PACIFIC DIALOGUE
ON
WATER AND CLIMATE

SYNTHESIS REPORT

October 2002

by

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dialogue on water and climate

SOPAC

South Pacific Applied
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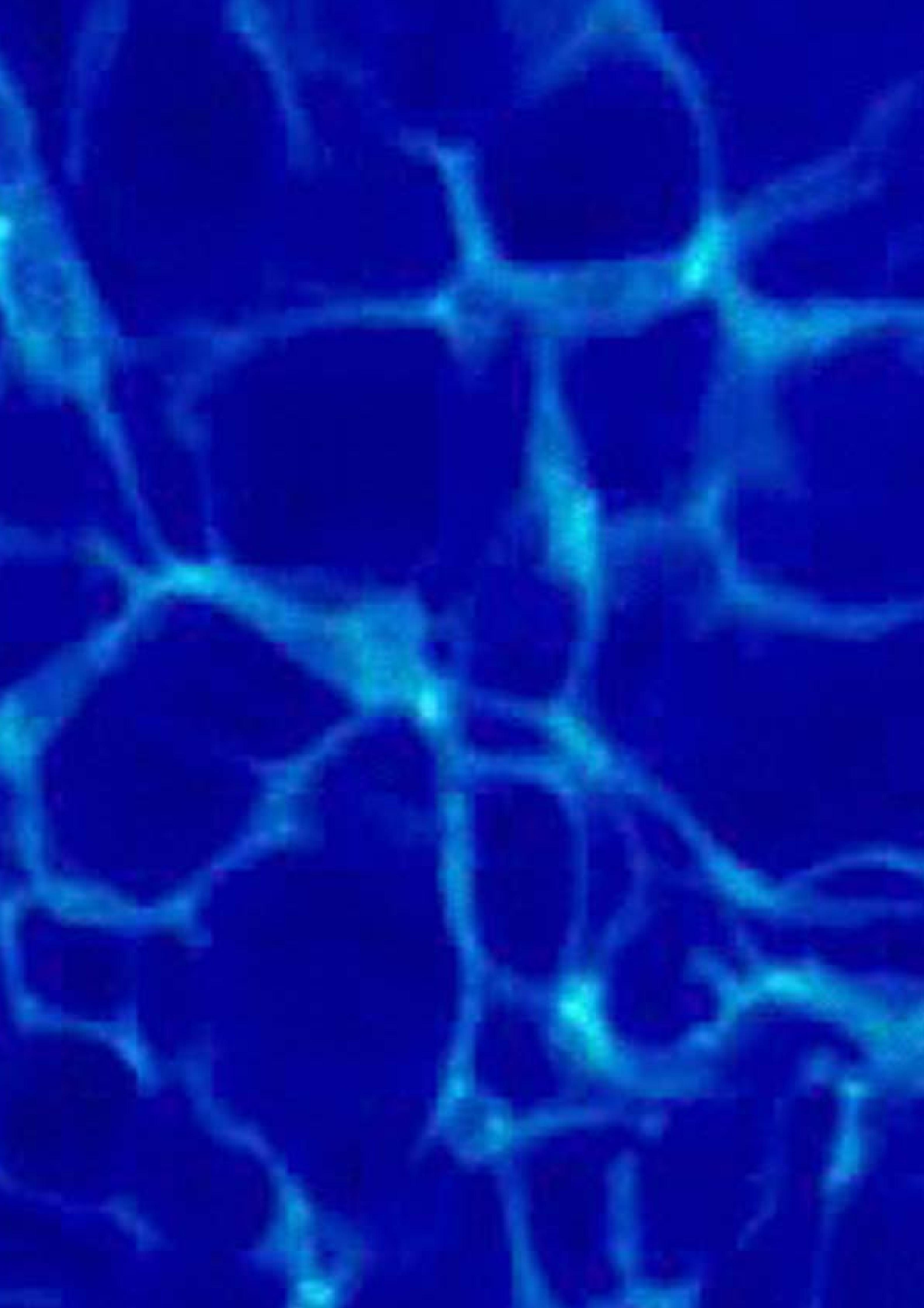

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List of Abbreviations

ADB	Asian Development Bank
AOSIS	Association of Small Island States
BPOA	Barbados Programme of Action
CCCCC	Caribbean Community Climate Change Centre
CEHI	Caribbean Environmental Health Institute
CHARM	Comprehensive Hazards and Risk Management
CLIPS	Climate Information and Prediction Services
DWC	Dialogue on Water and Climate
EEZ	Economic Exclusive Zones
ENSO	El Niño Southern Oscillation
ESCAP	Economic and Social Commission for Asia and the Pacific
FMS	Fiji Meteorological Service
GOOS	Global Ocean Observing System
GWP	Global Water Partnership
HYCOS	Hydrological Cycle Observing System
IETC	International Environmental Technology Centre
IGCI	International Global Change Institute
IHP	International Hydrological Programme (of UNESCO)
IPCC	Intergovernmental Panel on Climate Change
IRI	International Research Institute for Climate Prediction
IWRM	Integrated Water Resources Management
NEMS	National Environment Management Strategy
NIWA	National Institute for Water and Atmospheric Research New Zealand
NZAID	New Zealand Agency for International Development (formerly NZODA)
NZODA	New Zealand Overseas Development Agency (now NZAID)
PEAC	Pacific ENSO Applications Center
PICCAP	Pacific Islands Climate Change Assistance Programme
PICs	Pacific Island Countries
SOI	Southern Oscillation Index
SOPAC	South Pacific Applied Geoscience Commission
SPREP	South Pacific Regional Environment Programme
UNDTCD	United Nations Department of Technical Co-operation for Development
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework Convention on Climate Change
UNGCSIDS	UN Global Conference on the Sustainable Development of Small Island States
WMO	World Meteorological Organisation

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We wish to thank our colleagues from the Caribbean for their valuable contribution to the Pacific Dialogue. We sincerely hope to establish a close and fruitful future collaboration with other small island countries in Asia, the Indian Ocean and the Caribbean to jointly address problems related to Water and Climate.

This document has been edited for publication.

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INTRODUCTION

The Pacific Dialogue on Water and Climate

The economic and social well-being of small island countries, particularly those in the Pacific, are dependent upon the quality and quantity of their water. However, the ability of small island countries to effectively manage the water sector is often constrained by their small size and limited human resource base. In many island countries factors such as climate variability, increasingly variable rainfall, accelerating storm water runoff and increasing demand for water are so significant that they threaten their economic development and the health of their people.

The vulnerability and particular needs of small island countries has been acknowledged by the World Water Council by the inclusion of the “Water in Small Islands Countries” theme in the 3rd World Water Forum. The Netherlands based International Secretariat of the Dialogue on Water and Climate has recognised the significance of water and climate to Small Island Countries by providing support to collaborative projects from the Pacific and Caribbean regions which will provide relevant input to that Forum.

The Asian Development Bank (ADB) and the South Pacific Applied Geoscience Commission (SOPAC) co-organized a regional consultation meeting on sustainable water management from 29 July - 3 August 2002 in Sigatoka, Fiji in preparation for the 3rd World Water Forum.

The meeting was organised around six themes: Water Resources Management, Island Vulnerability, Awareness, Technology, Institutional Arrangements and Financing. The Pacific Dialogue contribution to the consultation included the Island Vulnerability theme which covered disaster preparedness and hazard management as well as the vulnerabilities associated with climate change and climate variability.

A special parallel session on the Small Island Countries Dialogue on Water and Climate was held on 1 August 2002 in Sigatoka with attendance of, and presentations by, Pacific and Caribbean water resources specialists, climate specialists, meteorologists and representatives from international organisations. In this session, coping strategies and adaptation strategies were highlighted, views and experiences exchanged and inter-regional collaboration between small island countries of the Caribbean and the Pacific promoted.

This Pacific Dialogue Report draws upon information mainly derived from the Pacific Regional Consultation thematic overview papers on Water Resources Management (Falkland, 2002) and Island Vulnerability (Scott, 2002) together with relevant case studies and components of the Regional Action Plan which was adopted by the meeting and subsequently endorsed through the signing of a Ministerial Declaration by 12 Pacific Island Ministers and Secretaries of State (Pacific Regional Action Plan, 2002).

The Island Vulnerability thematic overview paper directed attention to the stated goal of the Dialogue on Water and Climate: “*to improve the capacity in water resources management to cope with the impacts of increasing variability of the world’s climate, by establishing a platform through which policymakers and water resource managers have better access to and make better use of information generated by climatologists and meteorologists*”.

The Pacific Islands

The Small Island Countries involved in the Pacific Dialogue on Water and Climate include 18 Pacific Island Countries as well as East Timor and the Maldives. The 18 Pacific Island Countries (PICs) considered in this report consist of only 550,000 km^2 of land with approximately 7 million inhabitants spread across 180 million km^2 of ocean or about 36% of the world’s surface. The map in Figure 1 shows the vast Pacific Ocean with the limited land area that make up the Pacific islands.

The Economic Exclusive Zones (EEZ) of the PICs cover as much as 37.5 million km^2 of ocean. Most of the islands can be considered as “small”, i.e. islands with areas less than 2,000 km^2 or widths less than 10 km (UNESCO, 1991) and most of these fit into the category of “very small islands”, which are less than 100 km^2 or have a maximum width of 3 km (Dijon, 1983).

Figure 1: Map of the Pacific Islands Region (Source: MAPgraphics, Brisbane 1995)

Excluding Papua New Guinea a non-qualifier as a small island country but containing many small islands the figures mentioned above drop dramatically; the land mass amounting to only 88,000 km^2 occupied by only 2.6 million inhabitants. Many of the populated islands in the Pacific are less than 10 km^2 while some, especially those on atolls, are less than 1 km^2.

Over 30,000 small islands are in the Pacific (UNESCO, 1992) and they vary greatly in their physical characteristics including high volcanic islands, low lying atoll islands and uplifted limestone islands. The high islands are large, consisting mainly of volcanic rock and are generally forested with fertile soil and usually an ample availability of freshwater. The low islands are usually small with limited freshwater resources and poor soil. In very small islands, surface and groundwater resources are generally limited to the supply of water to island communities.

South Pacific?
When the Spanish conquistador Balboa gazed south from Central America in 1513, he named the ocean he had discovered 'Mar del Sur', the South Seas – a name printed on many maps of the 16th and 17th centuries. Even after Magellan named the ocean the 'Pacific' in 1521 for the calmness of its water, the 'South Seas' and 'South Sea Islanders' were still associated with the tropical Pacific and its people both north and south of the equator. Modern regional institutions have continued this tradition, even if they include countries north of the equator, for example the University of the South Pacific (USP) and the South Pacific Applied Geoscience Commission (SOPAC). In 1999 the intergovernmental South Pacific Forum decided to correct the error, renaming itself the Pacific Islands Forum in recognition of its northern members.
(After: Lonely Planet, 2000).

