National Tidal Facility

South Pacific Regional Environment Programme

The South Pacific Sea Level and Climate Change Newsletter

Quarterly Newsletter Vol. 1, No. 5, October 1996

Mr S. Douangphoumy of NTF explaining the Real Time Display to the Prime Minister of Australia, Rt. Hon. John Howard during the Twenty-seventh Forum Meeting in Majuro, Marshall Islands.

Project Update

During 1996, the South Pacific Sea Level and Climate Monitoring Project, Phase II, has issued four Quarterly Newsletters albeit with some delay. The main contributors being the staff of the National Tidal Facility (NTF) and South Pacific Regional Environment Programme (SPREP). This issue of the newsletter focusses on different perspectives and views on the sea level and climate change issue, with new articles and other news from our Pacific friends in general.

In addition to the newsletter, 15 regular Monthly Data Reports (Vol II, Nos 1-15) were issued by the *Information and Training Component* of the Project to disseminate information on the development of the Project and the status of acquired data. In the new format of the Monthly Data Report for Phase II, only

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time-series plots of the data for the current month with brief notes and comments, operational performance and special events, and news about the Project during the month are included. The Monthly Data Reports for the second phase of the Project have been distributed to nearly two hundred mailing list addressees including participants that attended the Round Four Workshop in Adelaide in October 1995; the Curriculum Writing Workshop in Apia in June 1996; and others.

The third quarter of 1996 was a busy one for the Project's geodetic survey team in which Mr Steve Turner and Mr Brian Ratcliff were involved. July saw the completion of a four-week field trip to Western Samoa and the Cook Islands where Global Positioning System (GPS) observations were carried out for the first time. During September, a two-week visit was made to Kiribati and Nauru and the bench mark arrays were levelled for the fourth time. Further relative movements between the SEAFRAME sensor bench mark and the Tide Gauge Bench Mark was measured in Western Samoa and the Cook Islands. Measurement in Kiribati and Nauru showed no detectable movements.

The Project's technician team was also equally busy during this quarter. Mr Allan Suskin and Mr Peter Kearney visited Fiji, Marshall Islands, Kiribati and Tuvalu in August and September. A temperature sensor was replaced in Lautoka station (Fiji) and a full calibration and maintenance service was performed in Majuro (Marshall Islands), Tarawa (Kiribati) and Tuvalu. In addition to the usual maintenance service, a "Real-Time Display" of the Project data on PCs was also installed at Majuro Weather Service Office and Tuvalu Meteorological Service Office. As a result of a request by the Ministry of Foreign Affairs of Marshall Islands, a temporary "Real-Time Display" was installed at the Capital Building for the Twenty-seventh South Pacific Forum.

While the Computing and Data Management team as well as the Administration group of the Project were busy working behind the scene, the Information and Training Component of the Project was carrying out substantive promotional work in the Pacific region. Some of the activities included the following: the government of Vanuatu invited the Training Officer of the Project, Dr T. Aung, to participate in the *National Science Teachers'-* Conference in Santo, Vanuatu where he conducted two two-hour sessions on sea level and climate change issues. He was also interviewed by the local radio station for an Education Programme. In Suva Fiji, he took part in the *Fifth Regional Remote Sensing Seminar on Tropical Eco-Systems* as a member of the Marine Studies Programme team for the University of the South Pacific (USP). During the visit, Dr Aung was invited by the Representative of AusAID (First Secretary of Australian Embassy) to give a promotional talk on the activities of the Project during the luncheon of *Rotary Club of Suva-North*. He also assisted the Department of Education in Suva, in updating the *Basic Science Book* in Fiji, by introducing and contributing the science of sea level and climate change into the text.

NTF Computer Specialist, Mr Souk Douangphoumy, Drs T. Aung and C. Kaluwin (SPREP) took part in the Twenty-seventh South Pacific Forum as members of the SPREP delegation. During the meeting, general information and activities of the Project were displayed near the main entrance to the meeting venue. Brochures, booklets, fact sheets, monthly data reports, newsletter, colourful Pacific Surface Currents Charts, Tidal Predictions booklet for 1997 and Tidal Calendar for 1997 for 13 Pacific countries were also distributed to the Heads of State and delegates. The Prime Minister of Australia was also among the Heads of State and witnessed the Project display with great interest. A PC based "Real Time Graphic Display" of the SEAFRAME data from Majuro Port was demonstrated. Observers were pleased to see the real value of sea level, water temperature, atmospheric pressure, air temperature, wind speed, direction and gust, and how this data changed with time.

