Sustainable Water Management in the Pacific Islands

Theme 2: Island Vulnerability and Dialogue on Water and Climate

Contents

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1 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. 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 has been successful in gaining international recognition for those concerns.

The declaration emerging from the UNDP Global Roundtable on Vulnerability and Small Island Developing States (http://www.undp.org/wssd/docs/Declaration – Roundtable-on-SmallIslandDevelopingStates.doc) noted that vulnerability provides a useful context for understanding how comprehensively economic, environmental and social challenges are faced. While recognizing the interplay of the many factors contributing to vulnerability the Roundtable declared that it is the element of limited capacity that makes Small Island Developing States most vulnerable. This perspective was reflected in the plenary session of the Pacific Regional consultation when it was suggested that 'poverty of opportunity' was a significant issue for Pacific SIDS.

The Asian Development Bank's Pacific Strategy for the new millennium (http://www.adb.org/Documents/Policies/Pacific_Strategy/pacific_strategy.pdf) addresses the challenge presented by increasing poverty in several Pacific Island Countries and suggests that poor economic performance together with rapid population growth and urban drift are putting traditional support mechanisms under strain. The strategy notes the close link between poverty and vulnerability and refers to the development of a composite vulnerability index based on economic measures and susceptibility to natural disasters.

The Commonwealth Secretariat/World Bank Joint task force on small states (http://www.wbln0018.worldbank.org/html/smallstates.nsf/) also considered the characteristics that contribute to the vulnerabilities of small states and made particular reference to Small Island Developing States where the limited public and private sector capacity is compounded by large distances and dispersed populations.

Efforts to develop measures of vulnerability have conventionally focused on the economic and social components involved. Growing recognition of the significance of environmental vulnerability has led to efforts to establish an Environmental Vulnerability Index (SOPAC, 2001) focusing on risks to the natural environment. The issues involved in managing environmental vulnerability include several natural and anthropogenic hazards relating to water resources (SOPAC, 2002).

This multi-faceted nature of vulnerability is reflected in the scooping of the Pacific Regional Consultation on Water in Small Island Countries:

- issues associated with environmental vulnerability are considered largely in relation to Theme 1 (Water Resources Management) and Theme 2 (Island Vulnerability) within which the particular relationshipbetween water and climate are emphasized,

- issues associated with social vulnerability are largely considered within Theme 3 (Awareness) and Theme 5 (Institutional Arrangements)
- issues associated with economic vulenarbility are considered in the context of Theme 4 (Technology) and Theme 6 (Financing).

The World Water Council has acknowledged the vulnerability and particular needs of Small Island Countries by including the "Water in Small Island Countries" theme in the 3rd World Water Forum. 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. 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.

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 further input to the 3rd World Water Forum. The Dialogue on Water and Climate implicitly recognises inherent resilience in its stated goal:

"***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***".

2 Vulnerability in relation to water & 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 in the following table.

Natural hazards	Climate (Meteorological)	Drought
		Flood
		Cyclone
		Storm surge
	Non-climate (Geological)	Volcanic
		Seismic
Human hazards		Civil unrest
		Land tenure
		Land use
		Human resources

The range of physical environments encountered within Small Island Countries in the Pacific Region are often categorised in terms of low and high islands. The Ministerial Conference on Environment and Development in Asia and the Pacific (ESCAP, 2000) recognised the social and economic dimension by proposing three distinct zones based on resource endowments, size, and the state of economic development:

- Melanesian countries with rich natural resources and relatively large human populations. Though there are distinct socio-economic conditions within this zone these countries share environmental problems resulting from land degradation, unsustainable forestry, water pollution from mining and significant problems in the rapidly growing cities including limited access to adequate water supplies and sanitation in peri-urban settlements.
- Mid-sized islands of Polynesia and Micronesia and the small high Island Territories of the United States. These countries have limited land resources, minimal or no commercial forestry and no commercial mineral deposits. The predominantly rural and agrarian economies of these countries are sustained by external inputs from remittances from expatriate islanders or from territorial authorities (United States and France). These countries share problems of a growing scarcity of land, loss of forest areas and pollution of groundwater and coastal areas.
- Small, low island states. These countries have very limited land resources and rapidly growing populations. They share particular vulnerability to storms and droughts and face acute problems of fresh water availability and pollution of groundwater, particularly in the rapidly growing urban areas.