Almost atoll, Aitutaki, Cook Islands

Of the 18 Pacific Island Countries and Territories five are in Melanesia, seven are in Polynesia and six are in Micronesia. The Melanesian countries (Fiji, New Caledonia, Papua New Guinea, Solomon Islands and Vanuatu) are extensions or parts of submerged mountain ranges. The Polynesian and Micronesian islands are made up of small island groups consisting of a mixture of large volcanic islands and small coral atoll islands (American Samoa, Cook Islands, Federated States of Micronesia, French Polynesia, Guam, Palau, Samoa and Tonga) or consist only of atolls (Kiribati, Marshall Islands and Tuvalu) or small uplifted limestone islands which are the only non-archipelagic countries in the Pacific (Nauru, Niue). Variations of volcanic, limestone and coral atoll type islands in the Pacific are shown in Figure 2.

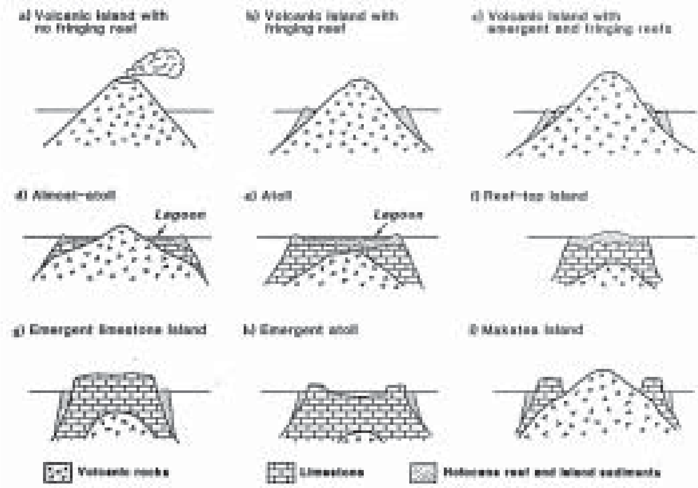

Figure 2: Main types of mid-oceanic islands in the Pacific. (Woodroffe, 1989).

Large variations in demographic and physical characteristics (total area, number and geology of islands) are evident. Summary data for each of the island countries and territories invited to the Pacific Regional Consultation Meeting have been collected as part of the regional consultation on sustainable water management in the Pacific as shown in Table 1 (Falkland, 2002). The data focuses on characteristics which impact on freshwater resources and water use in these island countries and territories.

Raised coral atoll, Nauru

Table 1 Summary data for island countries and territories

Country or Territory	Sub-Region	Approx. Population (in 2000)	Total Land Area (km^2)	Number of islands or atolls	Island type according to geology
Pacific Island Countries					
Cook Islands	Polynesia	16,000	240	15	Volcanic, volcanic & limestone, atoll
Federated States of Micronesia	Micronesia	114,000	702	607	Volcanic, atoll, mixed
Fiji	Melanesia	785,000	18,300	300 (approx.)	Volcanic, limestone, atoll, mixed
Kiribati	Micronesia	85,000	810	33	32 atolls or coral islands, 1 limestone island
Nauru	Micronesia	11,000	21	1	Limestone
Niue	Polynesia	1,700	260	1	Limestone
Palau	Micronesia	22,000	487	200 (approx.)	Volcanic, some with limestone
Papua New Guinea	Melanesia	4,400,000	462,000	?	Volcanic, limestone, coral islands and atolls
Republic of Marshall Islands	Micronesia	60,000	181	29	Atolls and coral islands
Samoa	Polynesia	175,000	2,930	9	Volcanic
Solomon Islands	Melanesia	417,000	28,000	347	Volcanic, limestone, atolls
Tonga	Polynesia	99,000	747	171	Volcanic, limestone, limestone & sand, mixed
Tuvalu	Polynesia	11,000	26	9	Atolls
Vanuatu	Melanesia	182,000	12,190	80	Predominantly volcanic with coastal sands and limestone
Other Pacific Islands (Territories of USA and France)					
American Samoa	Polynesia	67,000	199	7	5 volcanic and 2 atolls
French Polynesia	Polynesia	254,000	3,660	130	Volcanic, volcanic & limestone, atolls
Guam (USA)	Micronesia	158,000	549	1	Volcanic (south) and limestone (north)
New Caledonia (France)	Melanesia	205,000	18,600	7	Volcanic, limestone
Island countries in other regions					
East Timor	SE Asia	800,000	24,000	1 main island	Volcanic
Maldives	Indian Ocean	270,000	300	26 atolls (1,900 islands)	Atolls

Notes:

- Populations and areas: from Case Studies and Country Briefing Reports for the Regional Consultation Meeting and SOPAC (2002a). Actual population data may be different from that shown, as some of the data is from 1998.
- Number of islands: from UNDTCD (1983), UNEP (1999), UNEP (2000), various National Environment Management Strategies (NEMS) for PICs.
- Some numerical differences were noted between data sources.

The Pacific People

The cultures of the Pacific islands are very diverse but despite the fact that they are tiny dots of land separated by enormous distances of open sea they show many similarities in their religion, languages and custom. The history of oceanic voyaging that produced these similarities has amazed westerners from the time of James Cook.

Advanced navigational skills used in ancient Pacific islanders voyages brought Melanesians, Micronesians and Polynesians to all but the furthest-flung islands of the Pacific by 200 BC. Traditional knowledge to cope with the elements of sea, wind and weather on remote Pacific islands is still being used in modern times.

South Tarawa, Kiribati

Of the 30,000 islands in the Pacific Ocean only 2,000 are inhabited and of the 2.6 million Pacific islanders (excluding PNG) 1.6 million are in Melanesia, 600,000 in Polynesia and 450,000 in Micronesia. Individual country populations range from Fiji at 785,000 to Niue with only 1,700. The tiny and remote island Pitcairn, which is administered by Great Britain, has a population of only 50.

Most of the population in Pacific Island Countries live in coastal areas in rural villages and towns and the peri-urban areas on the fringes of the main centres (ESCAP, 2000). In many cases, living conditions in the peri-urban areas (fringes of urban areas) are poor and normal urban utility services (including water supply) are sparse, inadequate or non-existent (Chung and Hill, 2002). Often the conditions within Pacific Island Countries vary considerably, with outer islands being significantly less developed than the main islands.

Populations are increasingly concentrated on one island or in one main town. This is most prevalent in Micronesia (Nauru being almost exclusively an urban community). Population density varies from as low as 8 people per km^2 in Vanuatu to 430 per km^2 on Nauru. Ebeye Islet on Kwajalein Atoll in the Marshall Islands has a population density of 40,000 per km^2 with over 13,000 people on only 31 hectares of land.

Cloud hunting, Mr Abera Timea's capability to predict

Record of Mr Abera: during the long drought in 1967-1968 he displayed the kind of knowledge he had. When his supply of rain water became low, he sailed off on his 9 metres long canoe for a 2-4 days trip to an area in the open sea he had identified where there will be rain on a specific time. He sails away to his selected area, collects his rain water and sailed back home. He was well stocked with rain water even though he did not have a rainwater tank in his place.

From: Tungaru Traditional Concepts, a study on Traditional Knowledge of Tungaru (I-Kiribati) people on their weather conditions forecasts in relation to the scientific views on climate change and sea level rise (UNESCO, 1997).

The Pacific Climate

General

Apart from the cool highlands of some Melanesian islands the tropical Pacific islands are humid, and air temperatures are high and generally uniform throughout the year (21 to 28 °C). The year is divided into a drier season and a wetter season. South of the equator (Melanesia and Polynesia), the dry season is from May to October and the wet season (including the cyclone season in part of the region) is from November to April. North of the equator (Micronesia) seasons are reversed.

In the tropics, air flowing towards the equator is deflected by the Earth's rotation. Called the Trade Winds, these winds blow from the southeast in the southern hemisphere and from the northeast in the northern hemisphere. The climate of islands facing these cool rain-carrying Trade Winds changes from one side of the island to the other as the moist air currents are forced to rise upwards and condense as rainfall (the orographic effect). The region where the trade winds meet at the equator is referred to as the Doldrums, and this region gets little or no wind. Around December each year the prevailing easterlies weaken, and reverse for a time and blow from the west.

Rainclouds over Savaii, Savaii

The El Niño Phenomenon

The strong El Niño of 1997/1998 increased the attention of this phenomenon considerably. The effects of El Niño, and the La Niña that followed had major implications for small island countries in the Pacific. Some governments declared a state of emergency after the prolonged drought seriously affected the lives and wellbeing of the islanders. However, not every weather anomaly in an El Niño year is caused by El Niño itself. There is a tendency of scientists as well as non-scientists, just to blame about everything that happens during the year of an El Niño on that particular El Niño event (UNESCO, 1998).

Climate Variability

The climate of small islands within tropical regions is quite variable, depending on geographical location, island size and topography. The climate of small oceanic islands is governed by the regional climate, while small islands closer to continents or large islands may also be influenced by local climatic conditions.

Average annual rainfall varies considerably between islands in the tropical Pacific Ocean (e.g. Taylor, 1973 shows variations between rainfalls in excess of 4,000 mm to less than 500 mm). In high volcanic islands, orographic effects can cause much higher rainfall at altitude than in low-lying areas (e.g. Viti Levu, Fiji), while long-term rainfall does not usually vary much across individual low-lying islands.

Two of the most important climatic influences on small islands in the Pacific region are tropical storms and El Niño Southern Oscillation (ENSO) episodes. El Niño is the term used for the extensive warming of the upper ocean in the tropical eastern Pacific. The negative or cooling phase of El Niño is called La Niña and both events are linked with a change in atmospheric pressure between the western and central regions of the Pacific Ocean known as the Southern Oscillation (SO). A measure of this variation, called the Southern Oscillation Index (SOI), is based on the pressure difference between Tahiti in the south Pacific and Darwin in northern Australia. The term ENSO (El Niño Southern Oscillation) is widely used to refer to the effects of the El Niño and La Niña phases of this natural cycle.

During an El Niño event the lower pressure difference (when the SOI index is negative) causes weaker trade winds and a lower temperature difference in the water of the ocean (refer Figure 3). The low pressure zone which normally brings abundant rainfall around the western side of the Pacific Ocean shifts to the east with the potential to cause catastrophic droughts in Indonesia, Papua New Guinea as well as the other Melanesian islands. The warm water, which is accompanied by moist air shifts to the central part of the Pacific bringing typhoons and storm surges into islands like Hawaii and French Polynesia.

The reverse condition, popularly known as La Niña, occurs when the SOI index is positive and the eastern Pacific is relatively cool. The low equatorial islands of western Kiribati are seriously affected during a La Niña. When the SOI is strongly positive dry easterly winds are more dominant than usual and their influence may produce prolonged droughts.

