National Tidal Facility

South Pacific Regional Environment Programme

The South Pacific Sea Level and Climate Change Newsletter

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This quarter, our newsletter will report on a number of important activities and people connected with the Project, most importantly the Project Coordinating Committee (PCC) meeting that took place in Kiribati, on 14 and 15 February 1997.

The PCC group present in the meeting (see opposite photo) included Mr Ian Hodges (AusAID), Dr Bob Brook (Bureau of Meteorology, Australia), Prof. Roger McLean (University of NSW, Canberra, Australia), Prof. Tad Murty (National Tidal Facility, Australia), Mr Tekena Teitiba, Mr Nakibae Teutabo, Mr Irene Nikoro (Kiribati Government) and Dr Chalapan Kaluwin (SPREP, Samoa). Amongst others, the following are some important decisions regarding the implementation of Project activities:

The Project Coordinating Committee (PCC). From left to right: Mr Teutabo, Dr Brook, Mr Hodges, Dr Kaluwin, Prof. McLean, Prof. Murty, Mr Nikoro, Mr Teitiba

Contents

- The Modular Training Attachments for the Forum Government participants at the National Tidal Facility, Flinders University should continue to be implemented in May and October 1997.
- The Project will endeavour to make appropriate arrangements with the USA (NOAA) and Fijian Governments to include the Suva tide gauge as part of the network of gauges, and thus retrieve additional data.
- A technical presentation and public display of the Project outputs will be presented in this year's Forum Meeting in the Cook Islands.

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AusAID

With Dr Kaluwin and Prof. McLean are members of the IPCC working group, Mr Sem (second from left), Mr Ali (front right) and Mr Nurse (back right)

- The Project will try to work with AusAID and Forum Governments to complete the Project's Memorandum of Understanding (MOU) as soon as possible.
- A draft climate change curriculum manual for teachers and students of the Forum is to be circulated to all Forum Governments towards the end of this year.
- The venue for the next PCC meeting will be in either Vanuatu or the place of the next Forum meeting.

The Project and two members of the PCC, namely Prof. Roger McLean and Dr Chalapan Kaluwin, were invited as experts to contribute as authors for the "Intergovernmental Panel on Climate Change (IPCC) Working Group Two Special Report: Regional Impacts of Climate Change on Small Island States" (shown in the photo above). The report will be circulated to all governments, NGOs, and private institutions for review and comments to assist in the IPCC process.

After the PCC meeting, Prof. Tad Murty, Director of the South Pacific Sea Level and Climate Monitoring Project and National Tidal Facility resigned. He will move to Canada. After 3 years of coordinating and managing the Project in the region, the staff of NTF and SPREP wish him well in his future. In the meantime, the Deputy Director Mr Bill Mitchell will be the Acting Director.

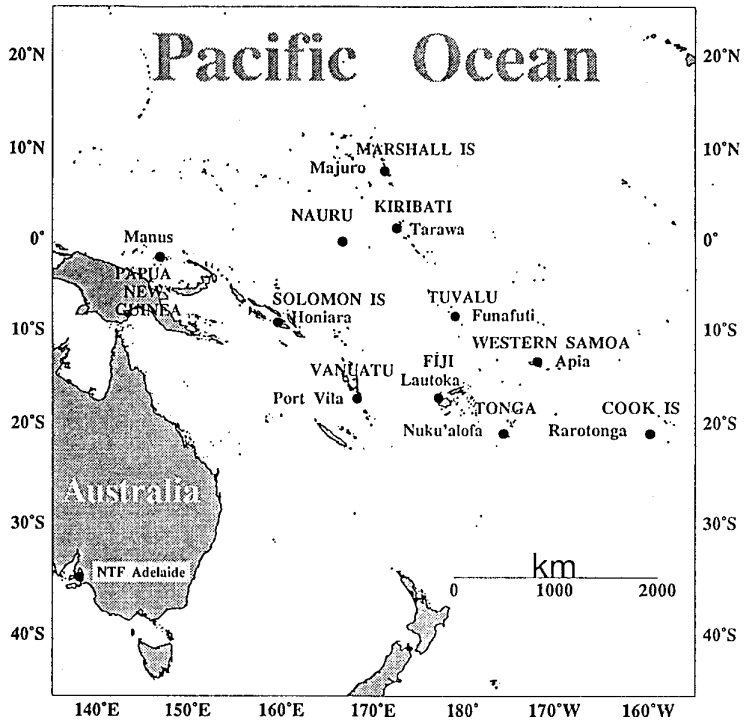
Despite the severe weather conditions and tropical cyclones in the Pacific region, this quarter was relatively quiet with respect to Project activities. However, a small organising committee for the Modular Training Attachment for May 1997 is moving into full swing. Tickets for thirteen participants from the Project member countries were sent out at the end of March. The modular training attachment programmes have been finalised and ready to be implemented.

This seventh issue contains data interpretation with respect to regional sea level and climate change, latest news and articles on climate change issues, as well as a closer examination of the Southern Oscillation Index and forecasting El Niño signals in the Pacific region. In our Children's Education section, we look at the importance of marine science while some participants attending attachment training discuss planning and responding to sea-level rise and climate change in their islands.

Some Features of the Project Data during this quarter

Cyclones hit the region

Although earthquakes featured in the data reports this quarter, it was the tropical cyclones occurring throughout the region which caught everyone's attention. Dr T H Aung reports on some features of the project data.



