National Tidal Facility

South Pacific Regional
Environment Programme

The South Pacific Sea Level and Climate Change Newsletter

Quarterly Newsletter Vol. 1, No. 3, April 1996

Project Up-date

During the last nine months of the South Pacific Sea Level and Climate Monitoring Project, Phase II, nine regular Monthly Data Reports [Vol II, No. 1-9] were issued to disseminate information on the development of the project and the status of data. In the new format of the Monthly Data Report for Phase II, only the time-series plots of the data for the current month with brief notes and comments on data, operational performance and some special events, and news about the project development during the month are included. Based on the responses from the readers thus far, it may be inferred that they are satisfied with the up-to-date information and its presentation. The Monthly Data Reports have been distributed to over one hundred mailing list addressees, including participants of the Workshop Round Four held in Adelaide on October 1995 and others who had expressed interest in receiving the publication.

As a result of the high demand from Niue and FSM for the *Tidal Predictions Booklet for other 11 Pacific Island Countries (PICs)*, the National Tidal Facility (NTF) has produced special *Tidal Predictions Booklet* for Niue and FSM based on the sea level data from other available sources. These tidal prediction booklets are special features of the *Information and Training Component* for the forum countries.

All eleven Sea Level and Climate Monitoring stations are in operation including Manus (PNG), from March 1996 providing wide coverage across the Pacific region.

The Sixth Annual Project Coordinating Committee (PCC) meeting was held at Majuro, Marshall Islands from 12-14 March 1996. The members of PCC, Mr. C Brock of *AusAID*; Professor T S Murty and Mr. W M Mitchell of NTF; Dr. R Brook of the Bureau of Meteorology, Melbourne; Professor R McLean of Australian Defence Force Academy; Dr. C Kaluwin of SPREP; Mr. I Lavea of South Pacific Forum Secretariat and Mr. J B Kabua, Mr J Chiba and Mr. P Peter of Marshall Islands drew the appropriate guidelines for the coming year.

The Project aims to help the PICs and their governments understand the scale and implications of changing sea levels and climate. Every effort is being made to introduce atmospheric and marine science curriculum to primary, secondary and tertiary level for all the PICs [See report at the back page 12]. As a part of Phase II which was approved by the PCC meeting, in its second year (which began on July 1996, there will be several short term attachments at NTF to train personnel from the PICs. Training will commence on the 18 November to 11 December 1996 at NTF, Flinders University.

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Contents

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AusAID

Depending on the requirements of the PICs, some specialised courses are carefully structured and are available:

1. *Data Management*
2. *Dynamics of Estuariesand Gulf*
3. *Extreme Sea Level Events*
4. *Forecasting of Storm Surges*
5. *Instrumentation*
6. *Modelling of Tides*
7. *NTF Information System*
8. *Oceanography for Pacific Islanders*
9. *Ocean-Atmosphere for Teachers*
10. *Surveying and Geodesy*
11. *Tides and Tidal Data Analysis*
12. *Tsunami Risk Assessment.*

To run these courses effectively, some entry requirements and pre-requisites will be applied. For more information on the short term attachment programme and details of the courses are available from NTF. The duration of the courses will vary from 2 to 8 weeks depending on the subject. NTF's academic and general staff will run the courses individually and jointly for others. All interested people from PICs are strongly encouraged to contact NTF for the short-term attachment programme, officially through their government channels.

The first joint teaching programme between NTF and Marine Science Programme of the University of the South Pacific (USP), successfully took place between 11-29 March 1996 at USP in Suva, Fiji. Training Officer of the Project, Dr Than Aung of NTF conducted several second year level lectures on part of the Physical Oceanography and Ocean Resource Management courses at USP together with a seminar to promote the Project. A very warm relationship between NTF and the Marine Science Programme has been established and it is expected that there will be many more joint teaching programmes to introduce the physical aspects of atmospheric and oceanographic sciences to the tertiary level in all PICs.

The South Pacific Regional Environment Programme (SPREP) and NTF held a two-week long Workshop on Curriculum Development on Sea Level and Climate Change in Apia, Western Samoa in June 1996. This is another special activity of the Information and Training Component of the Project for the education of children in the Pacific.

This issue contains an account of data interpretation in terms of regional sea level and climate change, numerical modelling on tides, geodetic survey and other related matters are discussed and highlighted. A special section, called *Education* especially for the children is also included. It is believed that the *Quarterly Newsletter* will interest a much wider audience than the Monthly Data Report. It will have widespread distribution and may be utilised as a source of further information dissemination by media, school teachers, and others in the Pacific region.

Notable Features of January, February and March Sea Level Data

***Dr J L Luick** is a Research Associate at the National Tidal Facility.*

The 1995/96 cyclone season was a relatively quiet one. The most destructive storm, Beti, did cause some damage in New Caledonia, with wind speeds of up to 90 knots estimated by the Fiji Meteorological Service. Within the region covered by the FMS three other storms reached cyclone or near-cyclone strength, but not while over land.

Sea level "residuals" - sea level measured by the SEAFRAME gauges, less predicted tides, are plotted in Figure 1, which show a number of interesting events.