ENSO episodes have a significant impact on the climate of many small islands and can produce extensive wet and dry cycles. The impact of current climate variability in PICs, especially in relation to droughts, has been a major focus in recent years (e.g. SOPAC, 1999). This topic has attracted considerable attention in the scientific community (e.g. Terry, 1998), the popular media, and by funding agencies (e.g. World Bank, 2000).

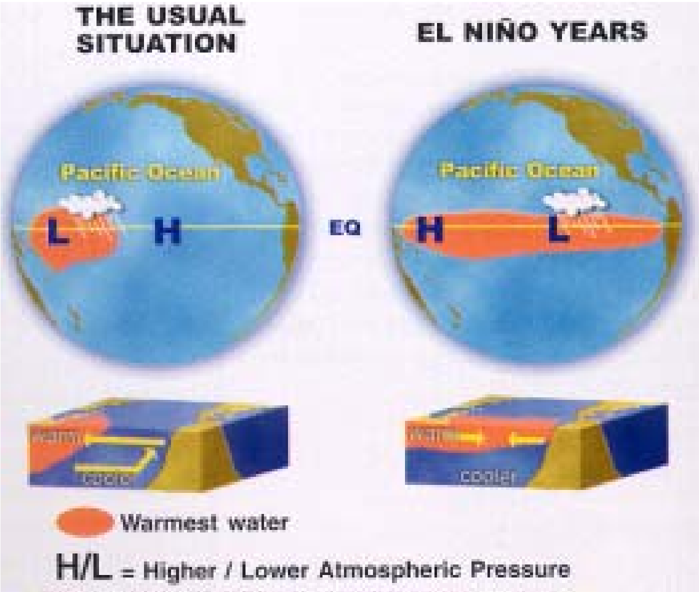

Figure 3: Water and atmosphere processes influence rainfall around the Pacific (modified after WMO brochure)

Understanding of the coupled ocean-atmospheric system which drives the ENSO cycle is still incomplete. Nevertheless, considerable progress has been made over the last decade by meteorologists, oceanographers and hydrologists and there have been significant improvements in the capacity to make observations of meteorological and ocean conditions. With this information an El Niño or La Niña event can be predicted more accurately and advance measures for mitigation can be taken.

Tropical Cyclones

Called hurricanes in the Atlantic and typhoons in the Western Pacific, tropical cyclones are large systems of wind rotating around a centre of low atmospheric pressure. Their winds, which can reach as high as 200 km/h, torrential rains and high waves can cause extensive damage to the Pacific Island Countries. In the Northern Pacific the typhoon season lasts from May to October and in the South Pacific the cyclone season runs from November to April.

Many small islands are affected by random cyclonic events, which are a major problem for communities, often causing significant storm damage and flooding. Storm surges have inundated land, caused loss of life and severely damaged infrastructure in some small islands, for example, atolls in Tuvalu, the Marshall Islands, Federated States of Micronesia and the northern Cook Islands. During these events, freshwater lenses may receive considerable inputs from land inundation of seawater and subsequent infiltration, and many months may pass before they return to a potable condition.

The frequency of tropical cyclones has been related to the ENSO cycle. Of the twenty-four tropical cyclones which developed in the Tuvalu region between 1940 and 1985, twenty-one developed when the SOI was negative (Nunn, 1995) making the suggestion that ENSO influences tropical cyclone formation plausible.

Climate Change

In addition to current climatic variability, there is the possibility of climate change and sea level rise due to the enhanced greenhouse effect resulting from worldwide emissions of greenhouse gases. Climate change scenarios for PICs vary according to location and the models used. Most models predict an increase in frequency of El Niño episodes and increased intensity of cyclones (World Bank, 2000). There is less certainty about changes to rainfall, which could impact on the availability of island freshwater resources. Current scenarios indicate a rise in sea level over the next century of approximately 0.3 - 0.5 m. (IPCC, 2001).

Suva harbour, Fiji

The impact of current sea level rise scenarios on freshwater resources is likely to be relatively minor, compared with other influences (e.g. present climate variability, human impacts). The main potential impact would be inundation on the edges of low-lying islands and coastal zones of high islands. Tarawa, Kiribati has been the focus of impact studies under possible sea level rise and climate change scenarios. Results of groundwater modelling studies to assess the impacts on a freshwater lens under the combined effects of pumping, climate change and sea level rise, show that impacts of sea level rise on freshwater lenses are not detrimental provided that land is not permanently lost by inundation at the margins (World Bank, 2000).

ISLAND VULNERABILITY

Introduction

The vulnerability of Small Island Countries has received increasing attention since 1994 when the Barbados Conference on the Sustainable Development of Small Island Developing States called for recognition of their ecological fragility and economic vulnerability (United Nations Department of Public Information, 1999).

The particular vulnerability of islands is often described in terms of their remoteness, small size and exposure to climatic instability. The significance of the climatic component of vulnerability has drawn particular attention to the impacts of climate variability and change and the Association of Small Island States (AOSIS) has been successful in gaining international recognition for those concerns.

The Pacific Regional Consultation planning meeting held in Port Vila identified “Island Vulnerability” as a major theme that should receive particular attention and noted that this should encompass disaster preparedness and hazard management as well as the vulnerabilities associated with climate change and climate variability (ADB/SOPAC, 2002a). Benson and Clay (2000) point out that most disasters are recurrent rather than one-off events, and so can have a significant cumulative effect on the rate and nature of development. This is particularly true with respect to those disasters resulting from climatic hazards.

Despite broad acceptance of the special needs of Small Island Countries there has been some concern that vulnerability may have been given undue emphasis. For example, at a recent Fiji National Multi-Stakeholder consultation workshop it was noted that vulnerability had become a contentious issue at UN meetings on Sustainable Development because everyone is saying they are vulnerable.

Campbell (1997) suggests that the term “vulnerability” should be used sparingly and that the adaptive capacity of Pacific Island communities should not be underestimated. Barnett and Adger (2001) note that the emphasis on vulnerability focuses on weaknesses and shortcomings rather than on inherent strengths and opportunities. They suggest that work on coping and adaptation should be framed in terms of resilience and that emphasis should be shifted from impact assessment to risk assessment.

Vulnerability in relation to water and climate

Vulnerability refers to the risk of being harmed by unforeseen, or unusual, events. There is a wide range of hazards with the potential to impact upon Water in Small Island Countries; a simple classification of these is presented below.

Climate hazards

Climate (or meteorological) hazards occur over a very wide range of spatial and time scales. Nevertheless, they generally occur frequently enough in human terms to have allowed the development of traditional coping strategies. In addition, the improved scientific capability to observe and describe the interaction of the ocean and atmosphere is now providing for useful forecasts of some of these hazards.

Measuring Drought – A Case Study from Rarotonga (Cook Islands)

Rarotonga, the largest island and economic center of the Cook Islands, is entirely dependent on surface water catchments for its water supply. During drought periods demand increases while supply falls and it becomes difficult or impossible for the system to satisfy existing uses. Staff from the Cook Islands Department of Water Works have worked with Water Resource Specialists from the South Pacific Applied Geosciences Commission (SOPAC) to test the appropriateness of alternative methods for measuring drought severity. Using more than 70 years of daily rainfall records they have developed adrought index that is simple to understand and calculate and can be used to compare current conditions with previously experienced droughts. This measure of drought intensity allows monitoring of evolving drought conditions and will be useful in developing and implementing drought management plans. This effort to better manage water resources will be strengthened by a newly developed stream gauging network and provides a practical example of the Dialogue on Water and Climate's goal of learning to better cope with climate variability and change. (Parakoti and Scott, 2002)

Drought

Drought is an unusual hazard as, by its very nature, its onset is gradual. It has the capacity to have a broad range of impacts and as a result it can be defined and quantified in a number of different ways. White et al. (1999) list the four most common definitions of drought as:

- meteorological or climatological drought
- agricultural drought
- hydrologic data
- socio-economic drought.

The nature and severity of any particular drought episode is dependent on the duration and magnitude of the rainfall deficit. The sequence of drought impacts is felt first in systems with small water storage capacity: shallow soils may be affected by a relatively short period of below average rainfall whereas an extensive aquifer may have sufficient storage to be little affected by a drought duration of several years.

Drought is one of the major natural hazards facing Pacific Island Countries with agricultural drought presenting a particular problem for the atoll nations and the leeward side of larger islands. The most vulnerable communities are impoverished peoples occupying marginal rural and urban environments (ESCAP, 2000). When associated with an ENSO event, drought can have severe impacts throughout the region as occurred in the 1997/98 El Niño, as illustrated by the following examples:

- this event resulted in some of the worst droughts on record in the Northern Mariana Islands, Guam, the Marshall Islands, Nauru, Papua New Guinea, Fiji, Tonga, Samoa and American Samoa.
- in the Marshall Islands only eight percent of normal rain fell over the period from January to March 1998 which led to the government declaring the country a disaster area and resulted in the controversial installation of desalination plants to provide drinking water on Majuro and Ebeye.
- the highlands of PNG experienced one of the worst droughts on record which, together with associated low temperatures, caused significant crop failures and resulted in a national crisis with a need for airlifting of emergency food and water supplies.
- in Fiji the extended drought was regarded as the worst in the 20th century and resulted in serious restrictions of water supplies for crops and hydropower production. The impacts of the drought were most marked on the leeward sides of the main islands where existing water supply limitations were exacerbated and many of those dependent on agriculture for their livelihood received emergency food supplies.

The drought impacts of the 1997-98 ENSO event have been extensively documented (Glantz, 2001). Lessons learned from Fiji's experience of that drought demonstrate the need for:

- effective and timely forecasting and warning systems,
- drought-response strategies,
- information on quantitative measures of drought,
- awareness and education programs for drought preparedness,

- improved water management, and
- improved crop and stock management.

Country briefing papers (ADB/SOPAC, 2002b) prepared for the Regional Consultation meeting revealed that American Samoa, Palau and Fiji are each involved in the development of drought manuals. During the meeting participants from those countries expressed willingness to share relevant information with others. The Tuvalu Country briefing paper recorded that a survey of water storage capacity was required to improve water management during dry spells and noted that the Water Authority will need Government assistance to implement the survey programme. The New Caledonia Country briefing paper noted that the country was very sensitive to the ENSO cycle and that some irrigation projects were in place or planned to manage drought impacts on agriculture.

A wide range of possible drought management strategies used in Pacific Island countries is presented by Falkland (2001). These include coping strategies such as those used in traditional subsistence situations and measures that can be taken at the individual household level to conserve freshwater supplies and seek substitutes where possible. Reliable and timely warnings of drought would be of assistance to people who are reliant on these measures.

