but plans for expansion extend as far south as Aitutaki. There are about 300 pearl farms at present with an annual value of exports probably in the order of NZD5 million.

The monitoring programme extends to physical water quality parameters. Some information that has been collected in the pearl farming lagoons includes temperature, salinity, dissolved oxygen and pH levels. Currents and tidal information at Manihiki was compiled into a lagoon circulation model. It appears that water temperature in particular is one of the critical factors affecting pearl farming i.e water temperature affects oyster food dynamics, which in turn affects pearl oyster growth and hence pearl quality. A long-term data set of accurate and precise temperature recordings is valuable.

In view of the importance of monitoring temperature, we are modifying this programme by deploying automated temperature probes at a depth of six metres, where pearl farming occurs (farms are submerged) and the bottom waters at a depth of twenty metres. The probes are set to record temperature every 15 minutes and are to be retrieved once a month. The data files are then downloaded to a PC and sent via email to our research headquarters in Rarotonga. This set-up has been trialled now for several months with probes deployed at Tongareva without major problems. It is anticipated that the programme will include Manihiki and Aitutaki in the near future.

Note: *The author, Mr Ben Ponia is the Director of Research, Ministry of Marine Resources in Cook Islands. He is a regular reader of our publications and now he has contributed to our newsletter. For more information, please email him at: benp@mmr.gov.ck (or) rar@mmr.gov.ck*

Next training attachment in October 1998

There will be another Short Term Training Attachment, Round V, at NTF for further information dissemination on sea level and climate change issues and technology transfer to the Pacific. The timing of this attachment has been fixed for ***12–30 October 1998*** in the fourth year of Phase II. As usual, a total of 13 candidates from the 13 project member countries of the Pacific will be invited by SPREP to participate. The Director of SPREP, Tamari'i Tutangata will invite the Forum government participants to this training attachment. Nominees will be carefully chosen based on certain criteria so that the appropriate candidates will be involved.

This training attachment will be slightly different from the previous rounds; the Research Component of the project has agreed to introduce two new courses, these being *Numerical Modelling in the Pacific Region* and *Time Series Data Analysis*. Accordingly, the following core courses will be emphasised in this attachment:

(1) Numerical modelling in the Pacific region and time series data analysis;

(2) Project data interpretation and use of new computer software; and

(3) Science of climate change, ocean circulation, tides and their application on coastal zone management.

The resource people for this training will include: J.Lucik, B. Mitchell, T. Aung, D. Strauss, C. Kaluwin and G. Lennon. Others will be invited from governments and private sectors.

As usual, some other complementary topics and activities will also be introduced during the training course. More detailed information about the above three-week training attachment and future training programmes is available from both NTF and SPREP.

Integrated coastal management for fisheries

by Philip Ronald Hill and Kenneth Bulehite

The training attachment for the Forum governments at the National Tidal Facility has allowed all the participants to start using the data and information on climate change and sea-level rise from the project (and others available to them) to plan and facilitate the development of Integrated Coastal Management (ICM) as an approach to adapt to the impacts of climate change. Below is an ICM framework which two participants from Fiji and Solomon Islands believe will provide long-term benefits to their countries by focusing on a priority economic sector such as fisheries.

Introduction

Low-lying islands of the South Pacific are very much concerned about climate change and sea-level rise. Although the causes of these phenomena vary from country to country, the effect on fishing is basically the same throughout the Pacific.

Most nations and people in the region rely heavily on fishing both for food and to generate a small income. This report will primarily address the issues, effects and a suggested programme of actions in response to these. It is hoped that this will integrate various levels of government departments, communities, landowners and other interested parties with local fishing[1] in regards to planning for sea-level rise and climate change in our countries and region.

Issues

Most Pacific islanders live along the coastal area of an island. Fish are generally the staple diet and source of income. However, an increase in human activity, climate change and sea-level rise will have long-term effects on the fishing sector in all Pacific countries. We wish to bring to your attention issues that affect the local fishing methods and techniques.

The following issues are generally due to sea-level rise :

Destruction of mangroves. This is caused by changes to sea level, especially increases in storm surge, and human activities which in turn cause coastal erosion.

Coastal erosion and sediment transportation. Coastal erosion is evident in most of our islands. The destruction of mangroves does not help the problem. Storm surges are increasingly hitting the coastline causing sediment transportation along the near shore. Mangroves and sea grasses normally act as a filter for sediments.