There were quite a few significant earthquakes in the Pacific Ocean during this quarter and details were given in the regular *Monthly Data Reports*. Based upon location and magnitude, these earthquakes were not strong enough to generate a significant tsunami. The nearest SEAFRAME stations of the Project did not pick up any significant signals on these dates. Instead of tsunami threats in the Project region, there were some tropical cyclones in the area—and these had far more impact than the tsunamis. Accordingly, it is necessary to pay closer attention to tropical cyclones in the Project area.

The first reported tropical cyclone in the area was called *Fergus*, which hit the Solomon Islands on 26 December 1996. High winds and rain damaged crops and caused serious flooding in the coastal areas. *Fergus* passed between New Caledonia and Vanuatu and, on 28 December, cyclonic winds and torrential rains damaged some garden areas in Vanuatu. Although very low atmospheric pressure and high winds were recorded in the Solomon Islands and Vanuatu on these dates, there was no particular explanation about it in our regular *Monthly Data Report*, Vol. II, No. 18 (Dec 96) as the news of *Fergus* was seen only in the *Pacific Islands Monthly*, March 1997.

During March 1997, NTF . . . was overwhelmed with many faxes, phone calls and letters (both directly and via AusAID) asking about the high sea level and severe weather in the various Project member countries.

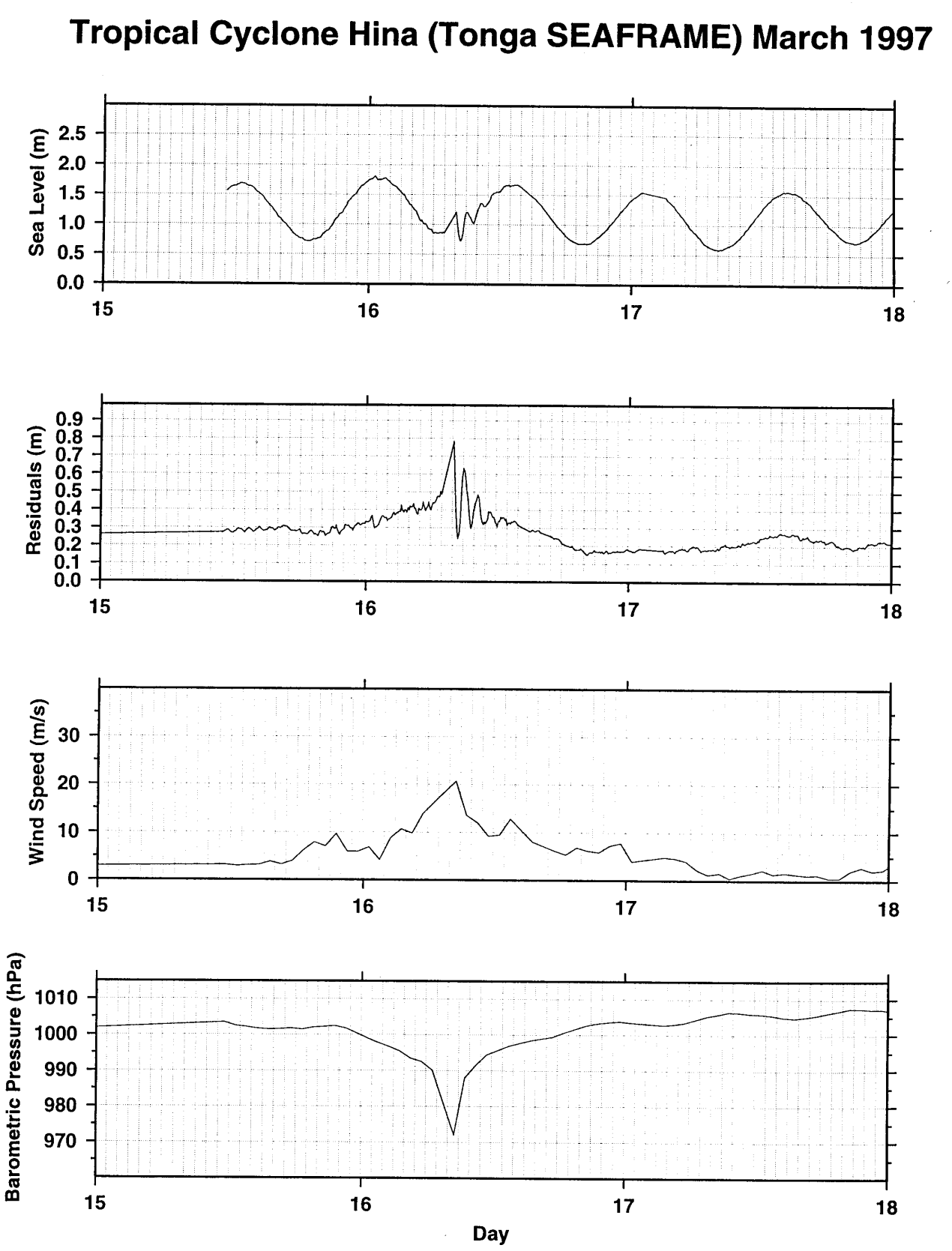

Tropical Cyclone Hina (Tonga SEAFRAME) March 1997
Sea Level (m)
2.5
2.0
1.5
1.0
0.5
0.0
Residuals (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Wind Speed (m/s)
30
20
10
0
Barometric Pressure (hPa)
1010
1000
990
980
970
15
16
17
18
Day