2.1 Natural hazards - Climate

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.

2.1.1 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 effected by a drought duration of the order of 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 (ESACP, 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 Majoro 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 in 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 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 (Mosley, 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.

2.1.2 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 effects 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 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 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 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.

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 can also have a significant affect 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. 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.

2.1.3 Tropical Cyclone

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 particularly damaging for low-lying islands:

- 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 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.

Changes in land use practices have tended to reduce the natural resilience of subsistence life styles and increased the risk of soil erosion:

- 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, the plantations, and damaged coastal coral reef communities.
- 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.

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 cyclone, 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. 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.

2.2 Natural hazards – non-climate

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 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.

2.3 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.

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.

Finally, it is worth noting the point made by Campbell (1997) that the emphasis given to vulnerability in climate change research may result in a loss of confidence in Small Island Countries since it focuses on weaknesses and shortcomings rather than inherent strengths and opportunities. Barnett & Adger (2001) suggest that that can be countered by framing such research in terms of resilience rather than vulnerability. They argue that there should be a shift of emphasis from impact assessment to risk assessment with explicit quantification of uncertainties.

3 Responding to hazards

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.

3.1 Application of seasonal and inter-annual climate forecasts

Research into the interaction of the ocean and atmospheric 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 conditions, forecasts and local variability summaries (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 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.

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."

3.2 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, 2002) 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.

3.3 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 (2002) the following are most relevant to the Island Vulnerability – Water & 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 that the anticipated affects 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 has been realised. 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.
- require 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.

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4 Identification of priority actions

Recommendation for action emerging from the Bonn Conference include several which are particularly relevant to the Island Vulnerability theme 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 potential priority actions.

4.1 Recommendations for Action from Bonn Conference

The International Conference on Freshwater (Bonn, 2001) 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 in-tended 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.

4.2 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 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.
- 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 will be constituted during the Regional Consultation meeting with the objective of formulating an endorsement for consideration to be included in the meeting declaration.

4.3 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, 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, 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. Development of a Pacific Climate Information and Prediction System may be promoted by its adoption as a priority action by the Pacific Regional Consultation meeting. It should be noted that this is likely to require the close collaboration of SPREP and SOPAC.

4.4 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.

5 Outcome of consultation on Island Vulnerability theme

The working group established for the Island Vulnerability theme adopted three key messages.

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 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 of

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,
  - 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

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 to 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 Met 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.

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Appendix – Notes on actions discussed at plenary listed by category

1. Policy, legislation, planning, advocacy, funding

- Appropriate legislation
- Planning and rehabilitation
- Political/government commitment
- Link to national plan
- Legislation to protect groundwater
- Identify vulnerable groups
- Drought manual
- Policies and guidelines on adaptation
- Regional bodies advise on risk to resources and systems
- Linkages between the actions – strategic planning
- Pre, during, post plans

2. Hazard analysis and risk management

- Mitigation measures
- Link to economic savings
- Link to disaster management
- CHARM (Drought)
- Hazard mitigation plans
- National disaster management office established and further funded (including location legislation funds)

3. Water and climate assessment and monitoring

- Assessment of climate variability
- Monitoring impact on water resources
- Assessment of resources
- Capacity building (USP training course on climate adaptation)
- Drought forecasting
- Hydrological data (extremes)
- Pacific HYCOS proposal funded: links Met/Hydro + regional
- Link rainfall prediction to water resources to drought preparedness
- Availability of prediction tools
- Link Met to water (National Mel Service/National Hydrological Service)

3. Responses to hazards

Disaster/drought response plan

Actions to address environmental health issues

IPCC actions

Storage for drought periods

Drought management techniques

Adequate insurance

Wastewater actions

4. Information systems, dissemination, participation & awareness

Information available for public

Closer links between Met Office and water resources

Establish and disseminate water resources information

Awareness: schools: conservation of water (include sanitation)

Participatory approaches to be included in actions

Community needs assessments

Bring poor into the actions

5. Non-climate hazards to be considered in vulnerability studies

(e.g. Over population, Pollution of water resources, Damage by humans to water supplies, Health problems, volcanic, seismic)

Land use planning and development – vulnerability analysis

Watershed management (IWRM)

Adequate compensation schemes

Enforcement of groundwater protection zones

6. Procedures

Reference to Bonn Declaration

Need to avoid duplication

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