Migration of fish. Due to the destruction of mangroves, small fish are not protected along the coastal area. These fish will generally migrate elsewhere.

Effects

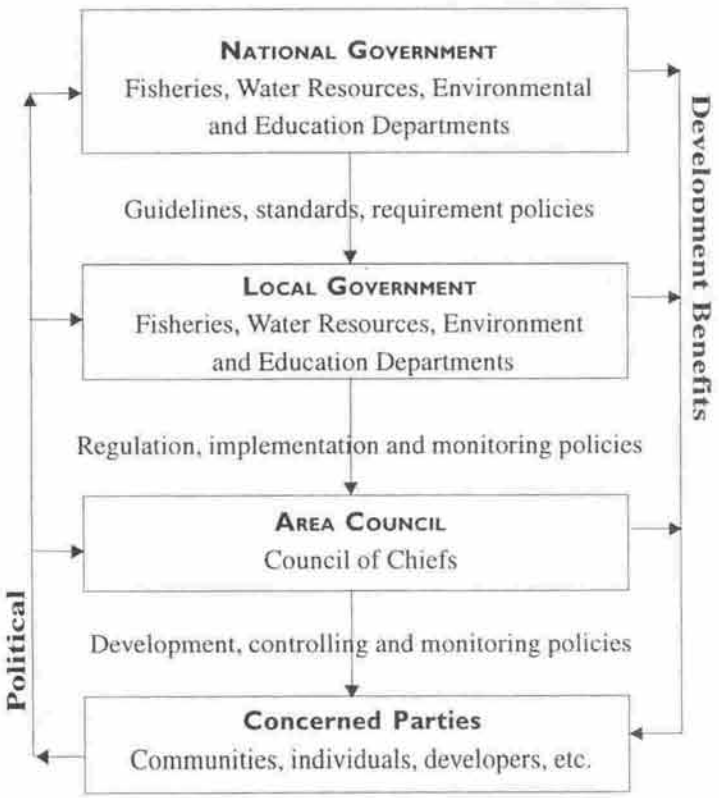
The following effects have resulted from the above-mentioned issues:

More travelling time required. There is an increased scarcity of fish near the coastal areas of villages or towns. Most fishermen are travelling further out in the ocean and spend more time away from their families. This causes, among other things, social problems with families.

More people lost at sea. This is due to the increased time and distance required to catch an adequate amount of fish for families. More people are getting lost in the ocean and many have lost their lives. Climate change causes a more irregular climate pattern and very little is understood about the effects or the impact of climate change, especially in rural areas and at the village level.

Increased costs. The increased travelling time and distances also increase the costs incurred (such as fuel and outboard motors). The increase in missing people also increases government expenditure, especially on rescues and disasters.

Structure of integrated coastal management and planning



1. *Local Fishing means "any fishing methods or system used by the local fishermen to provide food and income for their families along with their basically claimed customary land rights".*

Programme of actions

I. Legislation and policy

A. National government

The national Government, through various government departments, is responsible for developing policies and guidelines to govern the activities of various developers and communities. These should be done in consultation with the communities and the policies and guidelines should not deprive them of their right to use the resources.

B. Local government

Local government, with its various representatives, is responsible for developing detailed guidelines and regulations regarding the use of resources in consultation with the communities. The local government should also be responsible for monitoring and implementing the required specifications.

C. Area Council

The Area Council is responsible for controlling and monitoring the implementation of the policies and guidelines.

D. Communities

In the development of this legislation, the community must always be considered, as the implementation of policies will generally affect the local people and their

II. Public awareness

A. School

- Develop awareness through the school syllabus at various levels.
- Develop various small student projects to increase understanding of the effects of climate change.

B. Government departments

- Develop pamphlets, posters and video cassettes for presentation.
- Organise workshops for village communities.
- Develop appropriate media programmes.

C. Communities

- Organise workshops for their own people to understand the impact of sea-level rise.

III. Implementation

A. Local government

- Develop working policies.
- Allocate funding as incentives to encourage sustainable methods of fishing and other small income-generating mechanisms.
- Develop an effective method of monitoring the effects of climate change and sea-level rise and for understanding it.
- Encourage replenishment of affected areas.