- large amplitude fluctuations were observed in the Nauru data in February. These were not accompanied by wind gusts, which would be recorded and saved by the SEAFRAME anemometer as "peak gust" for each successive hour;
- sustained high sea levels at Nauru over a three-day period. During this period, the wind had a westerly component, therefore the sea level rise could be explained by simple setup of the water against the coast, as the gauge is on the western side of the island;
- a gradual but steady increase in sea level at Tuvalu, lasting over the first two months of the quarter. Sea level changes of this sort are normally accompanied by a warming surface layer (upper hundred meters or so), but this was not the case as far as the SEAFRAME water temperature sensor was concerned. Wind set-up is also possible here, the wind stick plots over the quarter [See the Monthly Data Reports] show a number of northwesterly episodes;
- a moderate storm surge was registered by the gauge at Tonga in January. This was accompanied by strong winds; and
- westerly winds also produced some enhanced sea levels at Lautoka, Fiji, although certainly nothing that could be considered dangerous.

The Manus Island, PNG gauge was finally re-commissioned after site-works were completed on a new wharf. The data resumed in March, and the PNG residuals will be added to the residuals plot in future Quarterly Bulletins.

For an analysis of the climate for this quarter, we refer to the *El Niño Southern Oscillation Advisory* issued by the

Climate Prediction Center (CPC), of the *National Centers for Environmental Prediction* in the U.S. Analysis of data from satellites, weather buoys, and other sources. The CPC advises that the "cold episode" (opposite of an El Niño) conditions have strengthened since the last quarter of 1995. For example, the central equatorial Pacific has cooled, and the convective activity in the same region was weakened. Within 5° of the equator, and 10° of the dateline, both sea surface temperatures and convective activity were well below normal in the month of February. However, the CPC reports that forecast for the coming quarter are mixed, depending on the type of forecast method. For those with access to the "World Wide Web", try browsing through http://nic.fb4.noaa.gov for further details.

The author would like to thank Graham Ward of the Fiji Meteorological Service for information concerning tropical cyclones during this quarter. Séana O'Brien of NTF produced the Sea Level Residuals plot.

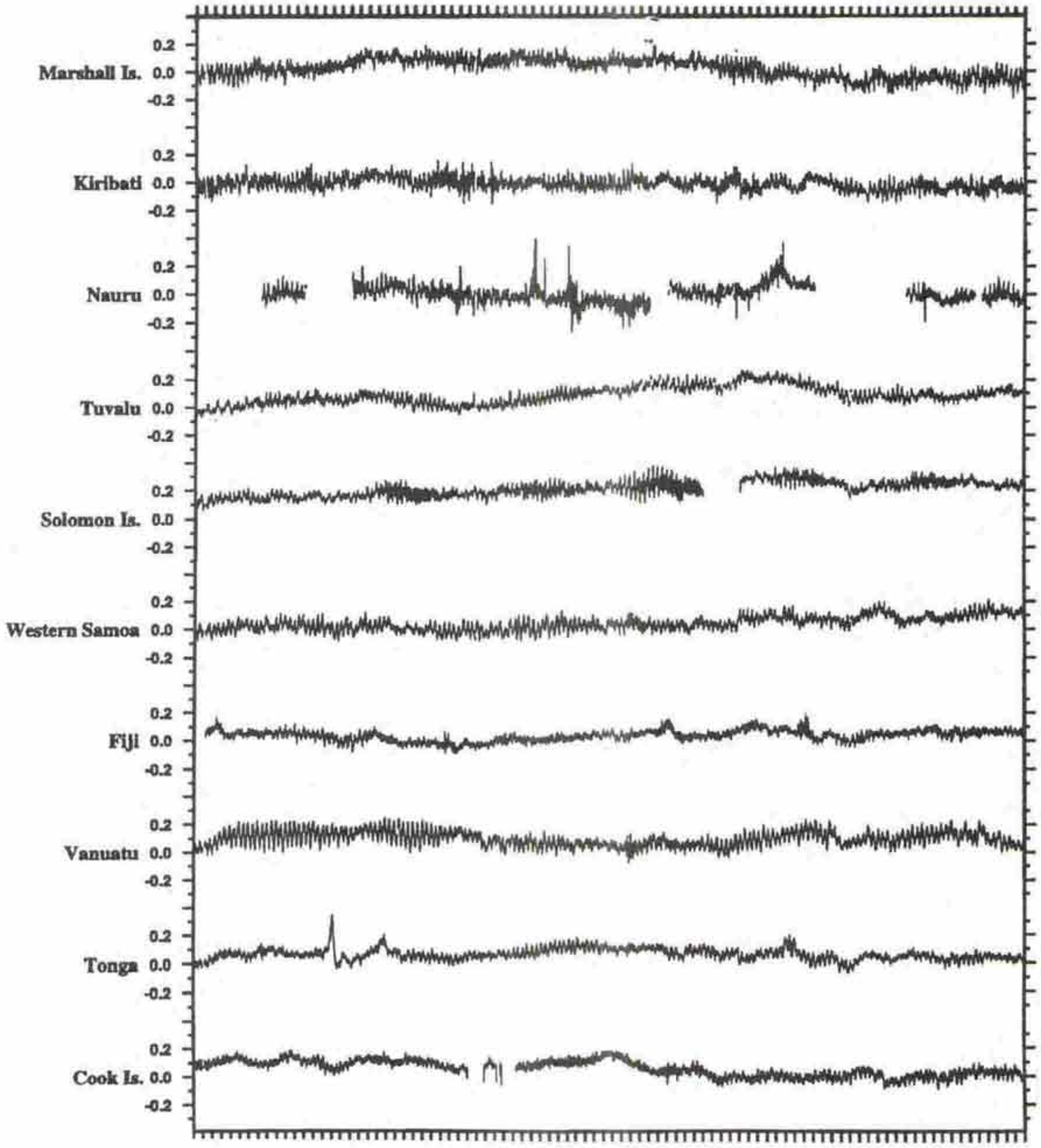


Figure 1. Sea Level Residuals

Storm Surge in Tonga

***Professor T S Murty** is the Director of National Tidal Facility and the Director of the South Pacific Sea Level and Climate Monitoring Project.*

During 15-16 January 1996, a minor storm surge occurred in Tonga and was recorded on the SEAFRAME (shown in Figure 2). The following information can be deduced from an examination of this figure.

