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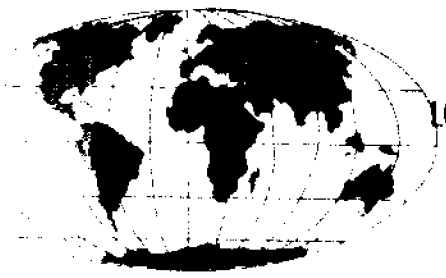

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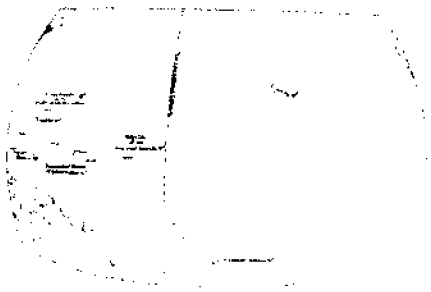

# U.S. Country Studies Program:
## Support for Climate Change Studies

# CLIMATE CHANGE IMPLICATIONS AND ADAPTATION STRATEGIES FOR THE INDO-PACIFIC ISLAND NATIONS: WORKSHOP PROCEEDINGS

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# CLIMATE CHANGE IMPLICATIONS AND ADAPTATION STRATEGIES FOR THE INDO-PACIFIC ISLAND NATIONS: WORKSHOP PROCEEDINGS

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# Contents

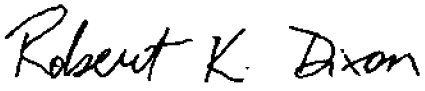
# Preface

A major objective of the U.S. Country Studies Program, in addition to inventorying greenhouse gases and adopting mitigation measures, is to assist participating countries in carrying out vulnerability assessments on the potential impacts from climate change and developing adaptation response strategies to address future threats. All island nations are taking some protective measures to cope with potential adverse impacts due to climate change. One appropriate plan recommended by the Intergovernmental Panel on Climate Change is to develop national Integrated Coastal Zone Management (ICZM) programs that focus on sustainable development of island resources. However, most Pacific island nations have strong indigenous cultures where traditional land and marine tenure systems play a significant role in resource management. Many Pacific island countries have started to develop ICZM programs that attempt to integrate ICZM programs with these community-oriented land tenure systems.

This workshop, which was supported by the U.S. Country Studies Program and other institutions, brought Pacific island nations together to discuss issues of common concern and to exchange experiences in dealing with potential adverse effects of climate change. Several island countries which have developed ICZM programs as part of their adaptation strategy were encouraged to share their experiences with those that are in the process of developing such programs. Vulnerability assessment tools and adaptation response strategies were also presented. The workshop identified several promising opportunities for regional cooperation and data information sharing.

This workshop emphasized a practical application approach through candid discussions and exchange of ideas among participants along with presentations of prepared papers. We hope the recommendations from the workshop will serve as a good practical guide and reference to island government and regional organizations as well as to the general Pacific audience.

The U.S. Country Studies Program was pleased to support this Regional Workshop for Pacific Island Nations. We thank all participants, especially the presenters for their hard work and a job well done. Special thanks go to Ms. Sharon Ziegler and Mr. Peter Rappa who worked very hard on every step of the workshop; Mr. Andrew Tomlinson for helping to prepare this report; and Mr. Christopher Dahl for assisting in the logistical arrangements for the workshop. Mr. Ben Mieremet, Mr. Granville Sewell and Ms. Susan Ware were instrumental in planning and implementing this workshop. We also thank Ms. Patricia Dornbusch for her assistance in editing the proceedings. The Division of Marine Law and Policy of the State Department also provided essential support. To all of you we express our deepest gratitude!



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# I. EXECUTIVE SUMMARY

A workshop held at the East-West Center in Honolulu, Hawaii, in September 1994, brought together 12 Indo-Pacific states, federal agencies, academic representatives, and representatives of international organizations, to discuss implications of global climate change on insular states and possible adaptive strategies. The purpose of the five-day workshop was to explore the unique problems faced by these insular areas, especially those of the Pacific island nations, and to suggest how they may respond to climate changes by utilizing a mixture of low technology, traditionally based resource management strategies, and high technology information systems. The workshop included presentations and discussions regarding general information on the potential regional impacts of global climate change to methodologies and tools for assessing those impacts, and strategies for adapting to and coping with global climate change by Indo-Pacific islands.