Figure 3

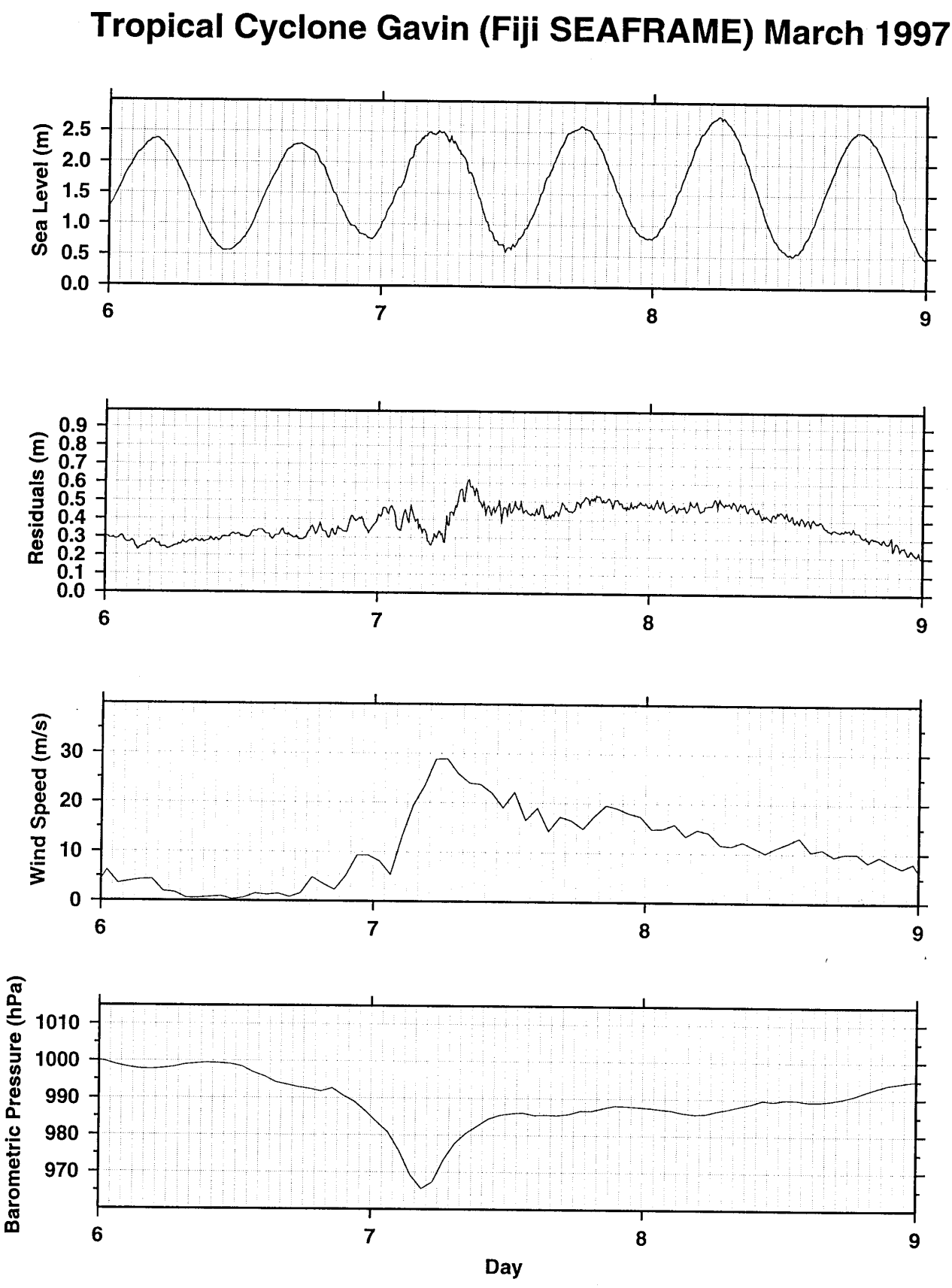

Tropical Cyclone Gavin (Fiji SEAFRAME) March 1997
Sea Level (m)
2.5
2.0
1.5
1.0
0.5
0.0
Residuals (m)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Wind Speed (m/s)
30
20
10
0
Barometric Pressure (hPa)
1010
1000
990
980
970
6
7
8
9
Day

Figure 4

Due to the strong activities of the tropical cyclones in the region, the various atmosphere and ocean parameters monitored at the SEAFRAME stations were more extreme than normal for this quarter. During March 1997, the Information and Training Component of the Project at NTF was overwhelmed with many faxes, phone calls and letters (both directly and via AusAID) asking about the high sea level and severe weather in the various Project member countries. Among them, a note from Nauru was most interesting and the story is featured in our Children's Education section of this newsletter.

There were some significant sea level residuals at most of our SEAFRAME stations, but they seemed to be the signals associated with a "squall line" which lasted only a few minutes at each site. Here the word, "squall" can be defined as a sudden increase of wind speed lasting for several minutes before decreasing. To be classified as a squall, the wind should rise by at least 8 ms^{-1} and reach at least 11 ms^{-1}. A squall is often, though not always, accompanied by heavy rain and thunderstorms. At our SEAFRAME stations, although sea level is recorded at six minute intervals, hourly observations of pressure and wind fields would not register the squall line.

Occasional wavy sea level residual trends at some stations during this quarter are mostly attributable to the atmospheric pressure and wind field. Strong winds can drag waters towards the coast or away from the coast, depending upon the wind direction. In the Pacific Island countries, most islands are narrow and strong winds, regardless of their direction, push water towards the coast on one side of the island. These winds can also result in a very high sea level. It is to be noted that a decrease of barometric pressure by 1 hPa may cause an approximately 1 cm rise in sea level. The contributions of strong winds and low atmospheric pressure are clearly evident in Nauru, Tonga, Fiji and a lesser extent in Tuvalu during March 1997. When these periods are coincident with the Spring tides, the resultant sea level may be significantly higher than normal conditions.