Total residual or storm surge ~0.33 m.

Wind set-up (residual adjusted for the atmosp here pressure effect) ~0.18 m.

Inverse barometer effect = 0.33-0.18=0.15 m. Pressure drop ~15hPa (hectoPascals).

The wind set-up can be estimated from the following formula.

$$\frac{\partial\eta}{\partial\chi} = \frac{\rho_a C_D W^2}{\rho \quad g^D}$$

η	=	amplitude of the surge (m)
x	=	coordinate perpendicular to the shoreline
ρ	=	density of air (1.25 kg/m³)
ρ^a	=	density of sea water (1.026x10³ kg/m³)
C	=	drag coefficient (2.8 x 10^{-3}, dimensionless)
g^D	=	gravity (9.8 m/s)
D	=	average depth of the water (10 m)
W	=	wind speed (35 m/s)

Using these values, we get:

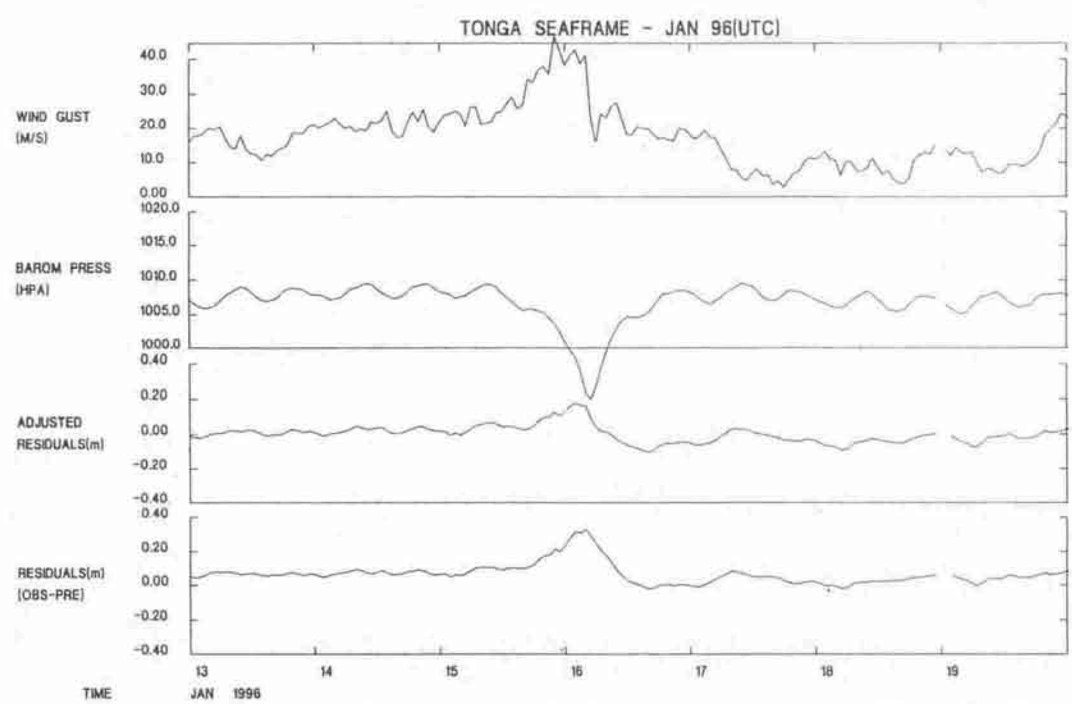
$$\frac{\partial\eta}{\partial\chi} = 0.42 \times 10^{-4}$$

Based on the information from NTF technicians and survey team, it is reasonable to assume that a fetch is ~5 km in the area and one can write:

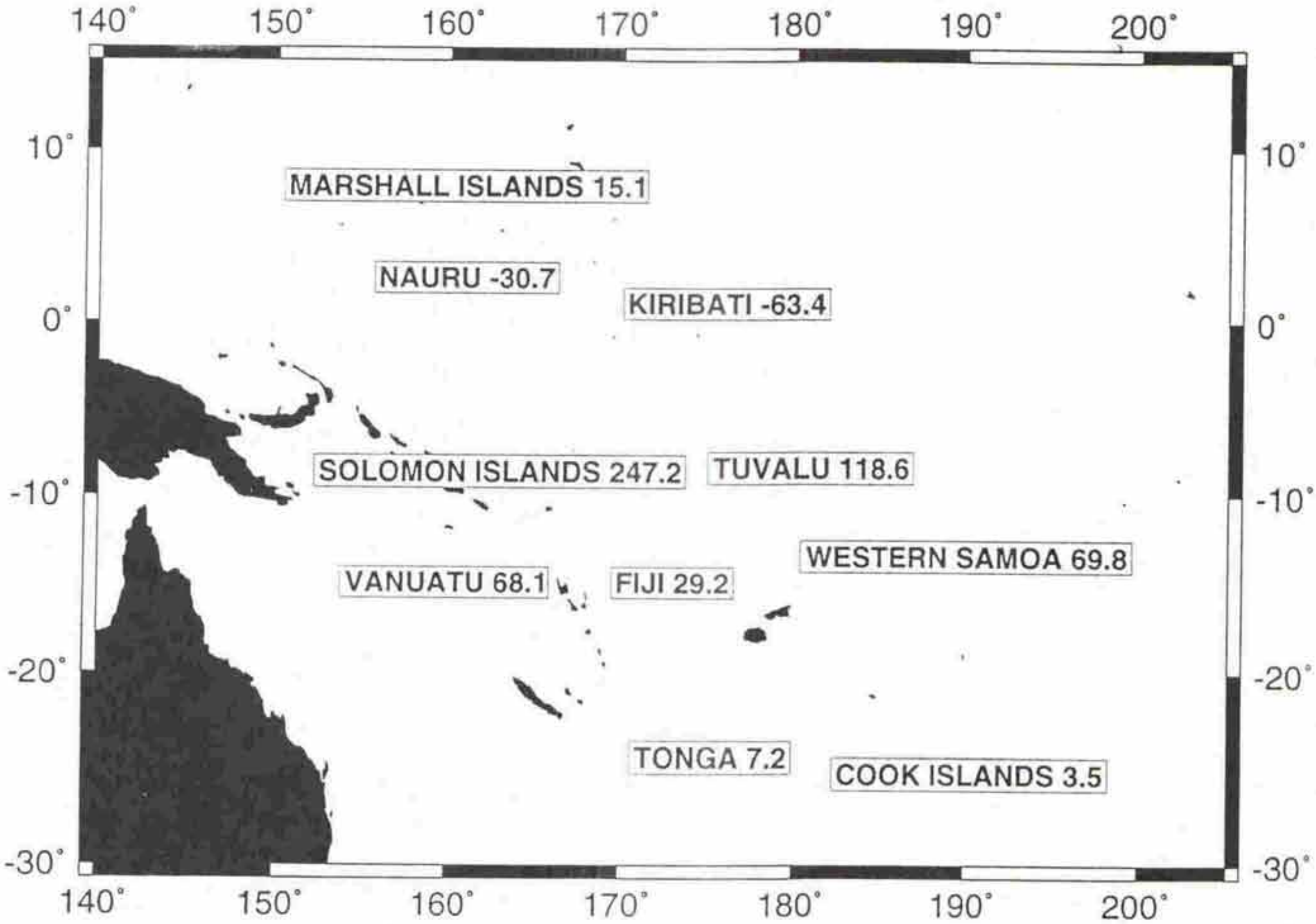
$$\eta = \frac{\partial\eta}{\partial\chi} = 0.42 \times 10^{-4} \times 5 \times 10^{3}\ m = 0.21\ m$$

The amplitude of the wind set-up computed from the simple formula is 0.21 m which compares reasonably well with the observed wind set-up of 0.18 m. A numerical model will yield a better agreement. Finite-element numerical models will be developed through the short term attachment training programmes at NTF in November - December 1996.

Figure (2)



RELATIVE SEA LEVEL CHANGE (mm) FROM SEAFRAME GAUGES FROM START DATE TO MARCH 1996



Station	Start Date	
Papua New Guinea	9/94	Insufficient data for trend calculation
Marshall Islands	5/93	
Nauru	7/93	
Kiribati	12/92	
Solomon Islands	7/94	
Tuvalu	3/93	
Vanuatu	1/93	
Fiji	10/92	
Western Samoa	2/93	
Tonga	1/93	
Cook Islands	2/93	

NOTE THAT THIS OBSERVED RELATIVE SEA LEVEL CHANGE INCLUDES NATURAL VARIABILITY, EVENTS SUCH AS EL NINO AND EFFECTS DUE TO SEVERAL OTHER ATMOSPHERIC AND OCEANOGRAPHIC PROCESSES. TO SEPARATE THE GREEN-HOUSE EFFECT SIGNAL, THE DATA SET MUST BE AT LEAST TWENTY YEARS LONG.

Computer Models of Tides

Dr R F Henry *is the Head of Research at the National Tidal Facility and the Research Scientist for the South Pacific Sea Level and Climate Monitoring Project.*

After sea level has been measured with a tide gauge in a harbour or similar site for a year or more, it is possible to predict very accurately what height the tide will be at that place at any particular time, even years ahead. This is why it is possible to publish tide tables at the beginning of each year. Like calendars, they are even more useful before the event than after.

Knowing the tide at a gauge site usually gives us a fair idea of what the tide will do even some distance away from the gauge, provided that the stretch of coast in question is not complicated by major features such as estuaries, nearby islands, and so on. If there is another reliable gauge not too far along the coast, say 100 to 200 km away, then we can work out the tide fairly accurately at any place between the two gauges by a type of calculation known as interpolation.

Tidal rise and fall of sea level at the coast, which is the only place we usually pay attention to it, is a side-effect of the gravitational pull of the sun and moon on the world's oceans. Until recently, our knowledge of tidal behaviour at any substantial distance from land was theoretical, backed by only a few measurements from special deep-sea tide gauges. Over the greater part of the oceans, it was quite uncertain whether the theoretical estimates of the tides were correct or otherwise.

In the last two years, this situation has changed completely by the Topex/Poseidon project, a joint American-French satellite which can measure sea surface height to an accuracy of better than 5 cm. Its orbit is regulated carefully so that the satellite follows the same track over the earth's surface at fixed intervals. The satellite repeatedly measure sea surface height at a set of several thousand locations covering most of the oceans. From these measurements, it is possible to work out fairly accurately the rise or fall of the sea surface due to tides at any spot in the ocean for at least a century ahead.