The display at the Forum proved a successful publicity manoeuvre for the Project amongst the government and visitors into the Pacific region. In fact, of the three displays, our Project was given priority and was relocated to the main entrance by the Ministry of Foreign Affairs of the Marshall Islands. Two senior officers of the Environmental Protection Authority (EPA) in Majuro, Mr Anwest Eleas and Mr Karness Kusto, provided round the clock assistance to the Project team. The general supervision and warm hospitality given by Mr Jiba Kabua, Secretary to Ministry of Foreign Affairs in Majuro, was greatly appreciated.

The Project continues to assist the Pacific Island countries (PICs) and their governments to understand the scale and implications of changing sea level and climate. Every effort is being made to introduce Atmospheric and Marine science curriculum to the primary, secondary and tertiary level for all PICs. As part of the Project (approved by the Project Coordinating Committee (PCC) meeting), from the second year of Phase II (starting from July 1996), there will be several short-term attachments at NTF to train personnel from PICs. This component was held between 18 November to 6 December 1996. A total of 13 candidates from 13 Forum Member countries of the Pacific were invited to participate. Based on the requirements of the PICs, 14 specialised courses have been carefully structured of which the following are focussed on in the first round:

1. Instrumentation
2. Surveying and Geodesy
3. NTF Information System
4. Data Management
5. Tides and Tidal Data Analysis
6. Integrated Coastal Zone Management
7. Bio-assessments in the Tropics

To run the courses effectively, entry requirements and pre-requisites will be applied. Further information on the short

South Pacific Sea Level and Climate Monitoring Project display during the Twenty-Seventh Forum Meeting at Majuro, Marshall Islands

term attachment programme and details of the courses are available from NTF and SPREP. The duration of courses will vary from one to three weeks depending on the subject chosen, and Pacific personnel are requested to take a minimum of three courses at this time. NTF, SPREP and USP staff will run the courses.

This issue contains accounts of the data interpretation in terms of regional sea level and climate change; other related matters; and the *Children's Education* section. The *Quarterly Newsletter* has a much wider audience than the Monthly Data Report and may be used as a source to further information dissemination by media, school teachers and others in the Pacific region, on climate issues.

Project Reports

Notable Features of Sea Level Data during this Quarter

Dr T. H. Aung

The author ***Dr T. H. Aung*** *is the Training Officer of the South Pacific Sea Level and Climate Monitoring Project based at the National Tidal Facility*

The various atmosphere and ocean parameters monitored at the SEAFRAME (Sealevel Fine Resolution Acoustic Measuring Equipment) stations of the Project were generally quite normal during this quarter. The occasional wavy sea level residual trends at some stations (detailed plots were given in Monthly Data Reports) are mostly due to atmospheric pressure and wind field. It should be noted that an increase of barometric pressure by 1 hPa may cause ~1 cm drop in sea level. Although one may generally expect that water temperature effect enhances sea level change, the temperature plots indicated no significant changes during this quarter in the Project region. Several significant sea level fluctuations were observed by some stations, these were directly attributed to the wind fields, especially when winds were stronger than normal. At times, these signals may have been due to the pressure and wind fields associated with a *squall line* (which only lasts for a few minutes) at a site. Here the word, *squall* can be defined as a sudden increase of wind speed lasting for several minutes before dying away quickly. To be classified as a squall, the wind should rise by at least 8m s^{-1} (~16 knots) and reach at least 11 ms^{-1} (~22 knots). A squall is often, though not necessarily, 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.

Seven earthquakes occurred in the Pacific Ocean during the July to September 1996 period. These earthquakes were not strong enough to generate any significant tsunami. The nearest SEAFRAME stations of the Project did not pick up significant signals of tsunami waves for further analysis and discussion.