In Tonga, although 16 March was during the Neap tide period, wind gust reached around 45 ms^{-1} (around 160 km/hr) and the atmospheric pressure was as low as around 970 hPa (see figure 3). In this case, the pressure effect alone might have caused an approximately 50 cm sea-level rise. According to the short media report, Tropical Cyclone *Hina* hit Tonga on this date. High winds and torrential rainfall resulted in power and communication failures and flooding. The impact of the cyclone was significantly felt by a lot of the economic sectors of Tonga.

In Fiji, Tropical Cyclone *Gavin* had significant effects on the islands. The days of 6–8 March were coincident with the Spring tide period (normal predicted values of sea level maximum was approximately 2.2 m), the average wind speed was around 30 ms^{-1} (wind gust was around 45 ms^{-1}) and the atmospheric pressure went down to below 970 hPa (see figure 4). Due to the combination of low atmospheric pressure, strong winds and the Spring tide, the sea level rose considerably. Subsequently, the results were catastrophic as was apparent from the media reports. Serious flooding and damage to buildings and infrastructure resulted, with some casualties in coastal regions.

Dr T.H. Aung is the Training Coordinator of the South Pacific Sea Level and Climate Monitoring Project and works in the National Tidal Facility.

Global warming chills out over Pacific

Climate researchers believe they know one of the reasons why world temperatures are not rising as fast as existing models of global warming predict. A team based in New York has found that as the Earth warms up, currents in the tropical Pacific change. This means that more cold water reaches the sea's surface, causing air around the world to cool. This feedback mechanism is keeping global warming in check—at least for now.

"Traditionally, climatologists have seen the ocean as passive features that absorb whatever happens above. But we say oceans can have a much more dynamic role in climate."

To study the effects of global warming on sea temperatures, Richard Seager and his colleagues at the Lamont-Doherty Earth Observatory at Columbia University in New York State modelled changes in wind and currents in the Pacific. They also analysed temperature records over the past century. Their results suggest that cooling in the eastern Pacific may be slowing down global warming by as much as 22 percent. "This is not just modelling, this is something that has actually occurred", says Seager.

The research challenges other theories about why global warming has been slower than expected. Climatologists in Britain and Germany have argued that soot and sulphate particles in the air are shading the Earth and keeping temperatures down. But this view has come under increasing attack from researchers in the US, who say no one knows whether airborne particles cause cooling or warming.

Seager worked with Mark Cane and Stephen Zebiak, who had originally developed a statistical model to predict the timing of El Niño events—the periodic reversal of currents and winds in the eastern Pacific. The team used the model to predict what would happen to sea surface temperatures when air over the Pacific warmed. "We expected a uniform warming", says Seager, "but we found that there was heating on the west side of the ocean and cooling on the east side."

When the researchers examined temperature records, they found that the waters of the eastern Pacific had indeed cooled this century. Seager says this is linked to a constant upwelling of cold water from the ocean depths. Models suggest that when this cold water reaches the surface of the ocean it initially offsets the effects of heating in the air above.

But this is just the start. Because warming in the eastern Pacific has been checked, the temperature difference between the cool east and warm west should increase. And, when the researchers examined temperature measurements for this century, they found just this trend.

This temperature difference in turn drives the trade winds, which blow westwards, taking surface water with them and allowing more cold water to reach the surface in the east. The effects of the circulation system in the Pacific are felt far away, the researchers say. They found that on average, global temperatures had been significantly cooler in years when the upwelling was strong in the eastern Pacific—as happened last year, for example.

The findings are published in the current issue of Science (vol. 275, p957). "Traditionally, climatologists have seen the ocean as passive features that absorb whatever happens above. But we say oceans can have a much more dynamic role in climate," says Seager.

He warns, however, that this moderation of global warming will not last forever. The water that is upwelling today has been deep down for many decades, and so has been kept cool. But at some point this water is bound to get warmer, diminishing the chilling effect.

The above article was written by Dr F. Pearce and is reproduced with permission from the New Scientist, 22 February 1997, No. 2070.

Geodetic Surveying
On an even keel

Tidal gauges are often placed, out of necessity, on unstable reclaimed land. So, how can we possibly manage to get accurate tidal information? In the following article, Steve M. Turner explains how he makes sure the measurements taken are accurate.

The tide gauge equipment being used in this Project has been designed with the special and rare quality of datum stability, and it is of sufficiently high resolution to monitor sea level with respect to a deep seated Tide Gauge Bench Mark (TGBM).

However, due to various factors, including technical, logistical and safety, the Project installations are situated on wharves and jetties in ports and harbours. Many of these ports and harbours are surrounded by reclaimed land. Consequently, there is no certainty about the stability of any structure that may be built in the area.

Therefore it is vital that a check be maintained on the stability of the tide gauge datum. That is, we must know whether or not the structure upon which the tide gauge is situated is stable. If it is not stable, we must be able to measure how much the structure is moving.

How do we do this?

Firstly, a series of deep-seated bench marks are established near the tide gauge. These are survey marks whose height is known and from which levelling and heighting can be carried out.

A major limitation to the study of sea-level changes over periods of many decades is the stability of the level datum. Unfortunately, in the past many of these bench marks have

been destroyed due to harbour redevelopments. To overcome this problem, and to also check against local subsidence, arrays of at least three deep bench marks have been placed at each Project site.

Unless you are a surveyor, it is most unlikely that you will ever see one of these marks!

The siting and spacing of these bench marks are site dependent. Ideally, one bench mark is placed within 100 metres of the tide gauge while the others are placed about 500 metres on either side. One of these bench marks, usually the closest mark, is designated the TGBM. It is against this mark that the stability of the tide gauge is checked.