At a larger scale, other short-term measures are resorted to e.g. bulk cartage of water and desalination. Ideally, however, water management plans should address the inevitability of climate variability so that droughts do not necessarily require an emergency response (SOPAC, 1999). However, it should be noted that this requires adequate hydrological data for analysis and design, as well as the financial resources for implementation. A WMO workshop on reviewing national capabilities for Water Resources Assessment in the South Pacific countries (Nadi, September/October 1999) indicated significant constraints and led to the development of a proposal for a Pacific Hydrological Cycle Observing System (HYCOS) project (WMO, 2000) to address the needed capacity building.

Regardless of the measures taken to safeguard the security of water supplies it is almost certain that other sectors will remain susceptible to the impacts of drought. Over the last decade the ability to observe and predict the behaviour of the coupled atmosphere-ocean system has improved to the extent that useable forecasts of drought conditions are becoming available. The benefits that the agriculture, forestry and environment sectors could gain from reliable monitoring and predicting of drought conditions could justify the application of suitable forecasting techniques.

Flood

Floods are a significant hazard in those Pacific Island countries with high islands. The hazard is greatest when these islands are within the zone affected by cyclones and their associated extreme precipitation intensities. Floods can result in loss of life and extensive property damage, especially when river floodplains have been settled and/or cultivated. In cyclone conditions the affects of floods are often exacerbated by high-intensity rain induced landslide and resulting debris which can obstruct river channels and create potentially hazardous temporary dams.

The hazards that floods present to any structure also threaten water supply infrastructure (e.g. damage to intake works, treatment plants or distribution networks) and river flow monitoring stations. Floods can also threaten water supplies in a less direct way by compromising water quality. This range of hazards has been demonstrated in recent flooding in various Pacific Island countries:

- in 1986 Cyclone Namu caused widespread property damage in the Solomon Islands and floods which resulted in the destruction of several highway bridges and the loss of river flow monitoring sites.
- in 1987 Cyclone Uma hit Vanuatu where it was reported as being the worst cyclone in living memory in South Efate. The resulting widespread damage included the destruction of hydrological stations.
- in 1991 Cyclone Val devastated the islands of American Samoa. Water supplies were adversely affected when flooding caused by the accumulation of debris resulted in the inundation of wellheads.
- in 2001 flash floods in Samoa (Upolu) caused by extreme rainfall intensities associated with an unpredictable micro-weather system resulted in widespread damage including the contamination of potable water supplies and destruction of river flow monitoring sites.
- Typhoon Chata'an in 2002 completely destroyed or badly damaged all 11 flow monitoring sites in the Guam streamgage network.

The unavoidable susceptibility of river monitoring sites to flood damage compromises efforts to establish adequate flow monitoring networks. This has the potential to discourage capital investment in structures exposed to flood hazards (e.g. bridges, dams, floodplain developments) since these generally require sufficient hydrological information to allow estimates of flood magnitude of a specified probability.

Hydrological monitoring, Espiritu Santo, Vanuatu

In most situations the practical approach to managing flood hazard is to manage the landuse in those areas subject to flooding. A perception of increasing flood hazard may result if landuse controls are poorly enforced and these areas are allowed to become informal settlements. Landuse in river catchments (e.g. forestry, agriculture) can also have a significant effect on flooding risk. This range of factors points to the desirability of Integrated Water Resources Management concepts to assist with hazard management.

As with the hazard of drought, it is possible to take advantage of flood warnings in some situations. Flood warning systems require near real-time data on precipitation rates and/or upstream water levels or flows. In the relatively small and steep catchments encountered in Pacific Island countries telemetry systems are likely to be necessary to provide for timely flood warnings. A flood forecasting system has been operated on the Rewa River in Fiji since the late 1980's despite the difficulties encountered in finding replacements for obsolete equipment and maintaining a telemetry capability (Raj and Kumar, 2002). A flood warning system installed on the Sepik River in Papua New Guinea is no longer functional. The New Caledonia Country briefing paper revealed that a flood warning system was currently in operation for a hydropower dam and that a programme to map flood hazard was underway for selected areas of the country. This involves the use of hydraulic methods and simpler geomorphological methods. New Caledonia also referred to future plans to develop flood-warning systems including the acquisition of weather radar and the use of telemetry to provide observational data for rainfall-runoff models.

Tropical Cyclones

Tropical cyclones are a serious hazard in most Pacific Island countries but are more frequent in the western and central Pacific than in the eastern Pacific. The very high wind speeds of tropical cyclones are often accompanied by extremely intense rainfall and storm surge that is likely to be amplified by the associated low atmospheric pressures. This combination of factors can result in destruction of buildings and gardens, damage to tree crops, flooding, coastal inundation, and erosion, pollution of water supplies and destruction of coral reefs.

- Tropical cyclones are damaging for low-lying islands particularly where changes in land use practices have tended to reduce the natural resilience of subsistence life styles and increased the risk of soil erosion:
- in 1980 Cyclone Ofa caused extensive damage to the atoll islands of Tokelau. Public buildings and houses were extensively damaged, gardens and tree crops were destroyed, and inundation of sea-water washed away or contaminated the remaining topsoil.
- Cyclone Ofa also caused devastation in both Samoa and American Samoa where the widespread property damage was exacerbated by flooding problems resulting from the accumulation of debris in streambeds.
- in 1983 a sequence of five cyclones which struck French Polynesia had a devastating effect on many atoll villagers with storm surge conditions submerging or totally removing some villages. Groundwater resources were contaminated by seawater inundation, boats and fishing equipment were destroyed and vegetation and tree crops were extensively damaged.
- in Pohnpei (Federated States of Micronesia) large-scale forest clearing for commercial kava plantations resulted in massive landslides after a severe cyclone in 1997. The landslides caused loss of life, destruction of plantations, and damaged coastal coral reef communities.

It is considered likely that global warming may result in an increase in cyclone wind speeds and more damaging storm surges. Climate modelling may be able to provide some indication, in a particular cyclone season, of the probability of experiencing more or fewer cyclones than normal. These indications, though still somewhat experimental, may be helpful in reinforcing the efforts of disaster

management offices to promote public awareness of cyclone response plans.
However, the main focus of cyclone warning systems is at the near-time scale and depends upon a capacity to observe and track the spawning and evolution of individual cyclones: a capacity which has been transformed by the use of weather satellites which provide meteorologists with real-time views of weather systems. Recent progress in computer modelling of atmospheric systems has made it possible for meteorologists to predict cyclones, wind speeds, expected sea level rise and wave heights for several days in advance.

Several Country briefing papers reported on initiatives to develop disaster management plans (ADB/SOPAC, 2002b). These had often been undertaken or reinforced in response to particular disasters e.g. the creation in American Samoa of the National Disaster Preparedness Plan following Cyclone Tusi in February 1987. Samoa noted that the creation of a permanent National Disaster Management Council to coordinate early warning programmes and respond to extreme events was a huge improvement from the earlier ad hoc Disaster Management Committee which apparently only became active in times of extreme events. The Papua New Guinea National Disaster Management Office coordinates all reports and any responses to major disasters in conjunction with Provincial Disaster in each Province. However, as the Country briefing paper notes, despite many disasters hitting PNG the country is poorly prepared largely as a result of resources constraints and the lack of a coordinated National Response Plan.

A regional network of disaster management teams exists to develop and promote suitable emergency responses. This disaster management effort is supported by the Nadi Tropical Cyclone Warning Centre in Fiji which was designated as a WMO Regional Specialized Meteorological Centre in 1995 to provide advisory services on tropical cyclone detection, monitoring and forecasting to the National Meteorological Services of the South Pacific. Better storm prediction should reduce the risk of loss of life and damage to property by enabling governments to mobilise emergency response teams to assist communities with food, medicine, and shelter. The vulnerability of water supply systems to damage by cyclones makes it a priority for water utilities to have appropriate risk management plans in place (Mearns and Overmars, 2001).

Samoa Observatory

Non-climate hazards

Geological

Non-climate natural (or geological) hazards include volcano, earthquake, tsunami and landslide. Apart from landslide (which is often associated with high intensity rainfall during tropical cyclones) these hazards have a relatively low frequency and are difficult to predict with useful reliability.

Volcanic activity can produce a range of hazards to water supplies including contamination resulting from the spread of ash from volcanic eruption to catastrophic damage from volcanic blast. Under some circumstances vulcanologists are able to provide a warning of increased risk of volcanic activity and this can allow evacuation of people and possessions in advance of an eruption as occurred in Rabaul (Papua New Guinea) in 1994.

Many parts of the Pacific Region are subject to seismic activity which is generally localised and unpredictable but can result in very severe damage. The destructive potential of seismic activity was demonstrated in 1998 when an offshore earthquake and subsequent submarine landslide produced a tsunami which devastated the low sandy islets at Sissano in north-west Papua New Guinea, killing thousands and causing complete villages to disappear. In more developed areas, seismic activity has the potential to affect water supply catchments and to do extensive damage to water supply infrastructure.

Though monitoring and prediction of these hazards may improve in future, from the perspective of the Island Vulnerability – Water & Climate theme these geological hazards are similar to cyclones in that they require development of appropriate risk management plans.

Human hazards

There is a wide range of hazards created by human activity which are capable of causing considerable harm to water supply infrastructure and to have negative impacts on water quality. Some of these hazards can be unpredictable and difficult to manage. Others are quite predictable but may require measures that are difficult to implement. Examples relevant to Pacific Island situations include:

- Civil unrest (e.g. in East Timor following the popular vote for independence in 1999 an outbreak of violence resulted in widespread damage including the destruction of water supply and sanitation facilities)
- Land disputes (e.g. vandalism of water intakes located on customary land)
- Land use (e.g. inappropriate planting practices, use of agricultural chemicals, poor sanitation and waste disposal methods).
- The degradation of water quality though inadequate sanitation and waste disposal is arguably the largest hazard to Pacific Island water resources. The need for public education and effective land use controls to deal with these issues was noted in the Country briefing papers of Vanuatu and American Samoa (ADB/SOPAC, 2002b).

Another category of human hazard is created by what might better be called ***human inactivity*** where a lack of resources creates a risk. Examples include:

- Inadequate human resources or technical capacity (e.g. loss of trained personnel may compromise delivery of a critical service)
- Inadequate information may limit investment in water resources development or expose projects to poorly understood risks
- Budgetary limitations (e.g. communications disrupted though lack of financial resources)
- Institutional (e.g. lack of legislative or administrative control.

WATER RESOURCES AND WATER USE IN THE PACIFIC

Types of water resources

Freshwater resources in small islands can be classified in two main categories as follows:

o Naturally occurring water resources requiring a relatively low level of technology in order to develop them. This category, which is sometimes referred to as 'conventional' water resources, includes surface water, groundwater and rainwater.

o Water resources involving a higher level of technology (sometimes referred to as "non-conventional" water resources). This category includes desalination, importation and wastewater reuse.