The lengthy calculations required to convert the satellite observations into tidal predictions also need fairly detailed information about ocean depth. Unfortunately, near land the ocean depth often varies-considerably over short distances and even the largest modern computers cannot handle all the depth information which would be needed to work out tidal behaviour accurately near land from satellite observations. So, although the satellite provides tidal information everywhere in the ocean, the quality of this information is quite poor near land, where it would be of most practical value.

The way around this problem is to use a computer model of a limited area of ocean around the coastal part where accurate information about the tide is required. Provided that the area chosen for the model extends into deep water, tidal behaviour all around the outer edges of the model can be worked out accurately from the satellite measurements. This, together with details about water depths in the model area and well-established knowledge about the dynamics of tidal motion (which can be summed up mathematically in tidal equations), form most of the essential ingredients for a computer model of tides in the area of interest.

The remaining step needed in preparing a computer model is to decide where to calculate the rise and fall of sea level. This has to be done at points all over the model area, and these points must not be too far apart, otherwise the tides computed will be inaccurate. In particular, the points need to be more closely spaced in shallow areas, especially near coasts, where the tide varies with distance much more than it does in deeper water.

Figure 4 shows a network of points suitable for computing tides for the whole Forum area. In the diagram, neighbouring points have been joined by straight lines, not only to make the locations of the points more obvious, but to show that the set of computation points in effect divides the whole area of the model into a large number of small triangular elements. The computations done in a tidal model are roughly equivalent to treating each element as a triangular box filled to a certain height with water and then calculating how much water is flowing in or out of each box. Of course, the height of water in each box increases or decrease as water flows in or out of it. The flow between neighbouring boxes depends on the differences in the heights of water in the boxes, the exact relationship between the amount of flow and the differences in height can be calculated using well-known physical laws of fluid flow and are included in the computer programme which constitutes the model.

The calculation of all the flows between boxes and the related changing heights of water in all the boxes is done repeatedly at short intervals over the whole length of time for which information about the tide is required. If the information about the tidal heights around the edges of the model is accurate, as it usually is when derived from the Topex/Poseidon satellite observations, then the heights and flows calculated in all the boxes inside the model generally give an accurate picture of tidal behaviour throughout the area. Basically, the model calculations give the next best thing to the observations which could be gathered (only at huge cost) by putting a tide gauge and current meter out at sea for every triangle used in the computer model.

Once a tidal model has been prepared for some coastal area, it can provide a computed record of the tidal variation in sea level at or very close to any location on the coast or at sea. It is routine procedure to compare any records available from actual tide gauges or current meters with corresponding simulated records from the model. Any discrepancies found may suggest ways in which the model can be improved. For instance, it may be obvious that some water depths used in the model are out of date, as is often the case in estuaries subject to silting and erosion. If model results agree well with available tide gauge or current meter measurements, then it is fairly safe to conclude that the model is giving reliable estimates of tidal heights and water currents.

Since model results come in numerical form, it is simple to present them in a variety of ways. Tide tables may be calculated for any location or charts showing useful information for the whole area can be prepared. For instance, Figure 4, which is based on results from a computer model, shows how the estimated maximum tidal range (increase in water level between low tide and high tide) differs from place to place in the Fiji area.

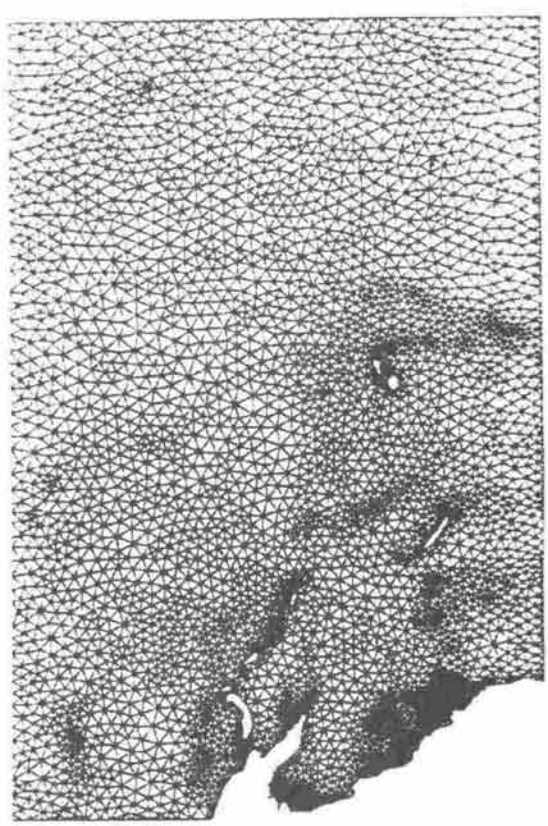


Figure 3 Grid for computer model of Forum area

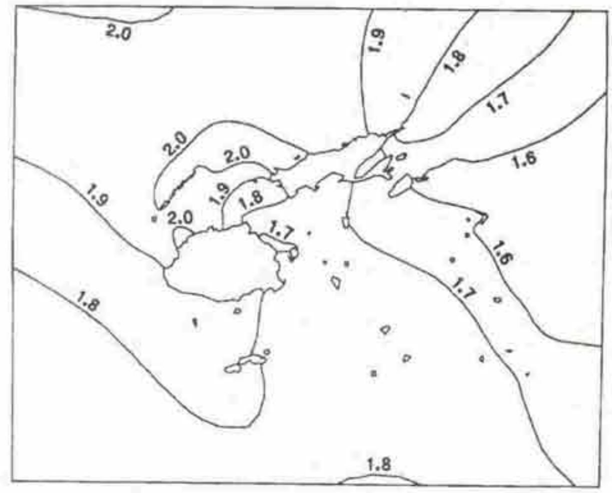


Figure 4 Estimated maximum tidal range for Fiji area (metres)

Geodetic Survey

Mr S M Turner is a Geodetic Expert in NTF and as a key person in the project, he has been to all PICs for geodetic survey and he has become an Islander now.