B. Area Council

- Assist the local government in providing a clear understanding of the impact of sea-level rise on their area.
- Control activities in the area that might enhance the problem.

C. Communities

- Encourage people to use sustainable fishing methods.
- Encourage people to protect various resources such as mangroves.

IV. Monitoring

A. Area Council

- Monitor all the development area.

B. Communities

- Encourage people to be responsible and accountable.

C. Individuals

- Report any unwanted development.
- Advise each other on the policies and required specification.

Note: *Mr Philip Ronald Hill is a Senior Hydrographic Surveyor in Fiji, and Mr Kenneth Bulehite is a civil engineer in the Solomon Islands.*

Project reports on NTF and SPREP sites

We are pleased to announce that the *Monthly Data Report* of the *South Pacific Sea Level and Climate Monitoring Project* and the status of daily data are now on the Internet at http://www.ntf.flinders.edu.au/TEXT/PRJS/PACIFIC/pacific.html. In addition, the Quarterly Newsletter is now available on the SPREP website: http://www.sprep.org.ws

Launch of "Climate Change Curriculum Modules for Pacific Schools" Part I and II

(by H.E. Meg McDonald, Australian Ambassador for the Environment)

H.E. Ms Meg McDonald, officially launching the curriculum books during the Pacific Regional Conference for Environmental Education and Training, at the University of the South Pacific, Suva, Fiji on 30 June 1998.

Distinguished guests, ladies and gentlemen.

I am very pleased to join you in the course of this important regional conference for environmental education and training. I don't need to tell you of the importance of the management and care of the environment—not just for ourselves but for future generations. The environment that our children and our children's children will inherit is being determined by us. This means it is vitally important that we as governments, as regional and multilateral organisations, as communities and as families all take responsibility for ensuring we leave future generations with a physical environment conducive to good health and well-being.

It also means that we have a responsibility as the guardians and educators of our children to ensure that they have the knowledge and awareness of their natural environment necessary to ensure its ongoing care and protection. This should happen at all levels, for example in community groups and within the family. Importantly, it should also be a part of the formal education system. Today environmental studies are part and parcel of the curriculum, and importantly, environmental awareness is integrated into a wide variety of subjects and teaching approaches.

These booklets that I am formally launching here today are designed to assist students and teachers in the upper primary and lower secondary schools in the Pacific region to better understand one critical aspect of the Pacific environment, Climate Change and Sea Level.

They are the first two of a planned series of curriculum modules dealing with the subject. Part One focuses on physical science covering such areas as the atmosphere, weather and climate, and ocean circulation. The second module covers the social science aspects looking at the actual evidence of climate change, its causes and the possible impacts of climate change on the physical environment.

These modules have been developed under the South Pacific Sea Level and Climate Monitoring Project of the Australian Agency for International Development, *AusAID*. This project is managed by the National Tidal Facility of Flinders University in South Australia. Its overall aim is to help Pacific island countries and their governments to understand the scale and implications of changing sea levels and climate.

Specifically, the project is part of Australia's response to the issue of the potential impacts of climate change on countries in the region. Successive South Pacific Forum leaders have emphasised the importance of this for all in the Pacific.

The project started in 1991 and is expected to continue for many years into the future. It is unusual for *AusAID* projects to have such a long time-frame but in the case of sea level and climate monitoring, it may require more than 20 years of data to begin to be scientifically meaningful.

The project has many facets. On the technical side, 11 monitoring stations are now in place in participating countries across the region. In Fiji, the monitoring station is near Lautoka. These stations are continuously monitoring sea level, wind speed and direction, wind gust, air and water temperatures and atmospheric pressure. The data is beamed via satellite back to the National Tidal Facility in Adelaide where it is collated, analysed and subsequently shared with Pacific island governments and communities.

Just as important as the highly technical scientific side of the project is the information and training component, and that's where these curriculum modules come in. These booklets are the result of collaboration between:

- the Flinders University National Tidal Facility (NTF);
- the South Pacific Regional Environment Programme (SPREP);
- the Atmospheric Radiation Measurement (ARM) Program of the USA; and
- Schools of the Pacific Rainfall Climate Experiment (SPaRCE).

continued on page 13

US Department of Energy's ARM program in the Tropical Western Pacific

by P. Lefale (SPREP) and
Dr Bill Clements (University of California, Los Alamos National Laboratory)

The US Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) program (see Figure 3 for history) began its operation in the Tropical Western Pacific (TWP) in October 1996 when its first semi-autonomous Atmospheric Radiation and Cloud Station (ARCS) was officially commissioned on Manus Island, Papua New Guinea. The installation of this ARCS was the first in a series of ARCS deployments across the Tropical Western Pacific over the next few years.