Other "non-conventional" water resources include use of seawater or brackish water for selected non-potable requirements (e.g. wastewater disposal or fire-fighting) and substitution (e.g. coconut water has been used as a substitute for fresh drinking water).

Where available, the naturally occurring water resources are inevitably more economic to develop than the "non-conventional" water resources (Falkland, 2002). The main water resources in both categories are described in more detail below, as well as the major influences on the occurrence and distribution of the naturally occurring water resources.

Naturally occurring water resources

Surface water

Where conditions are favourable, surface water can occur on small high islands in the form of ephemeral and perennial streams and springs, and as freshwater lagoons, lakes and swamps.

Perennial streams and springs occur mainly in high volcanic islands where the permeability of the rock is low. Many streams are in small, steep catchments and are not perennial (e.g. Rarotonga, Cook Islands). Some streams flow for several hours or days after heavy rainfall, while others flow for longer periods but become dry in droughts.

Freshwater lagoons and small lakes are not common but are found on some small islands. These can occur in the craters of extinct volcanoes or depressions in the topography. Low-lying coral islands rarely have fresh surface water resources except where rainfall is abundant. Many small island lakes, lagoons and swamps, particularly those at or close to sea level, are brackish.

Brackish surface water, Tarawa, Kiribati

Groundwater

Groundwater occurs on small islands as either perched (high-level) or basal (low-level) aquifers.

Perched aquifers commonly occur over horizontal or sub-horizontal confining layers (aquicludes). Dyke-confined aquifers are a less common form of perched aquifer, which are formed when less permeable vertical volcanic dykes trap water in the intervening compartments (e.g. on some of the islands of Hawaii and French Polynesia).

Basal aquifers consist of unconfined, partially confined or confined freshwater bodies, which form at or below sea level. On many small coral and limestone islands, the basal aquifer takes the form of a ‘freshwater lens’ (or ‘groundwater lens’), which underlies part of the island.

Basal aquifers tend to be more important than perched aquifers because they are more common and generally have larger storage volumes. Basal aquifers are, however, vulnerable to saline intrusion owing to the freshwater-seawater interaction, and must be carefully managed to avoid over-exploitation and consequent seawater intrusion.

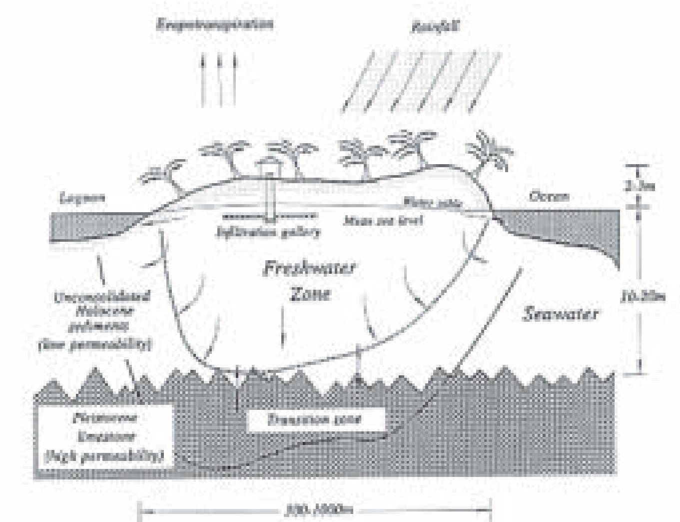

Figure 4: Cross section through a small coral island showing main features of a freshwater lens (exaggerated vertical scale) and location of an infiltration gallery.

The term ‘freshwater lens’ can be misleading as it implies a distinct freshwater aquifer. In reality, there is no distinct boundary between freshwater and seawater but rather a transition zone (refer Figure 4). The base of the freshwater zone can be defined on the basis of a salinity criterion such as chloride ion concentration or electrical conductivity.

Freshwater lenses often have asymmetric shapes with the deepest portions displaced towards the lagoon side of the island, as shown in Figure 4. Typically, the freshwater zone of a thick freshwater lens on a small coral island is about 10-20 m thick, with a transition zone of a similar thickness (e.g. Tarawa, Majuro). Where the freshwater zone is less than about 5 m thick, the transition zone is often thicker than the freshwater zone. The freshwater and transition zone thicknesses are not static but vary according to fluctuations in recharge and the sustainability of the groundwater abstraction.

Groundwater monitoring and assessment – A Case Study from Tarawa (Kiribati)

South Tarawa, the capital of Kiribati, is largely dependent for water on relatively thin freshwater lenses which float in a fragile equilibrium within the surrounding seawater. As in any atoll environment these freshwater reserves are vulnerable to seawater intrusion resulting from excessive pumping or insufficient rainfall. The rainfall in Kiribati is strongly correlated to the El Niño Southern Oscillation (ENSO) and the resulting variability results in extended periods of low and infrequent rainfall. These conditions have promoted a series of groundwater investigations over the last few decades which have provided the basis for progressively more reliable estimates of the sustainable yield of the freshwater lenses.

On-going monitoring and analysis have demonstrated that initial estimates of groundwater potential were conservative and have made it possible to plan future use with increasing confidence. The value of this groundwater resource knowledge can be gauged with reference to a World Bank study which indicated that the cost impacts on Tarawa’s groundwater due to climate change is between US$1 to 3 million per year. These high potential costs justify substantial investment in hydrological investigations and monitoring to ensure sustainable groundwater use. (Metai, 2002)

Rainwater

Rainwater collection systems are common on many islands. In small islands with high rainfall (e.g. the islands of Tuvalu), rainwater catchments using the roofs of individual houses and some community buildings, are the primary source of freshwater (Taulima, 2002).

In other small islands, rainwater is used as a source for essential water needs (e.g. drinking and cooking). In drought periods, when rainfall can be very little, or nil for many months, household rainwater storages are susceptible to being severely depleted unless very strict rationing is imposed. Common materials for rainwater tanks are ferrocement, fibreglass and plastic. Steel tanks are generally not used, owing to corrosion problems, unless they are well painted. Ferrocement tanks are commonly used in some Pacific islands (e.g. Tonga, Tuvalu, Kiribati, Federated States of Micronesia) as they can be constructed by local contractors and community groups which often contributes to the sustainability of their operation and maintenance. In recent years, plastic tanks have become popular for household rainwater collection in many islands of the Pacific and in Maldives.

In addition to roof catchments, rainfall is sometimes collected from specially prepared surfaces. Examples are paved airport runways (e.g. Majuro, Marshall Islands) and specially prepared surfaces with adjacent storage tanks or artificially lined reservoirs (e.g. some islands in Torres Strait, between Australia and PNG). Simple rainwater collection systems consisting of containers (e.g. plastic barrels) located under the crown of coconut trees where rainfall concentrates, are still used in some islands (e.g. some outer islands of PNG).

Runway rainwater catchment, Majuro, Marshall Islands

‘Non-conventional’ water resources

Desalination

Desalination is another, but less common method of freshwater production. Desalination systems are based on a distillation or a membrane process. Distillation processes include multi-stage flash (MSF), multiple effect (ME) and vapour compression (VC). Membrane processes include reverse osmosis (RO) and electrodialysis (ED). Descriptions of these processes are provided, together with approximate costs and a comprehensive reference list, in IETC (1998). The most common method used in small island countries is RO.

Desalination is a relatively expensive and complex method of obtaining freshwater for small islands (UNESCO, 1991). The cost of producing desalinated water is almost invariably higher than ‘conventional’ options (e.g. pumping of groundwater) due to the high energy and operating expenses.

The main drawback of desalination however, is the shortage of trained individuals and spare parts to maintain such systems. There are numerous examples of abandoned desalination plants throughout the Pacific. However, its selected use, especially in tourist resorts, can reduce the demand put upon conventional water resources.

Importation

Water importation has been employed for a number of islands, especially as an emergency measure during severe drought situations. Water has been imported by sea transport (boats, or barges) during droughts, for instance, to outer islands of Fiji and Tonga. Sometimes people on islands with a water shortage will travel by boat or canoe to nearby islands with more plentiful water sources.

In many small islands, bottled water has become an alternative source of drinking water (either imported or made locally by desalination plants). Invariably, its cost is higher than water supplied by local water authorities.

‘Bottled water’ for Ebeye from Kwajalein, Marshall Islands

Non-potable water sources

Non-potable water sources include seawater, brackish groundwater and treated wastewater.

There are many examples of the use of seawater and brackish waters in order to conserve valuable freshwater resources on small islands. For example, reticulated seawater is used for toilet flushing and as a source for fire-fighting in densely populated parts of Tarawa and Majuro. Dual pipe systems are used to distribute water to houses and other connections – one pipe system is for freshwater supply and the other for seawater. Seawater, or brackish well water, is often used for bathing and some washing purposes on small islands. Seawater is also used on some islands for cooling of electric power generation plants, for ice making and in swimming pools.

Treated wastewater is not a common non-potable source in small islands, but is sometimes reused for irrigation of garden and recreational areas at tourist resorts and hotels on some small islands (e.g. Fiji, Maldives).

Substitution

During severe drought conditions, or after natural disasters, coconut water has been used as a substitute for fresh drinking water. People on some of the smaller outer islands in Fiji, Kiribati, Marshall Islands and PNG, for instance, have survived on coconuts during drought periods. The coconut tree is very salt-tolerant and can continue to produce coconuts even when groundwater has turned brackish.

Water supply and use

As part of water resources management in small islands, it is important to understand the amount and pattern of water usage. The main uses of freshwater in small islands of the Pacific are:

- Water supply for human settlements, both urban and rural.
- Industrial activities (mainly in larger urban centres) and mining.
- Tourism.
- Agriculture and forestry.
- Environmental needs.

Additional non-consumptive uses are hydropower generation (e.g. Fiji, Samoa and Vanuatu), navigation and recreation.

The primary use for freshwater on small islands is water supply to urban and rural communities. Additional freshwater supplies are required in some islands to support tourist facilities, limited industry and farm and domestic animals. Overall, there is only minor utilisation of freshwater for industrial purposes, including mining, on small islands. Irrigated agriculture is not common on most small islands due to the limited water resources and abundant direct rainfall.

Further details of some of the more important water uses are outlined below.

Water supply and usage for human settlements

Potable freshwater is used for drinking and cooking and may also be used for bathing, washing and cleaning. Other applications may include toilet flushing, cooling, freezing, drinking water for animals and garden watering.

The types of water supplies and associated management systems vary from centralised water supply systems in urban areas to village and household systems in rural areas. The centralised systems most commonly consist of source works (groundwater abstraction systems and / or surface water collection and storage), transmission pipelines and networks of distribution pipe systems to consumers. These water supplies are sometimes metered so that water usage can be monitored.

At the village level on many small islands, freshwater is generally obtained in traditional ways and water usage tends to be reasonably low, on a per capita basis. Methods of obtaining freshwater include rainwater collection at the household level, groundwater withdrawal from privately owned wells and, on high islands, collection of water from small streams and springs. In addition to fresh (potable) water, non-potable water (brackish water and seawater) is utilised on some islands in order to conserve valuable freshwater reserves.