The vital role of a geodetic survey in monitoring the stability of tide gauges was outlined in our last issue. The following four-phase geodetic survey, which aims to monitor tide gauge stability with respect to nearby bench marks, is being progressively implemented throughout the Project area.

Phase 1

Although the tide gauge exhibits a high degree of datum stability, it is essential that the datum stability be checked periodically by a programme of precise levelling to an array of deep-seated bench marks located close to the tide gauge.

While every precaution is taken to ensure the safety of the tide gauges the gauge datum may be affected by natural phenomena such as cyclones and storm surges, by movement of the gauge due to settlement or port activities or from interference by unauthorised persons.

A regular programme of precise differential levelling is undertaken between the bench marks and the tide gauge. To help maintain a uniformity of datums, bench marks used by local authorities for the monitoring of other, less accurate tide gauges in the area are also levelled wherever possible.

Phase 2

The precise differential levelling done in Phase 1 monitors the stability of the tide gauge in relation to the bench marks in the coastal zone of the island. However, it does not determine whether the coastal zone is moving in relation to the main body of the island.

Wherever possible, a second array of 3-4 bench marks has been established approximately 10 kilometres inland from the tide gauge in either stable ground or, more preferably, bedrock. Precise differential levelling of the inland array of bench marks is done in conjunction with the survey of the coastal bench mark array. These surveys monitor the relative stability of the two arrays in isolation.

Global Positioning System (GPS) observations or precise differential levelling are carried out between the arrays in conjunction with the levelling of the coastal and inland arrays. The GPS observations are done simultaneously with the levelling. Local survey personnel actively participate in the field surveys and are being progressively trained in all aspects of both precise levelling and GPS observations.

Phase 3

Phases 1 and 2 help to establish the relative difference between sea level and tectonic motions at one point on the main island in each country (except in Papua New Guinea where the station is situated in the Admiralty Island group). The magnitude of tectonic movements in the Pacific can vary over small distances between islands whereas sea level signals over similar distances are assumed to be the same. Of specific importance to the people of other islands in each nation group are the movements of sea level relative to their island.

Subject to funding, bench marks will be installed in these other major islands and regular GPS connections made back to the main island. From these observations relative movement between the main island and the outer islands can be deduced. Similarly, trends in sea level can also be deduced for these outer islands. This data will be of vital importance to the South Pacific Forum countries for future use in climate impact evaluation.

Phase 4

The sea level movements this Project is aiming to detect are small and require the use of the latest geodetic techniques. Of importance to the understanding of sea level and its variance in a regional sense is the detection of small vertical movement over large distances.

Subject to funding, it is proposed to carry out inter-nation GPS observations between bench marks near each SEAFRAME station. Furthermore, it is proposed to tie this network to core GPS stations established by the International GPS Geodynamics Service under the auspices of the International Union of Geodesy and Geophysics.

There are two advantages to tying the network to the core stations. Firstly, the network will be surrounded by a series of stations with highly accurate geocentric coordinates. These stations can be used in an adjustment to produce the best possible results for all GPS-observed stations within the Project area. Secondly, this will relate the tectonically active South Pacific area to Australia, which is more tectonically stable and where sea level is also being monitored by a complimentary project.

An explanation of bench marks and their importance to this Project, the equipment and techniques used and progressive results of the geodetic survey will be included in future issues of this bulletin.

Children's Education

Why are the Sky and Oceans Blue?
by T S Murty

Children, you must have wondered sometimes why the sky and the water in the oceans look blue. I will try to explain in simple terms the reasons for this. Electromagnetic spectrum refers to a combination of waves of all types. This includes radio waves, x-rays, gamma rays, and also a type of wave which we can see. This is called the visible spectrum. Figure 5 shows the electro-magnetic spectrum in a very simple manner. The visible portion is only a very small part of the whole spectrum. On the long wave length end of the visible spectrum is the red colour and on the short wave length end is the violet.

AM FM TV   Red Violet   GAMMA RAYS

LONG RADIO WAVES | SHORT RADIO WAVES | INFRA RED | ULTRA VIOLET | X-RAYS

VISIBLE

LONG WAVE LENGTHS   SHORT WAVE LENGTH

FIG 5 Electro-magnetic spectrum shown in an extremely simplified manner (not drawn to scale)

On the long wave length side of the visible spectrum is infra-red and on the short wave length side is ultra violet, but we cannot see these.

In the visible part, starting on the long wave length side, there are a total of seven colours in the following order: red, orange, yellow, green, blue, indigo and violet. These seven colours together make up the white light. If you pass white light through a prism, it breaks up into these seven colours. In nature, water droplets in the clouds can act as a prism and this results in a rainbow.

People have made up words or sentences to remember the order of these colours.

ROYGBIV = Read Over Your Good Books In Vacation.
If you start on the other side
VIBGYOR

Now, let us talk about the colour of the sky. The sky is blue when the air is dusty, but the colour changes to white when ice crystals grow in the atmosphere. After a rainstorm has washed out the dust in the atmosphere, we see a dark blue colour. The air molecules produce the blue colour of the sky.

In the 19th century a famous British scientist, Lord Rayleigh, explained that the air molecules scatter more light in the blue colour part of the visible spectrum than any other colour and this is the reason why the sky is blue. If there were no light scattering, we would see the sun, moon and stars against a black sky. From the satellites, astronauts have verified that once we are above the atmosphere, the sky is black and not blue.