## Workshop Methodology

The workshop was organized in a progressive format. In an intensive two-day session, speakers presented information on traditional resource management systems, community based management and integrated coastal zone management (ICZM), and small groups then met to discuss how those topics could be applied to their own concerns and situations regarding potential impacts of climate change. Another day covered the predictive capabilities of global climate models and possible applications to local management programs. On the final day of the workshop, participants discussed recommendations for integrating these methods into management strategies and for the Country Studies Program (CSP) activities.

## Trends, Impacts, Tools, and Response Strategies

Three expert panels discussed the most recent forecasts for environmental changes that may occur because of changes in global climate patterns, potential impacts of these changes, prediction and assessment of available tools, and strategies for responding to the impacts brought on by environmental change. Impacts include weather anomalies such as more frequent tropical storm activity, high surf and wind conditions, more frequent floods and droughts, changes in the spatial distribution of marine resources (especially tuna), and social changes caused by the need to relocate residents, especially in the small outer islands. A gamut of assessment tools was presented, from the use of anecdotal historical data (which is generally lacking in the Indo-Pacific area) to regional computer forecast models. Response strategy panelists examined both (1) soft techniques, such as retreat from coastal areas, vegetation barriers, and changes in agriculture, and (2) engineering solutions, such as strict construction standards and beach shoreline protection techniques.

## Workshop Discussions

A series of four breakout sessions was held in which island participants were separated into two groups to discuss (1) what they thought were the greatest climate-change related threats to each of their islands; (2) traditional resource management practices; (3) how to involve their predominantly rural populations in developing responses to future climate change impacts; and (4) how to integrate traditional practices and more modern techniques in a program to improve their ability to respond to increased hazards. These facilitated workshop sessions included commentaries from islanders and regional experts on traditional management practices, community-based management, and integrated coastal zone management.

Findings of the workshop discussions were

1. Understanding and responding to future climate change impacts remains a significant challenge. A large listing of concerns was developed and divided into three interlinking areas: physical/environmental, social/cultural, and economic; however, islands lack the resources or capability to adequately plan for and respond to these concerns.

2. Many of the traditional methods for managing marine resources and preparing for disasters are still relevant today; however, many island nations have become independent and formed new governments with responsibilities to deal with managing natural resources and the protection of island societies. Each island is attempting to determine how to integrate its own traditional methods with new or existing government programs which must respect these traditional practices and support them when feasible.

3. Community-based resource management is an important aspect of integrated coastal resource management. Decentralizing management to communities can work where the population is homogenous, and people share values. Community-based management can work if village people participate meaningfully in the decision making process. Suggestions that are top-down often fail if they do not incorporate local views. Urbanization brings about the dissolution of the sense of community and so other approaches may be needed for urban areas.

4. Integrated coastal zone management strategy depends upon: process whereby local values are acknowledged and reinforced by the central government; community input is sought and utilized; and good management decisions by the local government. Developing island capacity to analyze problems and present solutions is also necessary to manage resources in a way to prevent disasters. More assistance from outside sources will be needed to prepare islanders to better understand and manage the responses to global climate change.

## Regional Modeling

Global climate models serve a useful purpose for developing global scenarios, but these are often not useful for regional scenarios. A key feature of this session was a demonstration of a computerized model developed by Rand Corporation that can predict coastal impacts attributable to changes in regional climate patterns given a particular set of interpolated conditions. Participants learned how the model and its underlying algorithm were developed. Computer models, however, are only as precise as the boundary condition data on which the calculations are made. Until more information on conditions in the Indo-Pacific region is generated, the application of the model to island-sized areas remains unreliable for planning purposes. A response by an island leader summed up a number of local concerns about the use of models:

1. Appropriate information must be gathered by islanders to make computerized models applicable to the region. Regional organizations such as the South Pacific Applied Geoscience Commission (SOPAC) and the South Pacific Forum, and regional institutions such as the University of the South Pacific should be enlisted to help provide the data needs of the models.

2. Islanders need to be trained to develop and interpret models. This is an important step to ensure that models will be relevant to island needs.

3. Models need to be developed which can tell islanders the types of information needed. For example, there is a need to know when the taro patches will be inundated and how the taro farmer can protect himself from the effects of salt water intrusion.

## Workshop Recommendations and Future Work

The following issues were listed by participants as action items or topics to be addressed in follow up sessions.