During droughts, private wells that normally supply fresh groundwater may become brackish. This water continues to be used for some purposes, for example clothes washing and bathing. In some islands, where residents have no access to freshwater, seawater is used for bathing.

Typical rural water supplies consist of communal systems and / or individual household systems. Communal systems have a distribution pipe network based on either surface water or groundwater sources. Surface water systems normally use gravity flow pipelines from streams or springs to tanks or standpipes in the village. Groundwater systems generally consist of a pump, which is operated for a number of hours each day supplying water to an overhead tank feeding standpipes within the village. Individual household water supply systems typically consist of a well, a rainwater catchment (e.g. roof) or collection from a spring or stream source near the village. In some cases, water is extracted from shallow wells dug at low tide on the beach.

Communal water supply systems are often managed by village or community 'water committees'. This may include collection of revenue to provide for operating costs (e.g. in Tonga, most rural water supplies use groundwater, and village water committees raise revenue to pay for pump operation and maintenance costs). Village water committees are also the basis of rural water supply implementation and operation in the Melanesian countries. In other PICs, communal water supplies are operated by island councils (e.g. Kiribati) or municipal administrations (e.g. Federated States of Micronesia). This may or may not include the collection of revenue from households benefiting from the water supply.

On Funafuti, the main island of Tuvalu, rainwater is collected in both household and communal tanks using church, schools and government buildings roof catchments. Where shortages are experienced at household tanks during extended dry periods, water is delivered by small tanker from the communal tanks. This service is provided by government and a fee is charged.

Per capita freshwater usage varies considerably between islands and within islands depending on availability, quality, type and age of water distribution systems, cultural and socio-economic factors and administrative procedures. Water usage varies from low values of approximately 20-50 litres per person per day (L/p/d), where water is very limited, to more than 1,000 L/p/d on some islands where water resources are plentiful. Water usage can be high where piped water supply systems are not kept in a good state of repair (leading to high leakage rates). Typical water usage in well-managed pipe systems is in the order of 50-150 L/p/d.

Water usage tends to be higher in urban than in rural areas for a number of reasons, including the use of water consuming devices (e.g. washing machines) and the inevitable leakage and wastage from distribution systems.

Tourism

Water supply to tourist resorts may represent a reasonably high proportion of total water consumption in some small islands, or parts of these islands. Water usage rates of 500 L/p/d are not uncommon (UNESCO, 1991).

In some islands however, the presence of tourist resorts actually enables local communities to benefit from higher technological solutions than otherwise could be financially sustained by the local population alone (e.g. Bora Bora, French Polynesia).

Agriculture

Many small islands, particularly coral atolls and small limestone islands, generally do not have either sufficient water resources or suitable soil conditions for irrigated agriculture. In some of the high volcanic islands where water is more prevalent and soils are suitable for agriculture Irrigation is possible and is practised on a relatively small scale.

Agricultural products Luganville, Vanuatu

Cultivation of root and tuber crops is practised in many Pacific islands. One important example is the cultivation of swamp taro on some coral atolls by digging pits to the water table. The production of cash crops, such as rice and sugarcane, involve high water use. Rice is grown with irrigation schemes in Fiji whereas sugarcane farming is predominantly rainfed.

Hydro-power generation

There are a number of small high islands where hydroelectric power generation schemes have been implemented (e.g. French Polynesia and Pohnpei). Some larger islands have extensive hydroelectric power generation schemes (e.g. Viti Levu, Fiji, Espiritu Santo, Vanuatu and Upolu, Samoa). Many other high islands have the potential for hydroelectric power generation. Hydro-power usage however, is not a consumptive use (i.e. the water is still available downstream of the structure).

Hydropower dam, Espiritu Santo, Vanuatu

Freshwater resources and use in the participating islands

A summary of the main freshwater resources and uses for each of the island countries and territories invited to the Regional Consultation Meeting is shown in Table 2.

As previously mentioned, the principal use of freshwater is for water supply purposes in villages and towns.

Table 2 Summary of freshwater resources in participating islands

Table 2 Summary of freshwater resources in participating islands

Country or Territory	Main freshwater resources[1]	Main freshwater uses[2]
Pacific Island Countries		
Cook Islands	SW, GW, RW	WS, T
Federated States of Micronesia	SW, GW, RW	WS
Fiji	SW, GW, RW, D (tourist resort only)	WS, T, H, I
Kiribati	GW, RW, D (limited)	WS
Marshall Islands	RW (from airport catchment and buildings), GW, D (emergency)	WS
Nauru	D (regular use), RW, GW (limited)	WS
Niue	GW, RW	WS
Palau	SW, GW, RW	WS
Papua New Guinea	SW, GW, RW	WS, M
Samoa	SW, GW, RW	WS
Solomon Islands	SW, GW, RW	WS
Tonga	GW, RW, SW (limited)	WS
Tuvalu	RW (primary), GW (limited), D (emergency)	WS
Vanuatu	SW, GW, RW	WS, T, H
Other Pacific Islands (Territories of USA and France)		
American Samoa	SW, GW, RW	WS
French Polynesia	SW, GW, RW, D	WS, T
Guam	SW, GW, RW, D	WS
New Caledonia	SW, GW, RW	WS, M
Island countries in other regions		
East Timor	SW, GW, RW	WS
Maldives	D (main island of Male); GW, RW (outer islands)	WS

Notes:
1. SW = Surface water, GW = groundwater, RW = rainwater, D = desalination.
2. WS = water supply to communities, T = tourism, H = hydroelectricity, M = mining, I = irrigation.

MANAGING VULNERABILITY

The terms coping and adaptation are often used to describe alternative types of response to hazards. Coping tends to be used in the sense of “coping with” and may imply a reactive approach whereas adaptation tends to be expressed as “adapting to” implying a more proactive approach. These distinctions are, to some extent, rather arbitrary and there is considerable overlap between the two terms. An alternative classification can be based on consideration of whether or not the response is based on a forecast. The following examples of systematic responses to hazards illustrate both types of approach. They are chosen to represent the broad range of responses at a strategic level.

Strategic responses

Application of seasonal and inter-annual climate forecasts

Research into the interaction of the ocean and atmosphere over the last two decades has resulted in an impressive ability to observe and account for many of the factors governing climatic variability at the seasonal and inter-annual time scale. This has led to the development of techniques that are able to produce climate forecasts of modest skill (Ropelewski and Lyon, 2002). A number of initiatives are underway within the Pacific region to provide useful information from the available forecasts to support decision makers:

- The Pacific ENSO Applications Center (PEAC), which was established in 1994 to conduct research and produce information on climate variability for the U.S. affiliated Pacific Islands, produces a quarterly bulletin (the Pacific ENSO Update) providing a summary of climate conditions, forecasts and local variability http://lumahai.soest.hawaii.edu/Enso/subdir/update.dir/update.html. PEAC has taken an active role in disseminating critical climate forecasts to decision makers, an activity that has depended upon good understanding of local climate variability and how it relates to larger scale climate cycles. PEAC’s role in warning governments in the U.S. affiliated Pacific Islands of the expected impacts of the 1997-98 El Niño contributed to the interest in developing a similar capability in the South Pacific.
- In response to a recommendation made at the Sixth SPREP Meeting of Regional Meteorological Services (Tahiti, French Polynesia, 2000), Directors the Australian Bureau of Meteorology collates and disseminates a South Pacific Seasonal Outlook Reference Manual. This document is directed at National Meteorological Services and provides a summary of current observations and seasonal and long-range forecasts of sea surface temperatures and rainfall.
- The National Institute of Water and Atmospheric Research, New Zealand (NIWA) publishes a monthly climate bulletin for the Pacific region which provides an overview of the present climate with an outlook for the coming three months. The Island Climate Update (ICU), which is distributed in hard copy and made available on the web at http://www.niwa.cri.nz/NCC/ICU, is designed to be useful to users of climate data as well as to National Meteorological Services.

From the perspective of water resources management the principal interest in long-term climate forecasts is their potential to provide early warning of the onset, severity and persistence of the precipitation anomalies leading to drought conditions. The SOPAC workshop on ENSO Impact on Water Resources in the Pacific Region (SOPAC, 1999) demonstrated the growing demand from users of climate information for seasonal and inter-annual forecasts. However, as Stern and Easterling (1999) note "the effectiveness of forecast information depends strongly on the systems that distribute the information, the channels of distribution, recipients' modes of understanding and judgement about the information sources, and the way in which the information is presented". They reinforce PEAC's conclusions regarding the significance of local knowledge by suggesting that forecasts will be most effective when "organised to meet recipients' needs in terms of their coping strategies, cultural traits and specific situations; that participatory strategies are likely to be most useful in designing effective climate forecast information systems".

These requirements place demands on the users of climate information (water resource managers, disaster managers) as well as the developers and distributors of forecasts. Without an adequate appreciation of the nature of a forecast and an effective response strategy it is likely that timely warnings will go unheeded. For example, Glantz (2001) records that in May 1977 the Fiji Meteorological Service provided a drought forecast that gained little response from users. He suggests that this was most probably because of the difficulties of using information presented in meteorological terms. However, it is also likely that a lack of effective response strategies would also have played a role.

Majuro atoll, Marshall Islands

Such needs are widespread. In a review of Regional Climate Outlook Forums IRI (2001) reported for the Caribbean, Pacific Islands and Southeast Asia that "capacity is needed to develop and enhance the application of climate information. Currently, climate information users include disaster managers, hydrologists and water managers, and, in the case of Southeast Asia, environment ministries. Pilot projects and workshops are needed to develop better understanding of user needs and to develop an understanding of the value of climate forecasts and information in agriculture, water resource management, health and other sectors."

Hazard and risk management programmes

The recognition that vulnerabilities should be addressed by risk management has been reflected in two guidelines recently developed by SOPAC:

- Guidelines for water and sanitation utilities risk management planning (Mearns and Overmars, 2001) provides a framework for identifying and analysing the hazards to utilities and promotes the development of specific plan required to prepare for, mitigate and respond to disasters. The Regional Consultation meeting will provide an opportunity for feedback on the implementation of these guidelines.
- A more comprehensive set of guidelines for Comprehensive Hazard and Risk Management (CHARM) has been developed as part of the SOPAC Disaster Management Unit's work programme. CHARM is defined as a comprehensive hazard and risk management tool and/or process within the context of an integrated national development planning process (SOPAC, 2002b).

Vulnerability and adaptation assessments

Vulnerability and adaptation assessments in relation to climate change are required of signatory countries to the United Nations Framework Convention on Climate Change (UNFCC). The Pacific Islands Climate Change Assistance Programme (PICAPP) was developed to assist with the reporting, training and capacity building required under the convention. Climate Change Country Teams established under PICAPP undertook to:

- prepare inventories of greenhouse gas sources and sinks,
- identify and evaluate emission reduction strategies
- assess vulnerability to climate change
- develop adaptation options
- develop a national implementation strategy for mitigating and adapting to climate change over the long term.