Similarly, in the ocean, the water molecules scatter blue light much more than any other colour and this is the reason the ocean also looks blue. However, due to biological productivity, the waters near the coastline could look green, yellow or even red.

The Greenhouse Monster

Miss Séana O'Brien *is the Officer for SEAFRAME Data Analysis for the South Pacific Sea Level and Climate Monitoring Project at NTF.*

Once upon a time there was a little tiny monster called the Greenhouse Effect, but all its friends called it Bogus, so we shall call it that too.

Bogus loved to eat gases, its favourite were carbon dioxide, methane, nitrous oxide and chlorofluorocarbon. Now none of these gases sound very good to you and I, but Bogus just gobbled them up whenever it could get its hands on them.

When Bogus was just a young monster, there wasn't much of these gases around, and besides, Bogus was always out and about riding his bike with its friends, swimming in the oceans, climbing trees, all the things that young monsters do.

As time went by, people on Earth began to make more and more of these gases. They had many animals for meat and wool that made methane gas; they burned lots of coal, oil and gas (to keep themselves warm and make their electricity), which makes nitrous oxide and carbon dioxide; they used fridges and spray cans and air conditioners and fire extinguishers that make chloroflurocarbons.

Now, the more people made, the more Bogus would eat, and the more Bogus ate the bigger Bogus got. And the bigger it got, the less time it spent riding its bike and playing with its friends. Bogus got to the stage where it was so big that it just sat on his bottom gobbling up its favourite gases.

Bogus' friends all came around to invite it to picnics, dances and parties but Bogus just sat there eating - and there was certainly lots of gas to eat. Perhaps if the people hadn't made so much gas, Bogus wouldn't have gotten so big, but they didn't think of that.

During one very hot day, Bogus' friends all came round to invite it to go swimming in the ocean. The sun was nice and warm so Bogus decided it would stop eating and go for a swim, it waddled on down to the beach with its friends and plopped into the water. All round the world the level of the ocean got a little bit higher - perhaps you have noticed this happening when you get in your bath, it is just like that.

Bogus by this stage had become so big that once it sat down in the sea, it couldn't get back up again. Its friends all heaved and strained, pushing and pulling, but they just couldn't budge Bogus.

Well, soon Bogus began to get cold, sitting there in the water with the sun going down, and its friends were getting worried, thinking Bogus might freeze to death. They thought and thought, and then one of them had a brilliant idea. They would all go and get their heaters and bring them back to keep Bogus warm. Off they went and in no time at all Bogus was as warm as toast, and happily began munching on gas again.

Well, Bogus is still there today, happily eating and getting bigger and bigger, making the water get higher and higher - for you know that if your big brother sits in the bath he can make the water rise more than you because he is bigger. The heaters are still going to keep Bogus warm, making all the air in the world get warmer and warmer.

How are we affecting the Earth's atmosphere?

by Dr. C. Kaluwin

Since large scale agriculture and industry began some 150 years ago, the level of carbon dioxide in the atmosphere has increased by about 25 per cent. Other gases that have increased because of our growing population and need for more energy and food are methane, chlorofuorocarbons, nitrous oxide and ozone. Evidence comes from direct measurements since about 1958 at a range of global atmospheric monitoring stations like the one at Cape Grim in Tasmania. Other evidence comes from the analysis of air bubbles trapped in ice cores from the Antarctic (the Vostok ice core shows 160,000 years of the Earth's atmospheric history). Because we know that our present climate is due to the natural effect of the "greenhouse gases" intercepting outgoing infrared radiation, we predict that an increase in these gases will cause global warming.

Almost all the current increase in carbon dioxide is due to burning fossil fuels but deforestation is another contributor.

The methane increase is probably caused by increasing agricultural activity around the world. Rice fields and ruminant animals like cattle and sheep produce methane and both these agricultural sources have doubled since World War II as the world's population and hence food needs have increased. Methane also comes from garbage dumps, termite mounds, coal mines, oil fields and burning forest debris.

Activities

2.1 The amounts of greenhouse gases in the global atmosphere are clearly changing.

What to do!

Use the figures from Cape Grim below to show how carbon dioxide and CFC-11 have changed in recent years. On graph paper, plot time on the horizontal axis and gas concentration on the vertical axis (the figures are the mean for June each year). Carbon dioxide (CO_2) is measured in parts per million (ppm). CFC-11 is measured in parts per trillion (ppt).

From your graph, estimate what the values might be in 10 years time.

Year	CO_2 ppm ppt	CFC-11
1979	333.68	154.5
1980	335.55	166.3
1981	337.14	174.8
1982	338.38	182.9
1983	340.25	191.1
1984	341.82	199.9
1985	343.18	209.3
1986	344.26	220.6
1987	345.99	230.5
1988	247.96	244.5

2.2 Carbon dioxide is easy to make and it is also easy to test for its presence.

What you need!

Soft drink bottle, balloon, baking soda, vinegar, straw, limewater, dish

What to do!

Blow up the balloon a few times and let it down. Place 3 teaspoons fo baking soda in the balloon. Put about 2 cm of vinegar in the bottle. Attach the balloon to the top of the bottle. Tip the balloon up so that the baking soda falls into the vinegar. A chemical reaction between the baking soda and the vinegar will produce carbon dioxide. Hold the balloon on tight to trap the gas.

Once the balloon is full of carbon dioxide you are ready to test for its presence. Pour fresh limewater into the dish. Place the straw in the mouth of the balloon that is now full of the gas. Slowly bubble the gas through the limewater. The limewater will react with the carbon dioxide. What happens to the limewater?