The Manus ARCS is a joint collaborative effort between the Papua New Guinea National Weather Service, the US DOE ARM program and the South Pacific Regional Environment Programme (SPREP). The ARM Tropical Western Pacific Program Office (TWPPO), located at the University of California's Los Alamos National Laboratory, has the overall responsibility for ARM activities in the TWP. Scientific guidance and control is the responsibility of the TWP Site Scientist Office at Pennsylvania State University in the USA. All ARM activities in the TWP are coordinated in association with SPREP. The PNG NWS is responsible for the day-to-day operations of the Manus ARCS with technical and training support from ARM and SPREP. The ARCS on Manus is performing successfully and data collected are already being used by the scientific community. These data are available on the World Wide Web.

Negotiations were already underway with the Government of the Republic of Nauru for placing the second ARCS on the island soon after the first was commissioned. During 1997 and the first half of 1998, teams from ARM, TWPPO and SPREP visited Nauru and held discussions with the government about planning and site preparations for the installation of this second ARCS. Assembling and testing of the ARCS at the ARCS integration facility at Sanidia National Laboratory in Albuquerque, New Mexico, is now complete, and the ARCS is currently being shipped to Nauru for installation. It is expected to be fully operational by mid-November 1998. The Nauru ARCS will operate in collaboration with the Nauruan Department of Island Development and Industry.

Negotiations with the Government of the Republic of Kiribati regarding the installation of a third ARCS on Kiritimati Island also began in 1997. A team from ARM and SPREP visited Tarawa in August 1997 and held discussions with government officials about the project. Planning and negotiations for the deployment of the third ARCS to Kiritimati Island are now underway. A team from ARM, SPREP and TWRCI will visit Kiritimati Island at the end of August 1998 for site inspections and discussions with government officials.

Negotiating ARCS for Kiritimati Island included (l-r): Mr Larry Abe, consultant to Kiribati Government; Penehuro Lefale, SPREP; and Hon. Teamba Teariki, Kiribati's Minister for Line and Phoenix Development.

Figure 3: The US DOE Atmospheric Radiation Measurement program[1]

The DOE ARM program was created in 1989 as part of the US Global Change Research Program to improve the treatment of atmospheric radiative and cloud processes in computer models used to predict climate change. The overall goal of the ARM program is to develop and test parameterisations of important atmospheric processes, particularly cloud and radiative processes, for use in atmospheric models. This goal is being achieved through a combination of field measurements and modelling studies. Three primary locales were chosen for extensive field measurement facilities. These are the Southern Great Plains of the United States, the Tropical Western Pacific, and the Northern Slope of Alaska and Adjacent Arctic Ocean.

For further information on the ARM Program, visit our web site (http://www.arm.gov) or email the ARM TWP Program Office, Dr Bill Clements (clements@lanl.gov), Program Manager, Dr Fairley Barnes (fbarnes@lanl.gov), Deputy Program Manager, University of California, Los Alamos National Laboratory, Los Alamos, New Mexico, USA ph (505) 667-1186, fax (505) 667-9122 and/or Mr Penehuro Lefale (pene@sprep.org.ws), SPREP, PO Box 240, Apia, Samoa, ph (685) 21929, fax (685) 20231.

1. Clements, E. William, Barnes, J. Fairley, Ackerman, P. Thomas, Mather, H. James 1997 The ARM Program in the Tropical Western Pacific, Paper for the Fourth SPREP Meeting of Regional Meteorological Service Directors, 8–10 July 1997, Apia, Samoa.