Ten Pacific Island Countries have concluded preliminary national vulnerability assessments. In a synthesis of these assessments Hay and Sem (2000) note the following adaptations with relevance to water resources:

- Improved management and maintenance of existing water supply systems has been identified as a high priority response, due to the relatively low costs associated with reducing system losses and improving water quality.
- Centralised water treatment to improve water quality is considered viable for most urban centres but at the village level it is argued that more cost-effective measures need to be developed.
- User pay systems may have to be more widespread.

  Catchment protection and conservation are also considered to be relatively low cost measures that would help ensure that supplies are maintained during adverse conditions. Such measures would have wider environmental benefits, such as reduced erosion and soil loss and maintenance of biodiversity and land productivity.
- Drought and flood preparedness strategies should be developed, as appropriate, including identification of responsibilities for pre-defined actions.
- While increasing water storage capacity through the increased use of water tanks and/or the construction of small-scale dams is acknowledged to be expensive, the added security in the supply of water may well justify such expenditure.
- Development of runways and other impermeable surfaces as a water catchment is seen as possible, but an extreme measure in most instances. Priority should be given to collecting water from the roofs of buildings.
- Measures to protect ground-water resources need to be evaluated and adopted, including those that limit pollution and the potential for salt-water intrusion.
- The limited ground-water resources that are as yet unutilised in the outer islands of many countries could be investigated and, where appropriate, measures implemented for their protection, enhancement and sustainable use.
- The development of desalination facilities is considered to be an option for supplementing water supplies during times of drought, but in most instances the high costs are seen as preventing this being considered as a widespread adaptation option.

Amongst the many assessment findings summarised by Hay (2000) the following are most relevant to the Island Vulnerability – Water and Climate theme:

- climate variability, development and social changes and the rapid population growth being experienced by most PICs are already placing pressure on sensitive environmental and human systems; and these impacts would be exacerbated if the anticipated changes in climate and sea level (including extreme events) did materialise;
- land use changes, including settlement and use of marginal lands for agriculture, are decreasing the natural resilience of environmental systems and hence their ability to accommodate the added stresses arising from changes in climate and sea level;
- given the limited area and low elevation of the inhabitable lands the most direct and severe effects of climate and sea level changes will be increasing risks of coastal erosion, flooding and inundation; these effects are exacerbated by the combination of seasonal storms, high tides and storm surges;
- other direct consequences of anticipated climate and sea level changes will likely include: reduction in subsistence and commercial agriculture production of such crops as taro and coconut; decreased security of potable and other water supplies; increased risk of dengue fever, malaria, cholera and diarrhoeal diseases; and decreased human comfort, especially in houses constructed in western style and materials;
- groundwater resources of the lowlands of high islands and atolls may be affected by flooding and inundation from sea level rise; water catchments of smaller, low-lying islands will be at risk from any changes in frequency of extreme events;
- the overall impacts of changes in climate and sea level will likely be cumulative and determined by the interactions and synergies between the stresses and their effects; and
- the current lack of detailed regional and national information on climate and sea level changes, including changes in variability and extremes resulted in most assessments being limited to using current knowledge to answer "what if" questions regarding environmental and human responses to possible stresses.

The first of these findings is particularly significant since it implies that in most parts of the Pacific region present problems resulting from increasing demand for water and increasing pollution of water may be much more significant than the anticipated effects of climate change.

The final finding is also significant in that it refers to climate variability. The UNFCC reporting obligations referred specifically to climate change (rather than to climate variability and change) possibly reflecting the perspective of climate change science current at the time the Convention was drafted. A greater appreciation of the role of variability has developed and it is now generally recognised that the impacts of climate change are likely to be experienced through changes in variability. These considerations suggest that managing water resources for variability and extremes is fundamental to the issue of adapting to climate change in the longer term.

That conclusion is also supported by the vulnerability and adaptation assessments completed for Fiji and Kiribati (World Bank, 2000) which provide examples of climate change impacts on water resources on high islands and low islands and reach the conclusions that:

- Pacific Islands countries are already experiencing severe impacts from climate events,
- island vulnerability to climate events is growing independently of climate change,
- climate change is likely to impose major incremental social and economic costs on Pacific Island countries, and
- acting now to reduce present-day vulnerability could go a long way toward diminishing the effects of future climate change.

Some key recommendations derived from these conclusions include:

- the adoption of a “No Regrets” adaptation policy,
  development of a broad consultative process for implementing adaptation.
- requiring adaptation screening for major development projects.
- strengthen socio-economic analysis of adaptation options.

These recommendations reflect the need for the mainstreaming of climate change adaptation policies.

Priority Actions

Recommendation for action emerging from the International Conference on Freshwater (Bonn, 2001) include several which are particularly relevant to the Island Vulnerability theme and the Dialogue on Water and Climate, and these are listed below. In addition, existing proposals for capacity development in relation to water resources assessment and climate information and prediction are outlined below along with some additional agreed priority actions as determined by the regional consultation.

Recommendations for Action from Bonn Conference

The Bonn Conference adopted a comprehensive set of recommendations for action many of which are particularly relevant to Island Vulnerability and Water and Climate as listed below:

- Water management arrangements should take account of climate variability and expand the capacity to identify trends, manage risks and adapt to hazards such as floods and droughts. Anticipation and prevention are more effective and less expensive than having to react to emergencies. Early warning systems should become an integral part of water resources development and planning.
- Knowledge is the foundation of understanding and decision-making. Shared knowledge, and respect for different forms of knowledge, are the basis for building consensus and resolving conflicts. Decisions can only lead to effective management actions if the actors have the right knowledge and skills. Enhancing human capacities at all levels is a key for wise water management. This needs to be based on integrating the distinct and complementary contributions of local, traditional knowledge, knowledge from different professionals and disciplines and the hands-on experience of practitioners. All can and should learn from each other. Practical actions to build partnerships and create channels for sharing information at all levels are a key first step in developing integrated water management.
- The knowledge and skills needed for water management change as new knowledge is generated and new needs emerge. Mechanisms to disseminate knowledge, change curricula, exchange teaching materials and create partnerships between educators and trainers around the world should be developed and funded.
- Knowledge must be shared globally and packaged appropriately for intended target audiences. This includes the provision by all countries of basic data for research and assessment. Information management must provide information to decision makers at the right time and in a form they understand.
- Capacity building and technical assistance are among the essential elements for institutional change for integrated water management. This is a long-term process, which should be based on gradual, practical steps. It must be flexible, as needs are constantly changing. Collaboration and international partnerships are particularly needed in many developing countries, where reform is most needed but resources are most limited.

- There are many positive experiences of institutional change throughout the developing world. Specific initiatives to develop models of good practice and improve South-South sharing of experiences are needed.
- The wealth of available experience in all countries and sectors needs to be tapped in a systematic fashion. Donor agencies and industry need to cooperate for the transfer and adaptation of the best available technologies. South-South technical transfer is also important.

Pacific HYCOS

The development of a Hydrological Cycle Observing System for the South-West Pacific region (Pacific HYCOS) was considered at a meeting of experts on "Hydrological Needs of Small Islands" held in Nadi, Fiji in October 1999. A project proposal, developed in collaboration with the countries and in consultation with Regional organizations, was circulated in February 2001 to the countries concerned in the region. The project has been endorsed for implementation by eight countries and territories (Cook Islands, Fiji, Nauru, New Caledonia, Niue, Papua New Guinea, Solomon Islands and Vanuatu).

The Pacific HYCOS has been developed on the basis of a detailed needs analysis and has a strong emphasis on regionally coordinated capacity building. The stated purposes of the project are:

- To assist the participating countries to establish the human and institutional capacity to assess status and trend of national water resources and to provide adequate warnings of water-related hazards.
- To establish basic hydrological monitoring and data capture systems, using technology that balances modernity, economy, robustness, and suitability for Pacific Island circumstances.

Wambu River, Espiritu Santo, Vanuatu

- To establish hydrological databases and information systems that provide users with the information they require, to the standards they need, and that provide a secure repository of information for the indefinite future.

The project proposes to deliver six distinct components which are designed to meet the range of needs of Pacific Island countries as follows:

- Flood forecasting capability,
- Water resources assessment in major rivers,
- Water resources databases,
- Drought forecasting,
- Groundwater monitoring and assessment, and
- Water quality monitoring and assessment.

This project addresses one of the critical areas relevant to Island Vulnerability and in recognition of this a working group was constituted during the Regional Consultation meeting in Sigatoka that resulted in the endorsement of the proposal as part of the consideration to be included in the ministerial level declaration of the meeting.

Pacific Climate Information and Prediction System

The potential for a regional approach to the provision of climate information and predictions has been recognised for several years. Basher (1997) developed a comprehensive proposal to build Pacific Island countries' capacity for management and application of climate data with multiple objectives including support for the application of climate forecasting in the region. Though that proposal failed to gain support, interest in the potential for climate systems has continued to grow and an Informal Working Group on a Pacific Climate Information and Prediction System was organised under the auspices of SPREP in 1999. At its initial meeting the group adopted the goal "to combine the unique assets and special expertise of a number of national, regional and international institutions and programs to develop and strengthen a Pacific Climate Information and Prediction System designed to support practical decision making in the context of climate variability and change".

The experience of the 1997-98 El Niño developed much broader appreciation of the value of climate information and forecasting and a Regional workshop on ENSO impacts on water resources (SOPAC, 1999) called for the development of appropriate programmes to deliver climate information and forecast services. The meeting, which was attended by representatives from 23 Pacific Island countries with backgrounds in water resources management, disaster management and meteorological services,

Raingauge, Espiritu Santo, Vanuatu

highlighted the need for more interaction between national agencies and urged WMO and SPREP to work closely with SOPAC and the Pacific ENSO Applications Centre (PEAC).

The concept of a regional climate system gained some support, initially from the Italian Government and subsequently from NZODA (now NZAID), which has provided for the production of The Island Climate Update. This climate bulletin is produced by NIWA (National Institute of Water and Atmospheric Research, New Zealand) and provides an overview of present climate in the tropical South Pacific with an outlook for coming months (http://www.niwa.cri.nz/NCC/ICU). The possibility of sustaining and developing this service received attention at the recent meeting of the WMO Regional Association for South-West Pacific (RA V) which recorded support for the establishment of Regional Climate Centres in the region. It should be noted that this is likely to require the close collaboration of SPREP and SOPAC.