Daily reversal in wind directions may be worth mentioning, notably in the Solomon Islands, and to a lesser extent in Western Samoa and Vanuatu. For example, the wind vector plots of September 1996, as illustrated in Figure 1, in which the length of a stick represents the magnitude of wind speed and the wind direction is indicated from the tip to tail of a stick. As mentioned in an earlier Monthly Data Report (November 95), the local daily reversals of winds are called *Sea and Land Breezes*. This is the effect of differential heating of land and sea water and can be seen along most coasts on a daily basis. Coastal dwellers are usually well aware of sea breezes. During the day

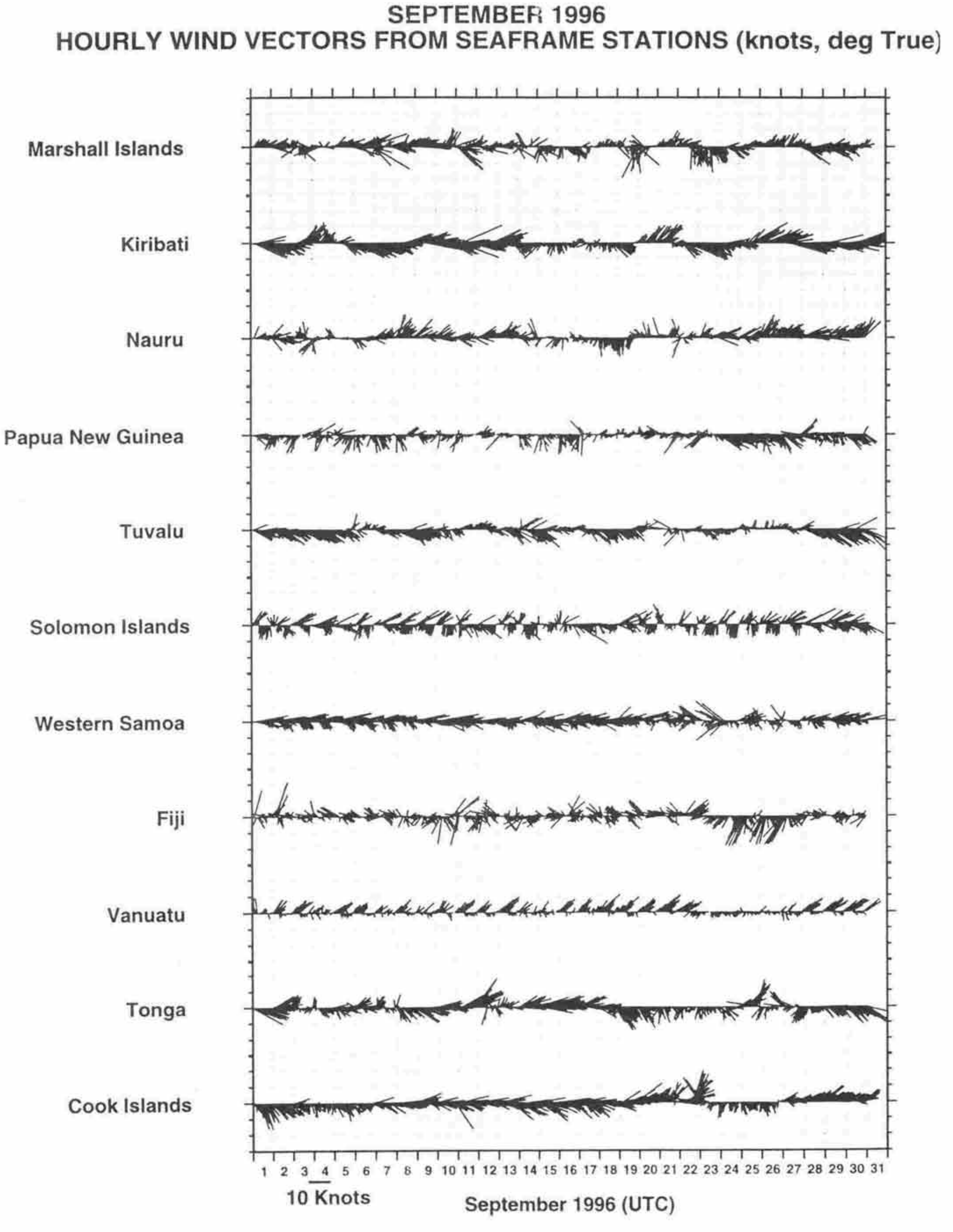

SEPTEMBER 1996
HOURLY WIND VECTORS FROM SEAFRAME STATIONS (knots, deg True)
Marshall Islands
Kiribati
Nauru
Papua New Guinea
Tuvalu
Solomon Islands
Western Samoa
Fiji
Vanuatu
Tonga
Cook Islands
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
10 Knots
September 1996 (UTC)

Figure 1

the land warms more quickly than the sea surface because it has a smaller value of *specific heat capacity* (amount of heat energy required to raise the temperature of 1 g of mass by 1°C). The specific heat capacity of sea water at 17.5°C is 0.95 cal g^{-1} $°C^{-1}$, means that 1 g of sea water needs 0.95 calorie of heat energy to raise the temperature by 1°C. The *specific heat capacity* value for the land (or solid) is less than 0.2 cal g^{-1} $°C^{-1}$. In other words, water needs more heat energy and takes longer to change its temperature.