2.3 All animals, including humans, exhale carbon Dioxide as waste.

What you need!

Drinking straw, dish, limewater

What to do!

Pour fresh limewater into the dish. Slowly blow through the straw into the limewater. What happens to the limewater? How does this compare to the results of vour test for carbon dioxide?

Book Reviews

by L. Dosung

Proceedings of the Ocean & Atmosphere Pacific International Conference 23-27 October 1995, Adelaide, South Australia.

This book as the title points out is a proceeding of the conference. The conference was organised by the National Tidal Facility at the Flinders University of South Australia to mark the establishment of II SEAFRAME sea level monitoring stations in the Pacific Forum island countries and highlights scientific results obtained during the South Pacific Sea Level and Climate Monitoring Project. The proceedings consist of 70 papers and keynote addresses from scientists and government officials.

For groups and individuals generally interested in climate change and sea level rise in the Pacific, this book presents detailed and illustrious reports from scientists involved in the field from around the Pacific.

Aung, Than H. (ed.)

Proceedings of the Ocean & Atmosphere Pacific International Conference 23 - 27 October 1995, Adelaide, South Australia - Adelaide: National Tidal Facility, 1996. v + 417p.

Climate change and sea level rise in the South Pacific Region: proceedings of the Second SPREP Meeting, Noumea, New Caledonia 6 -10 April 1992

This is a proceeding of the Second SPREP Meeting on Climate Change and Sea Level Rise. There are different projects and programmes involved in sea level and climate change issues in the region and this proceedings bring together results of findings and activities of different projects and programmes.

These reports cover impact studies on different habitats both marine and land based; and reports of sea level and climate variability in various parts of the Pacific region; and also covers reports of initiatives taken by Australia and New Zealand in research and monitoring of sea level rise and climate change in the Pacific. The reports present in good detail, climate change and sea level rise in different parts of the region and provide many good references to reading materials on the subject.

John E.Hay and Chalapan Kaluwin (eds.)

Climate change and sea level rise in the South Pacific region: proceedings of the Second SPREP Meeting, Noumea, New Caledonia 6-10 April, 1992. - Apia: SPREP, 1993. vi + 238p. ISBN: 982-04-0054-6

Climate change Calendar of Meetings

1. WMO/ICSU/UNEP
   5th Interantional Carbon Dioxide Conference
   Carins, Queensland, Australia
   8-12 September 1997.
   P.N.Holper,CSIRO, Australia
   Fax (03) 92939-4553.

2. IPCC Working Group I- Sixth Session & 12 th Session of the IPCC.
   Mexico City,10-13 September 1996.
   Contact IPCC Secretariat- Fax (4122) 733 1270.

The WGI will approve the draft Greenhouse Gas inventory methodology and the 6th session will elect the new chairman for the IPCC and review the continuing work programme of the IPCC.

3. Asia Pacific Climate Change Conference
   4-9 November 1996
   Suva, Fiji
   Funded by the Government of Japan
   Organised by University of South Pacific and SPREP.

4. World Meteorological Organisation (WMO) RA-V
   Tropical Cyclone Committee, 6th session.
   Honolulu,Hawaii.
   7-17 October 1996.

5. Health Effects of Ozone Depletion Conference
   9-11 September, 1996
   Hobart, Tasmania.
   For more information contact -Conference Scretariat
   Fax 03- 9417 7049.

6. First SPARC General Assembly (Stratospheric Processes And their Role in Climate)
   2-6 December 1996.
   Melbourne Australia.
   Contact : David Karoly, Email: sparc96@vortex.shm.monash.edu.au

Announcements of Upcoming Meetings

1. **The Second Australian Conference on Agricultural Meteorology** will be held 1-4 October 1996 in Brisbane, Queensland. Contact Secretariat on Phone (613) 9669-4401.

2. **The 5th Annual Meeting of the North Pacific Marine Science Organisation** will be held 11-20 October 1996, in Nanaimo, BC, Canada. Contact the Secretariat. Phone (1604) 363-6366, Fax (1604) 363-6827.

REPORTS

1. Centre for Global Environment Research, 1995. **Proceedings of the Tsukuba Global Carbon Cycle Workshop.** Available free from the Centre for Global Environmental Research. National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki, 305, Japan. Free.

2. Climate Convention Information Exchange Programme, 1996. **Update to the CC:INFO Report**. Climate Change Secretariat (UNFCCC). Palais des Nations,

3. Greenlife Society, 1996. **The UN Framework Convention on Climate Change and the Future of Small Island States.** Greenlife Society North America, 29 E. Wilson ST. Suite 202, Madison, WI 53703. US$12 (Plus $2 shipping for overseas).

4. International Energy Agency. Greenhouse Gas R & D Programme, 1995. **Ocean Storage of CO2-Workshop 1: Ocean Circulation**. IEA Greenhouse Gas R & D Programme, CRE Group Ltd., Stoke Orchard, Cheltenham, Glos GL52 4RZ, UK.

5. Kluge, H., Bittner, A. and Hohnhoiz, J.H., 1995. **Environmental Management in Developing Countries**. Institut fur Wissenschaftliche Zusammenarbeit, Vogtshaldenstrasse 24, 72074 Tubingen, Germany.

6. Orlans, C. and Skumanich, M., 1995. **The Population-Environment Connection: What does it mean for Environmental Policy?** Battelle Seattle Research Centre, P.O.Box 5395, Seattle, WA 98105-5428. CH-1211 Geneva 10, Switzerland.

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