Since these bench marks are in a highly reactive marine environment, they are made of marine-grade, stainless steel rod which is extremely resistant to corrosion. Furthermore, since the marks are needed for at least 20 years, great care is taken to place them in sites where they are least likely to suffer either human or natural disturbance. To minimise human disturbance, the mark is finished off below ground level and, wherever possible, the marks are placed away from private property.

Unless you are a surveyor, it is most unlikely that you will ever see one of these marks. Since they are in safe, unobtrusive areas and finished off below ground level, the only time you will see the mark is if you happen to be around while a surveyor is using it.

Rigid specifications are adhered to in the design and placement of these marks to prevent near surface soil movement from disturbing the mark. All the bench marks are driven to refusal. This is the point where it is physically impossible to drive the stainless steel rod any further into the ground. The depth of the bench marks varies widely throughout the region according to the type of soil in which the mark is being placed. In the coral atolls, many bench marks are less than 2 metres deep, while in other countries bench marks have been driven down more than 10 metres.

To assist in finding the mark, to help keep it clean and to aid in its preservation, a cast iron cover is placed over the top of the finished mark.

All the bench marks are placed in consultation with Government Lands and Survey personnel from each country. Recovery diagrams are drawn to assist in finding the marks and the relevant authorities endeavour to protect the marks from disturbance.

After placing the deep bench marks we use precise levelling to monitor the stability of the tide gauge in relation to the bench mark array. An explanation of how we do this, the equipment we use and results of the levelling will be included in future issues of this bulletin.

Mr S. M. Turner is based at the National Tidal Facility and is the Geodetic Expert of the South Pacific Sea Level and Climate Monitoring Project, Phase II.

One of the surveying equipment used by geodetic surveyors

Photo of Port Vila by Fatu Tauafiafi (SPREP)

Our ancestors held enormous amounts of knowledge about the oceans. Prof. G. R. South says we need to find some of that knowledge again if our oceans are to survive the increasing pressure placed upon them.

For the small island nations of the South Pacific, we do not have to emphasise the importance of the oceans. Since we first came to the South Pacific, ocean lore has been woven into the very fabric of our way of life, culture and languages. It could be argued, then, that Pacific Island people should be among the most knowledgeable and responsible with respect to the oceans. Certainly, many of our ancestors held enormous amounts of ocean knowledge and this was passed from generation to generation. Much of the knowledge had a basis that is compatible with scientific thinking within Western European tradition.

However, the direction of our development, particularly over the last two centuries, has had several significant effects. We have moved more and more to urbanised ways of life, and to the cash economy. Pressures on our limited marine resources have grown. We have enthusiastically embraced industrial/technology-dependent modes of operation, because they are convenient, comfortable, efficient and productive.

The net result has been that we have lost a lot of the traditional knowledge on which our daily lives depended in the past. We have allowed ourselves to act irresponsibly towards the marine environment, and made some of the same mistakes that have taken place in so-called developed countries; and this is happening in a technological context that makes the potential to damage our home quite appalling.

Now we are becoming increasingly aware of the critical effects that humans are having on the oceans, atmosphere and hence our future survival, world-wide. The importance of learning how to manage the oceans, rather than thoughtlessly abusing them, is a matter for our future survival. For these reasons, Pacific Islanders need to understand their ocean environment as a total, interdependent system, for it is through this knowledge and understanding that they will

be better able to manage their ocean inheritance in a sustainable and responsible way. They will also have the opportunity to become world leaders in ocean resources management.

When we talk of the need for responsible ocean resources management, we need to consider what resources we have. They may be generally itemised as follows:

- In the South Pacific, we have always relied on the oceans for much of our food.
- Increasingly we are turning to the oceans for non-living resources, such as sand and gravel.
- There is a large untapped potential awaiting development in deep sea minerals, energy and oil.
- Even in the age of air transport we also rely on the oceans for transport and communications.
- They are an important resource for the tourism industry, for which our spectacular beaches, beautiful islands and unbelievable biodiversity of living organisms on our coral reefs are a priceless resource.
- There is a rapidly growing body of knowledge about other ways of harnessing the oceans for our benefit, such as through aquaculture and ocean thermal energy conservation.

We are custodians of more than twelve per cent of the world's oceans. It is imperative that we become experts and leaders in the management of our oceans and their resources. Obviously, a good grasp of marine science will be an important step in this process.

References

UU111: Introduction to Marine Science for the Pacific Islands, Course Book One, Modules 1, 2 & 3, The University of the South Pacific, Suva, Fiji, 341pp.

Prof. G. R. Smith is the Director of the Marine Studies Programme at The University of the South Pacific, Suva, Fiji.

We have allowed ourselves to act irresponsibly towards the marine environment, and made some of the same mistakes that have taken place in so-called developed countries.

Do you know how smart our ancestors were?

According to ancient history, the greatest ocean voyagers of all times were the Polynesians. Dr T. H. Aung looks at some of their spectacular achievements.

With primitive ships and without compasses, the Polynesians in the centuries before 1000 AD located tiny islands spread over 14 million square kilometres of the Pacific Ocean, from New Zealand to Hawaii and Easter Island. The exact starting point of these migrations is not known, and is still a matter of controversy. Polynesians constructed elaborate double-hulled vessels. The largest of these had living quarters for people and animals and were used in transoceanic voyages to colonise the islands of the Pacific, including Hawaii.