Therefore, during the afternoon the air over the land gets warmer (volume expands and density reduces) and rises. The cooler air (more dense air) originally situated over coastal waters moves in to replace the vertically rising air over land. This is commonly known as the *sea breeze*. At the end of 1996, the author was in Rarotonga, Cook Islands, staying at the south coast of the island and experienced the strong southerly sea breeze. Based on personal observation, it may be inferred that the southerly wind was not only strong on the south side of the island, but is even stronger on the north side where the SEAFRAME station is located (Figure 1).

At night the land cools more rapidly than the sea. Therefore, air over the sea is still warmer due to the thermal capacity of water. Accordingly, warm air over the sea rises and the cold and dense wind blows from the land towards the sea to replace the vertically rising warm air. This is called the *land breeze*, which is strongest during late night and early morning hours. Local fishermen usually use these wind reversals to take them to sea in the morning and to bring them home in the evening.

In Figure 1 it is noticeable at Port Vila, Vanuatu, that the land breeze is significantly weaker than the sea breeze and differs from the other examples (Solomon Islands, Western Samoa and Fiji). This is because the wind sensor at Port Vila is somewhat sheltered from the southerly winds by a hill.

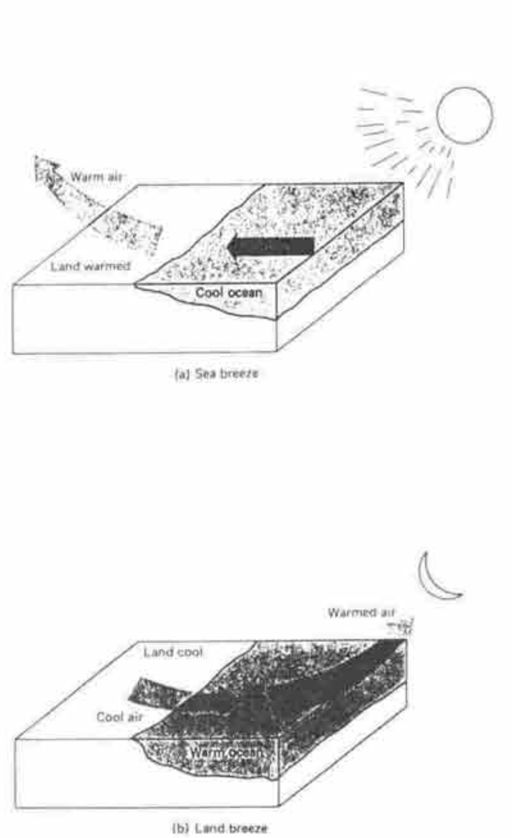


Figure 2a: Sea breezes occur when air warmed by the land rises and is replaced by cool air from the sea.

Figure 2b: Land breezes occur after the land has cooled below the sea surface temperature. Warm air then rises over the sea and is replaced by cool air from the land.

Responding to earthquakes

Mr A. V. Bapat

Amongst all natural disasters, the earthquake is the most gentle —it does not kill anybody. It is the collapse of artificial structures that kills. Compared to other natural disasters, earthquakes have the shortest duration. For example, volcanic eruptions may last for a few months or years; floods may cause inundation for a few days or up to a week; and cyclones may last for a few hours etc. Another interesting and useful feature of the earthquake is that it has a minimum safe distance. To ensure safety during the seismic shaking, one has to move outside and stand in open space. In the case of floods, people are required to evacuate their towns and villages beyond the flood-plain. In cyclones, the affected area is usually in a radius of about 15 to 30 kilometres. During all these hydraulic conditions, the minimum safe distance, to be in a non-vulnerable condition could be anything between 1 to 10 kilometres. Evacuation of a large population over such extensive distances is a cumbersome task not only for the population but also for the administration. Contrary to this, the minimum safe distance of a seismic disaster is only a few metres that could be easily covered in less than 10 to 15 seconds.

Safety involves moving outside a building and stand in open space. This ensures almost total protection from the seismic vibrations. Present day thinking in the minds of mitigation experts is that even if one gets just 10 seconds warning, prior to the commencement of seismic activity, this would help save several lives.