continued from page 11

Launching curriculum books

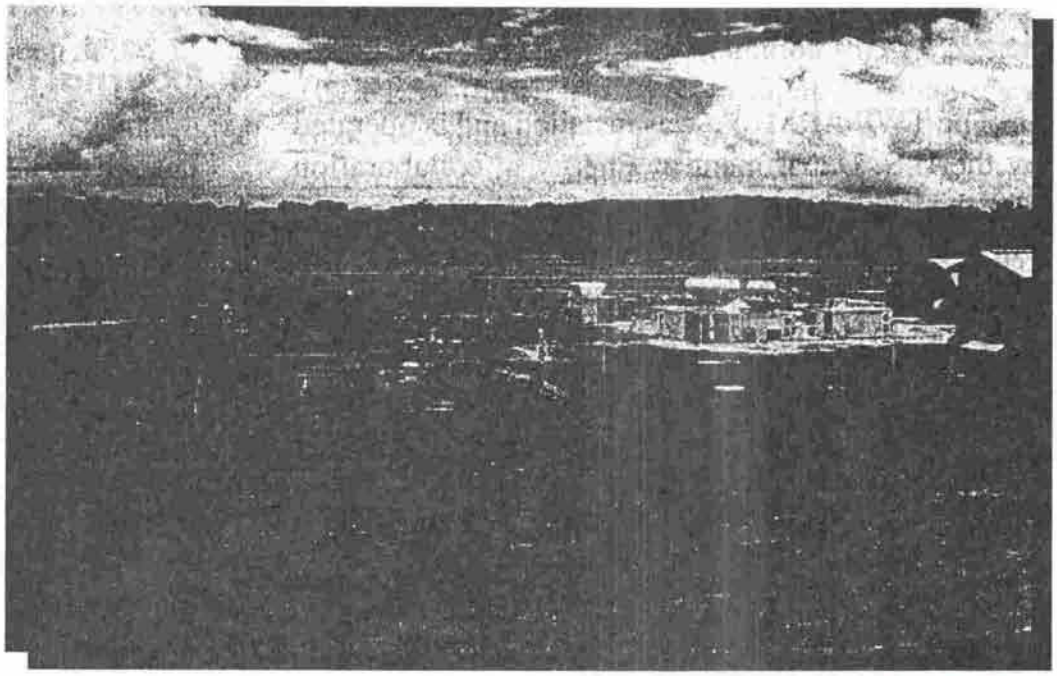
While the modules are designed for use in upper primary and lower secondary schools, I am sure they will also prove of great benefit to a wider range of interest groups in the community.

I congratulate everyone who contributed to the development of these resources. In particular, I acknowledge the three editors whose tireless dedication facilitated the completion of these modules ahead of schedule. They are:

- the Climate Change Officer at SPREP, Dr Chalapan Kaluwin;
- the Information and Training Coordinator at the National Tidal Facility, Dr Than Aung; and
- the former Director of the NTF, Emeritus Professor Geof Lennon.

All of us here who are concerned in our own way with environmental education and awareness are grateful to you.

I trust they will be put to good use throughout the region to help ensure that this and future generations are better informed about that most vital of human concerns, our natural environment.