The Micronesians colonised many of the larger islands of the western Pacific. We know very little about the seafaring traditions of these people, as there are no written records. In many cases, our information comes from the accounts of the first European explorers to contact them. There is ample evidence, however, that they were skilful sailors and navigators. One example of their navigational skills is the stick charts (see figure 5) used by Micronesians. Shells mark locations of islands, and the bamboo strips show wave patterns. Stars, cloud patterns and winds were also used by these skilled navigators to find their way between islands.

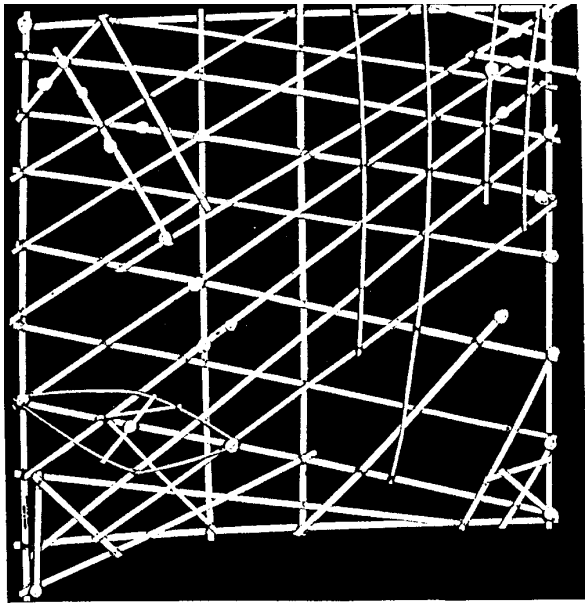


Figure 5: *Micronesians navigators used* ***stick charts*** *to sail the Pacific. Islands are represented by shells. Prevailing wave directions are shown by bamboos strips. Effects of islands on wave patterns are shown by the curved bamboo strips around the islands in the lower left*

Wasn't it amazing? They did not even have a compass for navigation. The kinds of oceanographic measuring instruments we are using nowadays were beyond their imagination. There was no computer, no mathematical equation for the dynamics of the ocean, no numerical modelling to predict various parameters in advance, no satellite image of the ocean, no proper knowledge of the Greenhouse effect or El Niño. However, they did very well in the Pacific Ocean by using their own methods. Today, we have more modern equipment, facilities and reading materials to learn the nature of the oceans in general—and to study marine science, in particular.

As was strongly highlighted by Professor Robin South, Director of Marine Studies Programme of the University of the South Pacific in the previous article, due to the growing population in the Pacific region, our responsibility to manage the ocean effectively is more important than ever. Our South Pacific Sea Level and Climate Monitoring Project is gaining more momentum in the region and more and more people are aware of the importance of the sea level and climate change issue. The Information and Training Component of the Project is also ready to disseminate the information and to train local personnel in this respect. The author firmly believes that if only one student from a school in the Pacific decides to study marine science as a major subject today, the number will multiply in the next few years. Accordingly, the future of the Pacific community will be brighter and the major objectives of the Pacific Project will also be achieved.

References

Gross, M. Grant 1987, *Oceanography: A View of the Earth*, 4th edn, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA, 406 pp.

Dr T. H. Aung is the Training Coordinator of the South Pacific Sea Level and Climate Monitoring Project, based at the National Tidal Facility, Flinders University of South Australia.

Deep concern from a little girl of Nauru

Uncle Than tries to answer the questions of Ana, a young reader from Nauru.

Since Phase II of the South Pacific Sea Level and Climate Monitoring Project began in mid-1995, this particular quarter (Jan–Mar 97) has had the most severe weather conditions, with tropical cyclones in the Pacific region. During this period, the Information and Training Component of the Project received many queries from different Pacific Island countries about the high tides, strong winds and bad weather. Among them, the most interesting letter was written by a 10-year-old girl, Ana, from Nauru.

Ana had come across our *Quarterly Newsletter*, either by chance or via her parents or teachers. Her sweet note, politely addressed to "Uncle Than", asked why weather was so bad in Nauru lately. She was fully aware of the high tides, strong winds and heavy rain and very scared of the possible sea-level rise and flood in Nauru. At the end of her letter, Ana said that she was praying everyday that a natural disaster would be avoided.

It is difficult indeed to explain such scientific problems to young children. However, we are very proud to have such questions from the children of the Pacific for the first time, and will try to explain the events as simply as possible.

The Spring tide period took place from 5–15 March, and sometimes high tides reached 2.5 metres (in Neap tide period in Nauru, highest water levels are around 1.5 metres). This means that, even under the normal circumstances, sea level would be about 1 metre higher during the Spring tide period. In addition, average winds on 5, 6, 7 and 14 March were as strong as 90 kilometres per hour, and some waters were dragged by the winds towards the coast. This made the water level even higher and the sea more choppy. At the same time, the atmospheric pressure was low (this also caused the strong winds in the area since winds generally blow from higher pressure to lower pressure) and sea level rose due to less pressure.

As all these effects (Spring tides, strong winds and low atmospheric pressure) were combined, very high sea levels resulted during that period. On top of that, tropical cyclone *Justin* was also looming in that area and heavy rain followed. We are monitoring seven oceanographic and atmospheric parameters everyday of the year. This helps us analyse the long-term climate change and sea-level variations in the South Pacific region and the results and the extreme events are reported regularly through our *Monthly Data Report*s and *Quarterly Newsletter*s.

Regarding the flood and Ana's prayers, we hope that Uncle Than's explanation is useful.

Developing an Integrated Coastal Management Plan

In the following article, Mr David Poihega of Niue and Mr Timoti Tangiruaine of Cook Islands present an outline of a water management programme, which falls under the umbrella of an ICM framework.