This philosophy could be easily put to practical use. Suppose there is an active seismic fault at a distance of approximately 50 to 60 km from a densely populated urban area. The primary seismic waves generated during an earthquake would take about 10 seconds to reach the urban area, assuming a velocity of about 7 to 8 km s^{-1}. An electromagnetic transmitter, coupled to seismic instruments, could transmit signals by electromagnetic waves immediately after the quake. This signal would be received at the urban area within a few nanoseconds. For this purpose, the existing communication channels could be fruitfully utilised. Alarm sirens could be sounded immediately and people could move out of their houses and stand in an open space. By the time the seismic waves arrive in the city, the majority of people (it is hoped) will have been evacuated from their dwellings.

There are several suggestions, instructions etc. to reduce and minimise damage caused during earthquakes. These are extremely useful and could be implemented at nominal cost, with little effort.

1. Do not put heavy articles like bags, boxes crates etc. on high shelves.
2. Shelves, racks, refrigerators etc., should be anchored to walls by bolts or screws. This ensures that these heavy items do not move during seismic shaking.
3. In hospitals and pharmacies, medicine bottles should not be stored on open shelves. They should be placed on a rack with doors. After the 1967 Koyna earthquake in India, no medicine was available for first aid as all the bottles fell from open shelving and were broken.
4. Do not park vehicles in a gear other than neutral with hand brake on, especially on slopes. Vibratory ground motions can sometimes start a vehicle engine.
5. Domestic utensils should preferably be kept at a low height.
6. Liquid storage tanks should be properly covered with light lids.

Earthquake engineers always discuss the aseismic design of houses and it is a fact that such houses are capable of withstanding seismic jolts better than conventional houses. This is perfectly correct for new houses. But what can we do with those abodes which are old, not designed aseismically and are still fit to dwell in? Listed below are a few tips which could strengthen these conventional houses.

1. Brick walls are extremely vulnerable during seismic shaking and falling bricks can be dangerous. Put an X-shaped bracing in two diagonal directions across the four corners of the wall.
2. Put a belt of steel wire mesh of about 50 cm in width around the house at the level of the lintel or roof. This should be fixed with the structure every half metre by nails. This is known as a "seismic belt" and it helps reduce the amplitude of the seismic vibrations. If required, the corner portions of the seismic belt could be strengthened by overlapping with small pieces of wire mesh.
3. For non-RCC constructions, where there are no concrete columns and beams, but there are wooden poles or brick columns, use small rods for joining the columns or beams diagonally in all directions.
4. To reduce the effect of seismic vibrations on the structure, use a simple conventional technique. Around the periphery of the land (not the house) dig a pit one metre wide and one to one and a half metres deep and fill it with coarse sand. This peripheral trench should be at least two to three metres away from the construction. This helps reduce the amplitude of seismic wave vibrations, which in turn reduces the damage potential.

When the seismic vibrations commence, do not panic: The safest places to take shelter during seismic vibrations are:

1. Open space.
2. If open space is not available then take shelter under a table, desk or cot (while sheltering in this manner resist protruding your head inquisitively). Keep your head on the ground and cover with both hands.
3. Door frames also provide some safety for one person within the house. Keep the door open if possible.
4. Avoid taking shelter near or under a chandelier, fan, clock, picture frame, storage rack or any hanging object.
5. Watch for any inflammable material lying unsealed or unsecured. Do not store kerosene, diesel or petrol in any container likely to spill over.
6. If time permits, switch off electricity before sheltering or evacuating.

To generalise these suggestions, ensure that no item in the house as a result of seismic vibrations causes injury to family members. The least amount of movement during a seismic episode also ensures the least injuries. It has been noted that the maximum rate of mortality and morbidity occurs in the ages between 15 to 35 years, because this group undertakes maximum movement during seismic vibrations. Infants and the elderly move less and therefore have a lower rate of mortality and morbidity. At times it is seen that a child is safe in the arms of a mother who may herself be injured.

The essence of the seismic disaster mitigation is that one should always take proper and appropriate precautions by ensuring that the seismic vibrations, which last for a few seconds, do not cause the displacement of any object which could be fatal to the occupants of the house. Precautions over years and alertness during the few seconds of the earthquake can definitely help to minimise the disaster.

Note: The author, Mr Arun Bapat is a Seismologist at the Central Water and Power Research Station, Pune, India. He visited NTF for two weeks in May 1996.