1. ***Education about climate change and its impacts***
   - disseminate information collected from the research community to the islanders
   - educate island leaders about potential hazards caused by climate change
   - educate the public about linkages between climate change and disasters
2. ***Data collection and monitoring***
   - develop a climatic database for the respective island nations
   - train islanders to interpret data sets for useful information
   - institute data collection and monitoring as programs related to regional and national analysis
3. ***Adaptive strategies***
   - integrate traditional management practices into the development of ICZM programs
   - incorporate community-based management into resource management programs
   - incorporate disaster planning into ICZM
   - investigate the feasibility of shoreline protection training in developing and managing community-based ICZM programs
4. ***Appropriate technology research and demonstration***
   - demonstration projects for alternatives
   - implement alternative agriculture crops and practices
   - research alternative energy sources, desalinization methods
   - develop application models tested on differing degrees of climate change
5. ***Regional cooperation***
   - sponsor more forums to share ideas
   - work with the South Pacific Regional Environmental Programme (SPREP) and SOPAC to develop geographical information systems (GIS) for coastal planners
   - coordinate international organizations with regional organizations to provide assistance regarding climate change impacts and adaptation for islanders
6. ***Hazard and disaster management***
   - provide equipment, expertise, and training regarding protection against hazards
   - set up regional coordination mechanisms for disaster relief
   - establish forums to discuss rehabilitation after disasters have occurred

# II. WORKSHOP OVERVIEW

The interagency U.S. Country Studies Program provides financial and technical support for studies related to climate change to 54 developing countries and to countries with economies in transition. The Country Studies Program supported this workshop, the first in a proposed series of regional workshops, to address common concerns on climate change as they were identified by the island nations participating in the program. The workshop convened, with co-sponsorship from the U.S. Department of State, the National Oceanic and Atmospheric Administration (NOAA), the Pacific Island Network (PIN), the UH School of Ocean and Earth Science and Technology, and other institutions in September 1994, to discuss the role of traditional management practices by island nations in adapting to the impacts of climate change. The following nations participated in this workshop:

Kiribati

Federated States of Micronesia (FSM)

Solomon Islands

Republic of the Marshall Islands (RMI)

Papua New Guinea

Fiji

Cook Islands

Western Samoa

Tonga

American Samoa

The Philippines

Indonesia

The U.S. Country Studies Program seeks to provide, through regional workshops, the type of technical assistance that would support the needs identified by many of the nations preparing to meet the requirements of the Framework Convention on Climate Change. Initial proposals to the program and subsequent discussions with Pacific island nations identified that most of those countries faced similar challenges in dealing with global climate change issues that pose potentially significant threats to their natural resources, island populations and traditional cultures, and economies. The need for long-term planning and management are becoming clear to these nations as many of the newly established governments face today's problems of population growth and accelerated development along low-lying and vulnerable shorelines which will be exacerbated by the impacts of climate change.

Traditional land-tenure systems, which regulated land and resource uses enjoyed by island societies, have served the populations of the past well and may continue to do so even as some societies are changing rapidly. Science, however, has provided new predictive tools such as computer models to examine the potential for accelerated sea-level rise, changes in precipitation and storm patterns, and others to occur within the next few generations. This information serves as a clarion call to nations to take steps now to develop adaptation strategies to minimize the resulting impacts of climate change. Many islands have declared that they will undertake integrated coastal zone management (ICZM) within forums such as the 1992 U.N. Conference on the Environment and

Development, the U.N. Framework Convention on Climate Convention, and their National Environmental Management Strategies. It is important that these island governments meet these challenges through approaches that make the planning and management tools available to both traditional leaders and governing bodies as well as the general public to encourage their integration into the way they govern their land and water uses of the coastal zones governed.

In many Pacific Island nations, traditional land tenure systems and traditional methods of making land use and resource management decisions coexist with more centralized, Western-style systems of governance. As the two systems of governance may be at odds with each other, ICZM may not be fully accepted by the traditional government systems, and, as a result, its effectiveness suffers. Traditional land tenure and resource management systems, meanwhile, are weakened by the existence of the Western-style government. In addition, traditional governments generally have lost some of their ties to the land and the coastal environment and lack the institutional capacity for acquiring and responding to recent information on resource management issues such as climate change.