One of the most important concepts associated with climate change, sea-level rise and environment changes is coastal management and planning—also known as "Integrated Coastal Management" (ICM).

The training attachment course is designed to help Forum Governments use the sea-level rise and climatic data/information arising from this Project and others to help develop appropriate response options. One of these options is ICM, which involves diminishing and depleting resources in coastal towns/cities and islands with the hope of sustaining development in the face of some external pressure, such as climate change and sea-level rise. This process has been tested in many parts of the world, although the results so far are inconclusive.

Even so, majority of the participants want to know and understand this process better in the hope of applying it in their islands/village after the training attachment course. Given the limited time available for developing an ICM programme, the following framework may be useful.

Introduction

Pacific island countries are particularly vulnerable to climate change, variability and sea-level rise. With the concentration of population and development found along the coastal areas, any changes due to sea level as indicated in the South Pacific Sea Level and Climate Monitoring Project results will have significant and profound effects on the economies of these nations and therefore on the whole island management.

Most Pacific countries are low lying atoll nations. These are all threatened by sea-level changes. Inundation of outlying islands and even the loss of these lands may result in reduced exclusive economic zone rights. Global climate change may alter the distribution of zones of upwelling and may affect fisheries production. In addition, it may impact on vegetation while saline intrusion will adversely affect the freshwater resources. The increased frequency and intensity of cyclone and storm surges that may result from climate change and sea-level rise will have profound effects on both economies and the environment. Increased information on climate change and its effects on the Islands should be made available to the public so that appropriate response strategies can be developed and implemented. These response strategies may well be an integral part of coastal management plans for the atoll island countries in the Pacific region.

Water: a vital resource

Water is essential for the survival of all living things on this earth and for the natural cycles of the ecosystems.

During the early days of human development, it was assumed that there would always be an abundance of good quality water for everybody to use. However, it is very obvious today—through overpopulation, pollution, poorly planned developments, erosion, sea-level rise, excessive waste products (both toxic and non-toxic) being dumped on the land, in the air and in the ocean—that the quality of water has been severely contaminated. To compensate, we use expensive procedures to purify what was once available in its natural form. Even rain is not as pure as it once was due to the increased amount of impurities floating in our atmosphere.

To address these problems, new approaches to management must be developed. These should include traditional practices, experiences encountered through natural phenomena such as droughts and hurricanes, as well as procedures developed through science and technology.

Actions

- The management approach will require the full participation and commitment of the government, village councils, farmers, industrialists, the private sector and the whole community to achieve its stated goals.
- The most important factor is to support actions that will ensure the best quality and availability of water to all those who are dependent on it at all times.
- Human waste products often affect the quality of the water lens as it seeps through the ground. Also,

Photo by Eddie Rasmussen (Photo Centre, Samoa)

Water is essential for the survival of all living things on this earth and for the natural cycles of the ecosystems. (Falefa waterfall in Samoa.)

thermal expansion of the oceans causes sea-level rise which could force itself onto the fresh water lenses and also affect the quality of the water.

- Strategic research and monitoring programme should be an integral part of the Project because effective management of water resources should rely on the most relevant scientific information.

Purpose

- To provide a good quality water to all users and, at the same time, ensure no undesirable effects arise out of it that could harm the environment or the ecosystem.

- To provide an efficient management system that will integrate all necessary relevant sections whose actions will ensure the end product described above.

Water management

The goal of this component is to effectively manage the water supply system of Niue or Cook Islands through the use of a National Integrated Water Management Scheme.

A. Pollution from human activities on land

Goal

To minimise and control pollution resulting from human activities.

Actions

- Develop and implement appropriate watershed management plans to address deforestation, erosion through slash and burn methods and bulldozer clearing.
- Develop and implement appropriate domestic and industrial waste management programmes for solid sewage, toxic and other forms of waste resulting from human activities.
- Enforce regulations and practices that eliminate or minimise the release of toxic gases that could have an impact on water quality.
- Develop and implement a monitoring plan to keep track of the levels of waste that is dumped on the land and into the atmosphere.

B. Adverse effects of poorly planned developments

Goal

To develop and implement environmentally-friendly projects that will minimise the adverse effects of poorly planned developments.

Actions

- Conduct an EIA report before any kind of development takes place.

- Develop and enforce regulations regarding blasting or excavating near water bores or known natural spring outlets.
- Due to the porous nature of the soil, develop and enforce regulations on the farming of livestock in both the government and the private sector.
- Develop and enforce control plans that will minimise effects of human settlement.

C. Effects of destructive activities

Goal

To prevent habitat destruction and careless use of water.

Actions

- Develop and implement management plans to ensure that all leaky taps, pipes and water tanks are fixed or replaced.

- Develop and implement management plans for the maintenance and safe-keeping of the water pumps on the island to minimise the effects of vandalism and bushfires.
- Develop and implement management plans to minimise excessive excavating of coral limestone in one area or near water bores.
- Adopt and enforce regulations to prohibit the excessive use of toxic chemicals and poisons that could easily seep through to the water lenses.
- Develop and implement management plans to ensure the proper use of water so that *all* community members receive adequate water.

D. Cultural, social and economic issues

Goal

Include cultural, social and economic considerations into the integrated water management plan.

Actions

- Develop and implement an awareness programme for the village communities, schools, farmers, private sector, government departments, industrial sites and agriculture on the proper use of water.
- Ensure all water bores, pumps and reservoirs are on crown land so as to prevent land disputes. Also ensure

that these are not situated on any sacred or traditional historical sites.