A genuine plea from Tuvalu

Ms L. Leupena

Tuvalu was formerly known as the *Ellice Islands* when it was under British administration. In 1978, Tuvalu gained independence and became the world's second smallest independent nation. It is situated about 100 kilometres north of Fiji immediately west of the international dateline and just south of the equator. It consists of nine low-lying islands. It has a total land area of about 26 square kilometres with a population of approximately 9400. Most of the land on Tuvalu is only between one and two metres above sea level. Despite the increasing influence from outside, Tuvalu has maintained its traditional culture and customs, community and family ties are still strong and very much part of the Tuvaluan society.

My concern with the future of Tuvalu deepened as I continued to listen and observe what industrialised countries are doing to address the issue of Global Warming. It inspired me, as part of my study at Victoria University of Technology (Australia) in Community Development, to focus my fieldwork on women living in Tuvalu and the potential problems they face if the sea level rises.

Due to its physical characteristics as a low lying country, Tuvalu is faced with the major threat of sea level rise. People are starting to feel threatened by dire predictions and are already experiencing destructive weather patterns and rising tides. In recent times, there has been an increase in severe storms and storm surges devastating most of the islands in the group. Inland areas including places with housing can be flooded if the tide is very high. Citizens of Tuvalu are continuously informed about the greenhouse effect and global warming through radio, the only effective means of communicating to the remote islands.

Swamp taro is a plant that performs a very important ceremonial role in Tuvalu society. For it to grow properly, great care and attention is required over a period of five to ten years, after which it is harvested. Saltwater however, is now flowing into *taro* pits during high tides. My father is already experiencing heartache every time he sees his *taro* plantation killed by the flooding salt water. All his years of hard work are thrown away and he has to start all over again.

Living patterns on these remote islands could also be disrupted if severe storms continue. With fish being the main source of protein, climate change could impose on the Tuvalu people the added hardship of catering for their families in times of heavy seas.

Although there is much documentation describing the impact of the greenhouse effect on low-lying atolls in the Pacific, there is very little written from the communities' perspective about their concerns on the real impacts at the local and personal levels. Of course, political bodies have their part to play, but I feel that ordinary people who make up the population should raise their voices to be heard more widely. Industrialised countries should commit themselves to decreasing gas emissions because ordinary people who live in this atoll face the consequences, while those in developed countries are not so affected.

As a Tuvaluan, I plead with countries like Australia, New Zealand, etc. to make sound commitment to actions that will address the issue, not just verbal or written agreements. My country will lose its strong cultural heritage which for many years has maintained peace and harmony among island communities, at a time when this style of living is being lost to many developed countries. I hope the small part I play in raising the awareness of the industrialised countries will enable them to understand the threat my country, as well as other low-lying islands around the world, is facing. It is important that everyone, as a citizen of the world, participates in activities to mitigate the greenhouse effect.

Special Note:
The author *Ms Lillian Leupena*, is a student from Tuvalu who is undertaking her graduate studies in the Victoria University of Technology. The above article is extracted and reproduced from **Habitat** Australia: The magazine for the Australian Conservation Foundation, Vol. 23, No. 1, February 1995.

Although there is much documentation describing the impact of the greenhouse effect on low-lying atolls in the Pacific, there is very little written from the communities' perspective about their concerns on the real impacts at the local and personal levels.

Based on the **Tiempo**: Global Warming and the Third World, Issue 20, June 1996, the following points may be extracted. Climate change clearly will increase the vulnerability of some coastal populations to flooding and erosional land loss. Estimates put about 46 million people per year currently at risk to flooding due to storm surges. In the absence of adaptation measures, a 50 cm sea level rise would increase this number to about 92 million; a 100 cm sea level rise would raise it to 118 million. If one incorporates anticipated population growth, the estimates increase substantially. Some small island nations and other countries will confront greater vulnerability because their existing sea and coastal defence systems are less well established. Countries with higher population densities would be more vulnerable. For these countries, sea level rise could force internal or international migration of populations. Studies using 100 cm projection (of sea level rise) show particular risk for small islands and deltas. Estimated land losses range from 0.05 percent for Uruguay, 1 percent for Egypt, 6 percent for the Netherlands, and 17.5 percent for Bangladesh to about 80 percent for Majuro Atoll in the Marshall Islands.