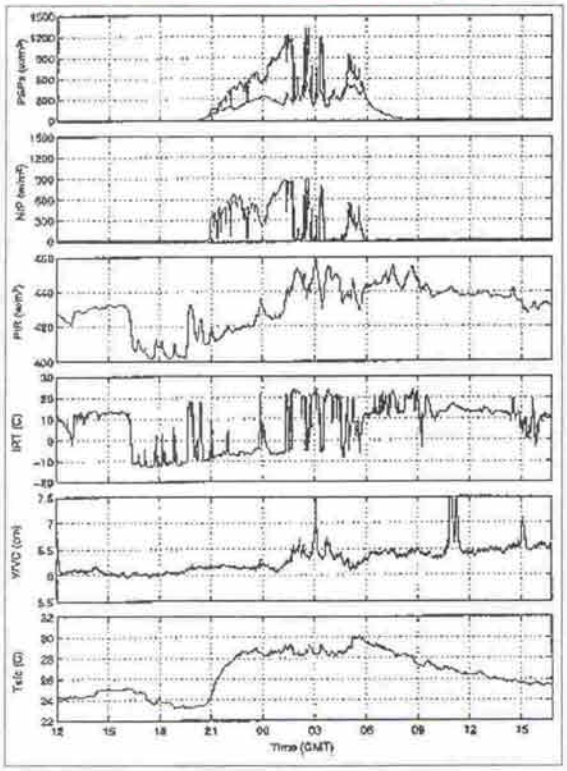


Atmospheric Radiation and Cloud Station (ARCS) on Manus Island, Papua New Guinea

Figure 4: Instruments included in ARCS

Measurements	Instruments
Surface radiation balance	Up- and downlooking pyranometers and pyrgeometers; sun-shaded pyranometer and pyrgeometer; normal incidence pyrheliometer; up- and downlooking 9–11-μm narrow-field-of-view radiometers; UV-B hemispheric radiometer; broadband (solar and infrared) net radiometer.
Surface meteorology	Temperature and relative humidity probe; barometer; optical rain gauge; anemometer.
Cloud properties	Cloud lidar; ceilometer (7.5-km maximum range); 35-GHz radar;* whole-sky imager.*
Aerosol optical depth	Multifilter rotating shadow band radiometer (total, direct, and diffuse irradiance in six 10-nm channels).
Column water	Dual channel (23.8 and 31.4 GHz) microwave radiometer.
Vertical structure of atmosphere	Rawinsonde; 915-MHz wind profiler with RASS.**

Figure 5: Time series for multiple ARCS instruments for 22–23 February 1997



Children's Education

Destructive storm surges

by D. R. Strauss

Whenever coastal areas of the Pacific islands are struck by seasonal tropical cyclones, most of the destruction is caused not directly by wind, but by water pushed ahead of the storm just like sand before a shovel. When this lump of water reaches shore, it is often called a storm surge.

The effect of winds at the sea surface is transmitted downwards as a result of internal friction within the upper layer of water. For example, the greater the wind speed, the greater the frictional force acting on the sea surface, and the stronger the surface current. From empirical observations, we know that the surface current speed is typically about two to three percent of the wind speed. However, this is only a rough guide. Generally, wind will also raise the sea level in the direction of wind speed especially in the equatorial Pacific area. This effect of wind is usually called *wind setup*.

Depression of the water surface under high atmospheric pressure, and its elevation under low atmospheric pressure, is often described as the *inverted barometer effect*. The water level does not adjust itself immediately to a change of pressure and it responds to the average change in pressure over a considerable area. Changes in sea level due to barometric pressure seldom exceed about 30 centimetres, but the effect is important as it is associated with those caused by wind setup since winds are driven by the atmospheric pressure gradient.

The combination of wind setup and the inverted barometer effect associated with a storm may create a pronounced increase in sea level producing a *storm surge*. A *negative surge* is the opposite effect. It is generally associated with high pressure systems and offshore winds, and can create unusually shallow water. This effect is of great importance to very large vessels that may be navigating with small under-keel clearances near the harbour.

The strong winds of tropical cyclones create waves driven so relentlessly forward that they begin to crowd upon one another, piling up when they reach shallow water and creating a continuous current rushing landward. A tropical cyclone with winds of over 100 kilometres per hour combined with low atmospheric pressure typically can produce a storm surge of approximately two metres. All that water surging over the land becomes a foundation for waves, which in turn cause more flooding. Such flooding can extend several kilometres inland. As mentioned above, the destruction may be enhanced by the extremely low atmospheric pressure that accompanies tropical cyclones. The low pressure at the centre of the storm causes the water beneath it to rise in a *hump* that floods inland when the storm strikes a coast. If this kind of extreme event coincides with *spring tides* (higher tidal range) period, the resultant effect will be worse.

One of the most destructive extreme events of this nature took place in the Bay of Bengal in November 1970. An approximately 10-metre storm surge that swept inland along the coast of Bangladesh killed over 200,000 people.

Note: *The author Mr Darrell Strauss is the Computing Systems Officer of the Pacific Project, based at the National Tidal Facility.*

Other related regional activities of the project

In the months of July and August, the project staff will be working with the governments of the region, SPREP and other regional institutions to increase understanding of the project and climate change issues. The following are some of the planned activities:

- In Nauru, training on climate change, sea-level rise and the Greenhouse Gas Inventory under the SPREP Pacific Islands Assistance Climate Change Programme (PICCAP) is planned for 6–10 July 1998. This will target educators, technical people, policy-makers and the community in general.
- In Papua New Guinea (Port Moresby) from 21–25 July a similar training will be conducted. The majority of the participants will be technical people from government departments and national institutions.
- In Tuvalu, the development of an Integrated Coastal Management pilot study and Greenhouse Gas Inventory training (PICCAP) will take place involving technical and policy planners of the government from the 10–14 August 1998.
- The Forum Meeting in Federated States of Micronesia (FSM) will be held in Pohnpei from 21–29 August 1998. The Project outputs/products will be displayed and distributed to government officials. Staff from FSM Weather Office and Foreign Affairs will work with the project staff during this period to promote this project.