Drought assessment and response

A drought forecasting capability is one of the components of the Pacific HYCOS. Nevertheless, if that project does not proceed or is delayed, it would be quite feasible to undertake an independent project to implement procedures to monitor and forecast drought in Pacific Island countries. Relevant preliminary work has already been undertaken in a case study of Tarawa Atoll, Kiribati (White et al., 1999) and led to the following recommendations:

- standard, broadly applicable drought indices be developed for all small island nations subject to drought as a method of identifying the severity of drought and as a trigger for water conservation and relief strategies;
- the characteristics of the various water storages in small islands be assessed and that the demand functions for those storages be identified;
- the relation between agricultural productivity and drought be examined particularly for coconut trees;
- the use of the decile rainfall ranking method to provide warnings of droughts be examined;
- the relation between the Southern Oscillation Index and ranked accumulated rainfalls be examined for periods longer than 12 months;
- a risk analysis be undertaken of small island water supplies in dry periods in relation to power failure;
- that routine monitoring of the salinity of a range of domestic water wells and large freshwater lenses be undertaken to test the assumptions in this analysis;
- given the frequency of drought relevant to rain water tanks and domestic water wells, educational and planning policy be developed to minimise use and maximise storages.

The potential value of developing procedures and extending their application to other island countries was recognised at the ENSO workshop in Fiji (SOPAC, 1999) and a draft project proposal has been prepared.

PACIFIC REGIONAL ACTION PLAN

Regional Consultation

As part of the regional consultation and preparation for the “Water in Small Island Countries” and “Dialogue on Water & Climate” themes of the 3rd World Water Forum, during the “Pacific Regional Meeting on Water in Small Island Countries”, held in Sigatoka, Fiji from 29 July to 3 August 2002, Ministers, Heads of Delegation and representatives of civil society groups with responsibilities for water affairs from 16 small island countries in the Pacific, as well as East Timor and the Maldives agreed upon the implementation of the **“Pacific Regional Action Plan for Sustainable Water Management”**.

The consultation process included the identification of national priority actions as determined by the participating countries on the basis of their national water strategies, national assessments and stakeholder consultations undertaken for the World Summit on Sustainable Development and the 3rd World Water Forum and the development of agreed regional actions through the consultation meeting process of plenary discussion, working group review and delegation approval.

Relevant to the Dialogue on Water and Climate, the regional action plan contained three key messages as follows:

Key Message 1: Strengthen the capacity of small island countries to conduct water resources assessment and monitoring as a key component of sustainable water resources management.

Because of the significant overlap between the Water Resources Management and Island Vulnerability themes this key message was adopted in collaboration between the two theme working groups. Supporting statements recorded for this key message are all immediately relevant to the Island Vulnerability theme as follows:

1. Many small island countries have noted significant deficiencies in their national and local capacity to conduct essential water resources assessment and monitoring in their country papers at this meeting and at previous regional and inter-regional meetings over the past decade and more.
2. These deficiencies prevent small island countries from conducting proper planning, development and sustainable management of their limited and vulnerable water resources.
3. Despite this fact, there continues to be no systematic, co-ordinated approach to addressing these deficiencies.
4. Most small island countries do not have adequate baseline data that is readily available for planning and development and lack of reliable hydrological databases.
5. There are similarities between needs which can be addressed at regional, as well as national level, through targeted training and capacity building.
6. Proposals for capacity building and training of technicians in Pacific island countries have been prepared in recent years by regional and international agencies with expertise in hydrology, water resources and water quality.

Amongst the priority actions proposed in response to this key message the following are particularly relevant to the Island Vulnerability theme:

- Implement actions to strengthen national capacity (equipment, training, etc) using the model outlined in the Pacific-HYCOS proposal (WMO, 2000) and recommendations regarding water quality in WHO (2001).
- Implement hydrological training for technicians in line with the recommendations presented in the proposal to meet training needs in SOPAC/WMO/UNESCO (2001).
- Develop and/or implement minimum standards for conducting island water resources assessment and monitoring.
- Strengthen and enhance communication and information exchange between national agencies involved with meteorological, hydrological and water quality data collection programmes (including water supply agencies and health departments) and with users.

Key Message 2: There is a need for capacity development to enhance the application of climate information to cope with climate variability and change.

Supporting statements adopted in support of this key message were as follows:

1. There has been growing recognition of the importance of climate variability and the impact of extreme climatic events and the need for climate forecasting to respond to these events.
2. Significant progress has been made in the development and dissemination of climate information and prediction in the Region based, in part, on observations of the coupled atmospheric/ocean system (e.g. GOOS).
3. WMO/CLIPS (Climate Information and Prediction Services) Program has established a framework of CLIPS focal points within National Meteorological/Hydrological Services.
4. A Pacific Climate Information and Prediction System has been proposed and endorsed at the Regional ENSO workshop (SOPAC, 1999).
5. Pacific Island Countries have recognised the significance of drought as a major hazard that needs to be planned for and that climate prediction allows a much more effective response.

Priority actions proposed in response to this key message are to:

- Enable WMO CLIPS/HYCOS with regional partners to develop and enhance the application of climate information and to strengthen links between meteorological and hydrological services by:
  - working with existing climate information services in the region,
  - formalising efforts to build climate information and forecasting capacity,
  - ongoing development of analysis, forecasting and application tools,
  - including participation by end users (e.g. water providers, hazard managers, health officials, agriculture and public).

- Develop rainfall and drought prediction schemes for Pacific Island Countries by:
  - adaptation of existing models to Pacific Island countries (e.g. see below "Rainfall Forecasting - A Case Study from Fiji Islands"),
  - future development of drought monitoring and prediction methods.

- Enable regional support to develop water applications of Climate Information and Prediction through:
  - training
  - applied research
  - technology transfer

Rainfall Forecasting - A Case Study from Fiji Islands

Rainfall in Fiji is highly variable with distinct wet and dry seasons which can have serious impacts on the nationally important sugar industry. This variability is closely related to the El Niño Southern Oscillation (ENSO) as demonstrated by the severe drought impacts on sugarcane resulting from the 1997-98 El Niño.

The Fiji Meteorological Service (FMS) has in recent years made significant progress in developing a seasonal rainfall forecasting scheme based on the Southern Oscillation Index (SOI) and have been promoting the application of forecasts in a number of sectors. A recent study carried out by FMS in partnership with the Fiji Sugar Corporation and the University of the South Pacific has produced a management strategy for the sugar industry using the rainfall forecast.

This example of a seasonal rainfall prediction scheme has generated interest in the possibility of adapting the method to other Pacific Island countries.

(Pahalad and McGree, 2002)

Key Message 3: Change the paradigm for dealing with Island Vulnerability from disaster response to hazard assessment and risk management, particularly in Integrated Water Resource Management.

Supporting statements adopted in support of this key message were as follows:

1. A shift is taking place in disaster management generally from a disaster response approach to hazard assessment and risk management.
2. Most disaster management has not addressed the risk of droughts and few governments have attempted to manage the risk of droughts in the Pacific Islands.
3. Climate change may result in more climate variability and the risk of extreme weather and climate events may increase. SPREP's current work on climate and PICAPP have provided a framework for assessing the potential impacts of climate variability and change.
4. Population growth and development are going to increase the vulnerability of island societies to droughts and other climate and extreme weather events.
5. The Disaster Management Unit at SOPAC has made strides in the development of CHARM. It provides an approach to shifting the approach from vulnerability to hazard assessment and risk management.
6. WMO, SPREP, SOPAC, ADB and other regional and international organization can contribute a shift to hazard assessment and risk management.
7. There are similarities between needs which can be addressed at regional, as well as national level, through targeted training and capacity building.

Priority actions proposed in response to this key message are to:

- Implement actions to strengthen national capacity to use hazard assessment and risk management using CHARM and other vulnerability assessment and risk management tools.
- Provide high-level briefings for political leaders from the region on the value of CHARM as a tool for planning and decision-making.
- Implement a programme of climate analysis for regional countries that can assess the risk of climate-related extreme event, particularly droughts and floods, and tropical cyclones.
- Develop and/or implement minimum standards for conducting island risk and vulnerability assessments and development of drought mitigation and response plans.
- Build on the climate analysis and forecasting capacity provided by Fiji Meteorological Service, the Pacific ENSO Applications Center, the Australia Bureau of Meteorology, and the National Institute for Water and Atmospheric Research to develop risk reduction strategies through the use of climate forecasting in conjunction with risk management.

Small Island Countries at the 3rd World Water Forum

As mentioned before the vulnerability and particular needs of Small Island Countries has been acknowledged by the global water community, by the inclusion of a 'Water in Small Islands Countries' theme at the 3rd World Water Forum to be held in Kyoto, Japan, 16-23 March 2003.

The outcomes of the Pacific regional consultation meeting have been incorporated in a Partnership arrangement under the so-called Type II initiatives that were part of the Pacific submission to the Commission for Sustainable Development in Johannesburg during the World Summit for Sustainable Development in August 2002.

A similar process took place in the Caribbean where during the 11th Caribbean Water and Wastewater Association Conference and 1st Caribbean Environmental Forum & Exhibition held in St Lucia 7-11 October 2002 a regional forum was provided for presentation, discussion and planning for the implementation of the outcomes of the World Summit for Sustainable Development and the input towards the World Water Forum in Kyoto within a Caribbean context. The Caribbean Environmental Health Institute (CEHI) played a leading role in facilitating these meetings as well as the Caribbean Dialogue on Water and Climate which was facilitated by the Organisation of American States (OAS).

The outcomes of both Pacific and Caribbean Dialogues will be taken to the World Water Forum and will contribute to a session organised by the International Secretariat for the Dialogue on Water and Climate as well as the Water in Small Island Countries session convened by the Asian Development Bank.

Whereas during the Pacific consultation meeting in Sigatoka “Island Vulnerability” was identified as a major theme that should receive particular attention in Kyoto, the meeting in St Lucia provided the basis for a joint Programme of Action for Small Island Countries that can be presented during the World Water Forum.

Despite the different approaches both regions adopted in its consultations and dialogues it is obvious that there are many commonalities between the Pacific and Caribbean in addressing problems related to water and climate and collaboration between the small island countries will contribute to a successful implementation of concrete actions in the future.

The following recommendations can be made to enhance this collaboration:

- ➤ Use should be made of the solid base provided by the combined capacity of institutions like CEHI, OAS and the Caribbean Community Climate Change Centre (CCCCC) in the Caribbean and SOPAC, SPREP, PEAC and IGCI in the Pacific.
- ➤ The idea of an Island States Water Partnership should be fully explored, possibly within the framework of the Global Water Partnership (GWP).
- ➤ Initiatives in both regions on Integrated Water Resources Management (IWRM) can be exchanged and a joint Programme of Action can be developed and endorsed during the small island countries session at Kyoto.
- ➤ The programme of action can be submitted to AOSIS and tabled at the follow-up Conference on the UN Global Conference on the Sustainable Development of Small Island States (UNGCSIDS or Barbados +10).

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