Benefits from the South Pacific Sea Level and Climate Monitoring Project — Response to "A Genuine Plea from Tuvalu"

Editors of the South Pacific Sea Level and Climate Change Newsletter are proud to point out that the Australian Federal Government has made a strong commitment to this global issue and has funded, through AusAID, the South Pacific Sea Level and Climate Monitoring Project. The Project's main goal is to help Pacific Island countries and their governments understand the scale and implications of changing sea level and climate. In addition, SPREP and NTF have recently completed a study report on *Vulnerability of Funafuti Atoll to Sea Level Rise* which may assist in understanding this complex issue and thereby reduce the concerns of Tuvaluans in general and of Ms Lillian Leupena in particular. The conclusion of the report indicates that sea level will rise by about 15cm at Funafuti between the years 1990 to 2050. Aside from loss of land, it will lead to increased vulnerability to extreme events such as storm surges. Numerical models indicate that freshwater lenses under Funafuti are highly sensitive to sea level rise as well as changes in rainfall and agricultural use.

Another report *Coastal Vulnerability and Resilience in Tuvalu: Assessment of Climate Change Impacts and Adaptation*, has been produced recently (March 1996 by SPREP and the Japanese Government) and is available from SPREP. The report identifies vulnerable economic and environmental sectors and in turn points out how to respond to these challenges in urgent, short and long-term planning. These studies have been made available to the Government of Tuvalu for their consideration.

Similar reports for the islands of Fiji are also available. It is important to note that the South Pacific Sea Level and Climate Monitoring Project continues to provide valuable research data and information to our Pacific Island governments and the international community on sea level and climate changes in this region.

Vulnerable coastline to any sea level rise in the north coast of Tuvalu. (Photo produced from *Coastal Vulnerability and Resilience in Tuvalu: Assessment of Climate Change Impacts and Adaptation*)

Physics Promoted in Fiji Schools

Dr H.Todd

The Western Schools Laboratory Workshop in Lautoka, Fiji was successfully held in July 1996. It was the *South Pacific Physics Society*'s (SPPS) attempt to bring physics equipment to western students in Fiji, and to help them understand through experiments the fun and importance of Physics.

In her opening speech, the following concern was raised by Fiji Minister of Education, Hon. Taufa Vakatale. In fact, this alarming concern is not only valid for Fiji but also for the whole Pacific region. As we are all aware, most scientific reasoning is based on the understanding of fundamental phenomena in physics.

> *"Because of a shortage of physics teachers in our secondary schools, it sometimes happens that students are taught by teachers not well qualified in physics."*

Another concern is that students in many schools do not have the opportunity to become familiar with physics equipment and to become confident in performing experiments because equipment is scarce. The result is that students lack laboratory experience and have little confidence in their own ability, which contributes to their decision to give up physics at an early stage.

The three-day event held at Natabua High School in Lautoka, attracted about 1500 students from 25 western schools, with groups coming from as far as Rakiraki and Yasawas. Students were able to experiment with equipment demonstrating radioactivity; momentum conservation; electricity; electromagnetism and communications; and waves among others. Helping the participants were University of the South Pacific staff and postgraduate and undergraduate student members of the School of Pure and Applied Science. A number of Natabua Form 7 (equivalent to Australia year 12) students made valuable contributions when the demonstrators' voice gave out. "*We really found it to be a good experience to explain what was going on to other students, we learnt a lot*", said one of the Natabua student demonstrators.

Would it not be wonderful if this sort of activity took place in the whole Pacific region more regularly?

Note: The author *Dr Hilary Todd* is the President of SPPS and a Senior Physics Lecturer in the University of the South Pacific. The major part of the article is extracted and reproduced (from USP Bulletin Vol. 29, No. 26, 16 August 1996)

Teaching children about Weather and Climate

Mr H.G. Segal

There is increased attention being given to teaching children about weather and climate. Perhaps, there is some hope that future generations will have more insight and ability to cope with the changes that are occurring, than the previous and present adult generations.

Today's children have to grow up with a myriad of problems to cope with; alcohol, drugs, smoking and sexual activity. These are the things young people often experiment with, but which have become deadly dangerous. To the above list however, we add the concerns of weather and climate change; ozone depletion; UV rays increase; sea level changes; greenhouse effect; the aftermath of fishing and agriculture losses; population movement; and coastal changes. All of these concerns will greatly affect island children.

It seems to me that we need to approach this subject with some degree of apology, for ours and the past generations, for adding to the problems although many of us would say we did so unknowingly.

Therefore, we need to help this generation of children realise that these are recurring phenomena. It has happened before and will happen again. Still, with an apology from us for speeding up the processes.