This situation presents unique problems and opportunities in the development and implementation of ICZM programs. Most existing ICZM programs are based on legislation and land use management techniques derived from American or Anglo systems. The effectiveness of these systems is often diminished when applied in a culture where traditional land tenure systems still are common. The potential for conflicts is great and could result in failures unless the right measures are taken to ensure coordination, cooperation, and mutual respect for the different types of authorities. By basing an ICZM program on a traditional land tenure system, and by integrating the traditional and the centralized, legislative managing systems in an ICZM program, the effectiveness of land and resource use decisions can be enhanced, and cultural tradition can be retained and strengthened.

The objectives of the workshop were to bring together these island nations and exchange information among the nations that have successfully experienced the integration between the traditional and modern systems with those nations that are just starting to develop an adaptation strategy to address climate change. In addition to the Pacific Island nations, two southeast Asian island nations that face similar problems were invited to participate in the workshop. It is hoped that the findings and recommendations that resulted from the dialogues and ideas exchanged at this workshop will assist the island nations to be better prepared in their ability to develop adaptation strategies for global climate change.

# III. WORKSHOP FINDINGS AND RECOMMENDATIONS

## A. Climate Change Impacts

Earth is a single, integrated system, whose behavior must be anticipated in order to formulate national and international policy and to make decisions relating to natural and human induced changes in the global environment and their regional impacts. Predictions vary as to the extent and magnitude of global climate change and its concomitant impact on the islands of the Indo-Pacific region, but most scientists agree that global climate changes are taking place that have serious regional implications. It is important for extremely vulnerable areas such as the Indo-Pacific islands, especially the low atolls of this region, to prepare for these potential impacts brought about by climate change. Several speakers and representatives from the island governments addressed the current climate change trends and the expected impacts they will have on island areas.

## Probable Causes of Climate Change

Global climate change is induced through both the natural variability of the planet, such as volcanoes, biological evolution, solar variability, and human activities, such as population growth, energy usage, and land use practices. The "greenhouse effect," which is the focus of analysis by many scientists, policy makers, and the media, is an essential factor contributing to global climate change. Additional forces such as subsidence, isostatic rebound, and sunspot activity also may be as significant when accounting for temperature change and sea-level rise. Two things are certain: (1) the amount of greenhouse gases in the atmosphere (such as carbon dioxide, methane, nitric oxide, sulfate, and chlorofluorocarbons) is increasing and may impact the global climate; (2) the sea level is rising globally, albeit with regional variations. All of these will probably have negative impacts on the Indo-Pacific region.

Methods of predicting which events will occur because of global climate change are imprecise; however, consensus seems to be forming on several important issues that are suggested in Table 1. The important task for both scientists and policy makers is to determine potential impacts and implement policies that will mitigate them.

## Impacts on Coastal Lands

An estimated 20%t of the world's population lives on land that could be inundated or dramatically changed by a sea-level rise of one meter. The populations most severely affected would be those living in low-lying coastal areas of continents and oceanic islands. For example, the Marshall Islands, a group of 31 atolls and islands, rises only two meters above mean high water, and are highly susceptible to such water level rise. In addition to threats of inundation, sea-level rise and other effects of global climate change may decrease the size of the freshwater lens on most islands, increase the amount of erosion caused by storm surge and periodic tropical storms, increase the length and intensity of drought periods, and increase precipitation in dry areas.

TABLE 1. **"Predictions" of Climate Change**

| Expected Effect | Confidence |
|---|---|
| Large Stratospheric Cooling | Virtually Certain |
| Global Mean Surface Warming | Very Probable |
| Global Precipitation Increase | Very Probable |
| Reduction of Sea Ice | Very Probable |
| Arctic Winter Surface Warming | Very Probable |
| Summer Continental Dryness | Probable |
| Arctic Precipitation Increase | Probable |
| Rise in Global Mean Sea Level | Probable |
| Regional Vegetation Changes | Uncertain |
| Regional Climatic Details | Uncertain |

Source: Mortensen, Lynn L. (ed). 1994. *Global Change Education Resource Guide*. NOAA Office of Global Planning. U.S. Global Change Resource Program.