Testing ocean currents

by T. H. Aung

The climate we have is influenced by ocean currents. These currents are driven by solar heating and global winds. Usually, surface water is warmer and bottom water is colder in the ocean. In other words, cold water has higher density and sits at the bottom of the ocean. The difference in densities cause the major circulation pattern and many local currents in the ocean.

Why not try this simple activity in your classroom to find out how different water densities affect ocean currents?

Objective

The main objective of this simple activity is to demonstrate the effect of cooling and heating on currents in the ocean.

Materials

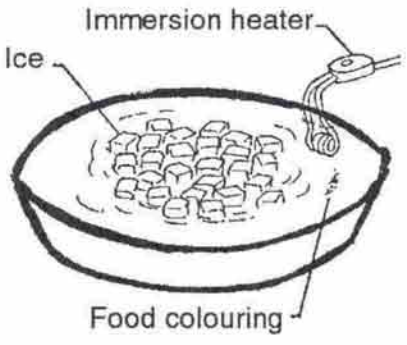
1) a large beaker
2) bunsen burner (*or* stove *or* immersion heater)
3) ice cubes
4) tripod stand
5) water
6) gauze mat
7) drops of black ink (*or* coloured dye)

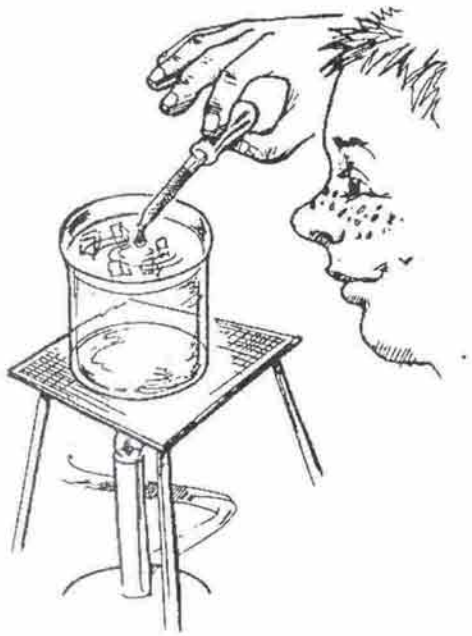
Procedure

1) Fill the beaker with water and let it stand for a few minutes.
2) Put the ice cubes on top and heat the water very slowly from below with the bunsen burner (or from one side with the immersion heater).
3) Add a few drops of dye or black ink.
4) Watch what happens.
5) You may repeat the above procedure until the process is clear.

Questions

1) What happens to the bottom water when heating begins?
2) What happens to the dyed water at the surface when heating begins? Draw a diagram to illustrate the movement of the colour.
3) Can you explain how water is circulating in the beaker?





Note: *The author, Dr T. H. Aung, is the Information and Training Coordinator of the Pacific Project based at the National Tidal Facility.*

Quarterly Newsletter for the *South Pacific Sea Level and Climate Monitoring Project, Phase II* (Con 4990) is prepared by *National Tidal Facility*, The Flinders University of South Australia and jointly issued with the *South Pacific Regional Environment Programme* for the *Australian Agency for International Development (AusAID)*. Further communication on the *Quarterly Newsletter* may be made to:

National Tidal Facility
Flinders University of South Australia
GPO Box 2100
Adelaide 5001
Australia
Ph: (618) 8201 7611
Fax: (618) 8201 7523
Email: mota@flinders.edu.au

South Pacific Regional Environment Programme (SPREP)
PO Box 240
Apia
Samoa
Ph: (685) 21929
Fax: (685) 20231
Email: sprep@sprep.org.ws

Technical Editors: C. Kaluwin (SPREP) and T. H. Aung (NTF)
Editor: Carole Hunter
Layout: Fatu Tauafiafi (SPREP)

Air Mail

Printed Matter

South Pacific Regional Environment Programme (SPREP)
PO Box 240, Apia, Samoa
Telephone: (685) 21929
Fax: (685) 20231
Email: sprep@sprep.org.ws
http://www.sprep.org.ws/