Finally, to teach weather and climate subjects in the next century, we should not only teach the factors of change but also what can be done to cope with these conditions. We must provide the next generations, who inherit these problems, with the scientific tools to cope with them. Should this be the *Curriculum* to be written?

Note: The author *Mr Harvey Segal* is a veteran Curriculum Officer at the College of Micronesia FSM (Federated States of Micronesia). He actively participated in the *Curriculum Writing Workshop on Climate and Climate Change* held in Apia, Western Samoa in June 1996. This workshop was one of the activities of the South Pacific Sea Level and Climate Monitoring Project.

Pacific students collect rainfall data for researchers

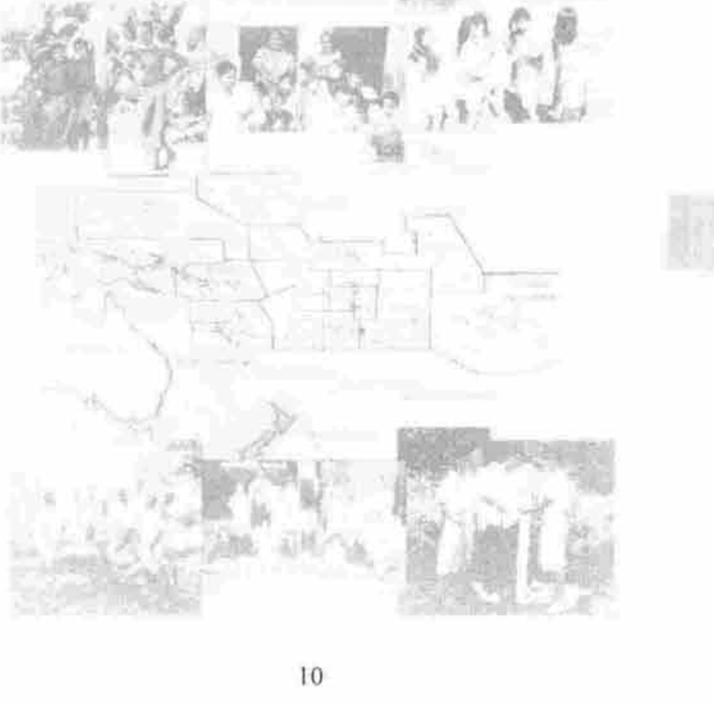
Dr B.Gibson

In order to provide scientists with some of the necessary data to study the effects of possible changes in climate (at the global, regional and national levels), the Schools of the Pacific Rainfall Climate Experiment (SPaRCE) was established four years ago by a team of researchers at the University of Oklahoma. SPaRCE is a cooperative field experiment which has both research and educational objectives. The goals of the programme include: increasing the number of rainfall measurements across the Pacific at a relatively low cost; educating students and teachers as to the importance of rainfall (particularly in the Pacific region) to climate studies; and to encourage scientific and cultural exchange between students from different countries.

When schools sign up for the project, they are sent a package of materials including rain gauges, instructional workbooks and videos tapes, and a single use camera to document the installation of the rain gauges. Then every few months, the schools receive additional instructional and science-related materials on topics such as Pacific climate and data analysis. In return, the schools send daily rainfall values from their rain gauge sites to SPaRCE headquarters in Oklahoma.

The rainfall data collected by SPaRCE participants is entered into the PACRAIN database and is available via the Internet. There is a metadata archive that is also located on the Internet to supplement the meteorological data collected. This information includes latitude/longitude, maps and photographs. Moreover, with the collaboration of certain US government agencies and science personnel, the programme has been able to expand to include the monitoring of ozone and the installation of automated weather stations (which provide three minute resolution data of standard meteorological variables). Future objectives of SPaRCE scientists include enhancing the current automated weather station network and the number of basic instruments sent to participants in order to monitor more environmental variables. More information about the SPaRCE programme can be obtained from the World Wide Web at; http://radar.metr.uoknor.edu/sparce/sparce.htm or by contacting SPaRCE Headquarters via e-mail at: sparce@hoth.uoknor.edu

Note: The author *Dr Barbara Gibson* is the Project Coordinator of SPaRCE and is closely working with SPREP and the ARM project in the Pacific region.



Members of the Display Team at Majuro, Marshall Islands (from left to right): Mr Souk Douangphoumy, Mr Karness Kusto, Dr Than Aung and Dr Chalapan Kaluwin.

Dr Kaluwin promoting the South Pacific Sea Level and Climate Monitoring Project to the local media in Western Samoa.

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