- Develop a National Strategic Plan which will provide for the conservation and efficient use of the water and related ecosystems.
- Develop a sound economical management plan to be enacted if and when water must be paid for.

E. Catastrophic events

Goal

To minimise the effects of catastrophic events.

Actions

- Incorporate measures that would minimise the actual and potential effects of catastrophic events such as cyclones, droughts, climate change, sea-level rise, tsunamis and earthquakes.

Laws, policies, guidelines and enforcement

Based on the strength of data collected, a Water Management Act should be put in place to protect and also to provide guidelines. It should be reviewed periodically for improvement, with the provision of laws to support it and allow enforcement in the islands. Long-term funding guidelines are to be incorporated in the policies.

Monitoring for success and future needs

Measures and guidelines are to be used at monitoring stations at each community level for the correct documentation of data. Proper procedures should be followed to determine the success ratio of the project. From there we can forecast and make relatively accurate predictions of future occurrences which will help with the decisions that decision-makers and policy-makers have to make.

Measure of success

The success of this strategy will depend on the support of the whole community, from the individual to the various government sections. These must work together to accept the responsibilities and take positive steps towards implementing the necessary required measures. To bring this about, the human resource should be adequately trained to handle the tasks involved. The coordinated policies for the implementation of the project should be in place and with the institutions, funding and other resources to carry them out.

Budget

A sound and reasonable budget is required to get things moving and this should be presented to the House of Parliament which will vote on it.

Trial period

A trial period of at least 3 years should be adequate for data to be documented and analysed. This will determine areas that could be improved so that the strategy would be more streamlined and more efficient.

Compatible development choices could then be made which would be of great benefit to the community and thus enhance the efficiency of the project.

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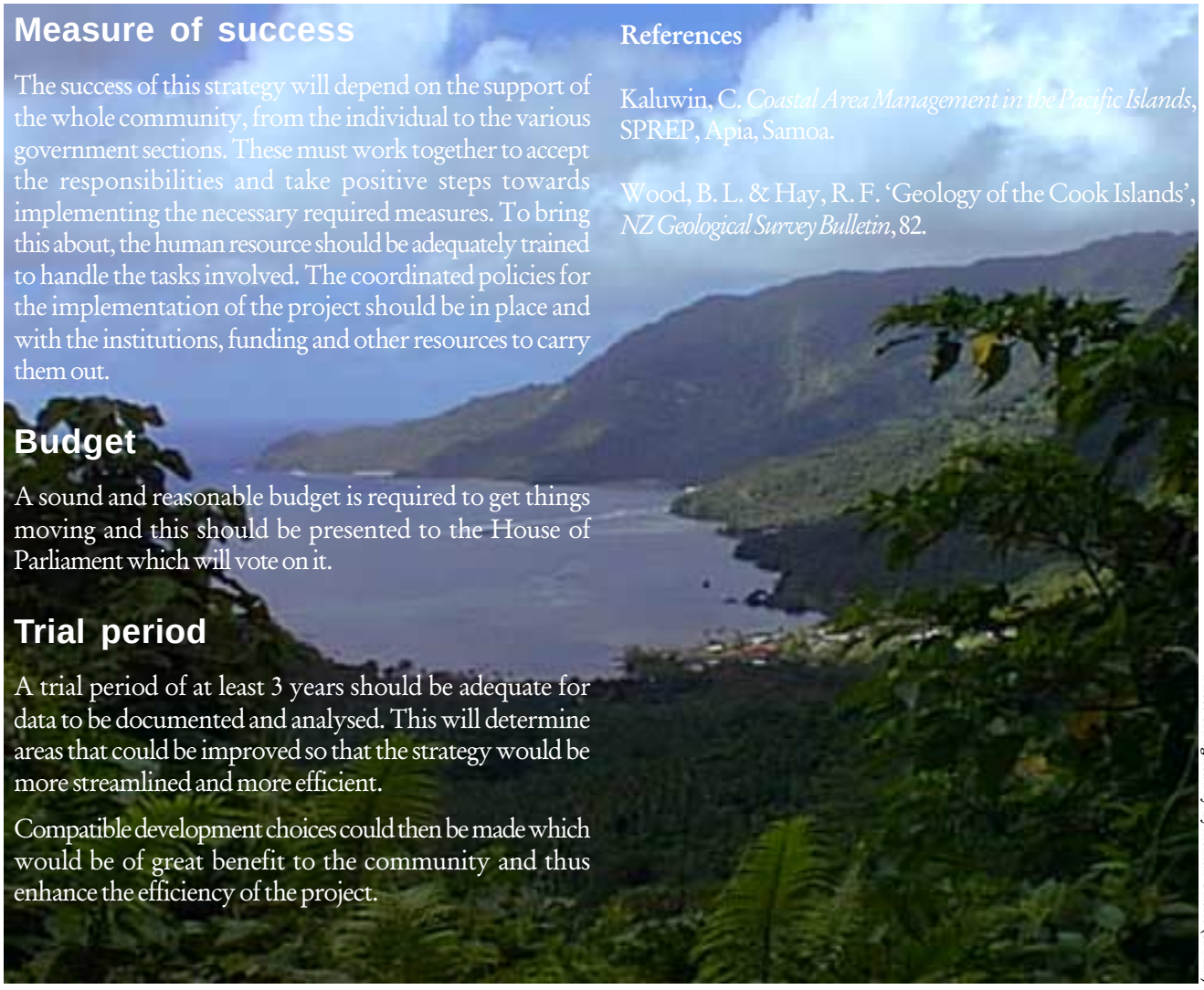

Photo of Fagaloa Bay by Komeri Onorio (SPREP)

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