### Impacts on Marine Resources

Most scientists agree that the growth of coral reefs will eventually keep pace with rising sea levels, but a lag period may occur because of natural and anthropogenic factors. Sea-level rise may also cause a vertical compression of nearshore ecosystems, as shoreline hardening is instituted as a response. Ecosystem compression would cause a corresponding loss of biodiversity, as species get squeezed out in the fight for limited available environment. Ocean warming may impact tuna migration patterns, driving the Western Pacific stocks in a more northerly or southerly direction. Tuna resources are among the most valuable marine resource for the oceanic islands of the Pacific. Coral bleaching, a problem that manifested itself more frequently in recent years, may also be linked to changing sea temperatures.

### Cultural Impact on Societies

The impact that climate change will have on people living on islands is much more difficult to predict than physical impacts. Many people of the Indo-Pacific region retain a strong attachment to the land and, in particular, to original ancestral home sites where ancestors may be buried. Many people practice subsistence agriculture which may only be allowed on ancestral lands. All of the land used for agriculture in atolls and low lying islands and much of the agriculture land in high islands are located in low-lying coastal plains or along river valleys. These areas would be susceptible to inundation as a result of sea level rise and more frequent flooding. Even where possible, moving inland to higher areas that are less fertile would lower agriculture output. Changes in temperature and precipitation may make some types of agriculture untenable. Traditional crops which have less tolerance to heat or drought would have to be replaced by more heat tolerant or xeriphetic plants that are unfamiliar and therefore less acceptable to residents. Salt water intrusion and salt spray may also negatively impact coastal agriculture, again requiring agriculturists to move inland where possible, plant new halio-tolerant strains when developed, give up agriculture, or relocate to higher islands.

Most island infrastructures of roads, telecommunications, schools, churches, and village meeting areas are located in coastal areas. Governmental response will be greatly taxed in potential situations caused by climate change. More frequent storms of greater intensity would require the national governments to respond to an increased number of emergency situations. Post-disaster relief, eventual rehabilitation of land areas, relocation of populations, and building shoreline defenses would additionally strain island governments' resources. Relocation of cultural facilities away from the coastline would be a great challenge, given the significance these traditional areas have for communities.

### Recommendations

- *Educate island leaders and populace about the dangers of global climate change and the need for long range planning.*

  In the past, most island cultures had the capacity to adapt to change when those changes occurred over a long period of time. However, new factors which move at an accelerated pace of change, such as rapidly increasing populations and their consequent demands on natural resources like agricultural land and freshwater, create a different time frame that is often difficult for cultures to absorb. Traditional methods of coping with problems, such as drought, should not be abandoned, but may be augmented by other contemporary methods.
- *Disseminate information collected from the research community.*

Island planners need access to information collected in the region from researchers outside of the region. By holding more forums similar to this workshop and by working through regional organizations, such as SPREP, USP, and the University of Hawaii Pacific Program, planners can gain access to this information. Researchers should improve their methods of providing information related to the impacts of climate change back to the area studied and making it useful to the local islanders.

- *Direct more research and extension activities to focus on technologies that develop appropriate solutions to problems in the region, such as salt-water intrusion and dwindling supplies of fresh water.*

  Research is needed to develop salt-tolerant strains of crops for the region or alternative crops that islanders might raise in a high salinity environment. Research should also be applied to developing more economical desalinization methods. Results need to be adequately demonstrated and provided to islanders through extension programs.

- *Develop region wide disaster responses and coordinated relief capabilities.*

  Most island governments lack the resources and expertise to respond in a timely manner to disaster situations that affect their islands. However, response and post-disaster relief efforts could be greatly enhanced through the development of a multilateral hazard management plan that would include participants from each island as well as the metropolitan powers with interest in the region.

- *Develop island-relevant planning models that incorporate worst case global climate change impact scenarios, so that island infrastructures can be built to withstand potentially severe impacts. Models would have to be easy to use and based on available inputs with clear outputs that can guide policy makers and public works agencies.*

- *Investigate the feasibility of different types of shoreline protection or retreat strategies in island settings.*

- *Conduct on-island studies that would examine cost and effectiveness of hard and soft technologies for shoreline protection.*

## B. Assessment Tools

In order to adequately assess climate change, tools have been developed that rely on both observation and models. The purpose of assessment is to evaluate the current and past climate situations and predict future climatic conditions. Several assessment approaches were discussed during the workshop, including the Intergovernmental Panel on Climate Change (IPCC) Common Methodology, procedures utilized by the El Nino Southern Oscillation (ENSO) Application Center, and the use of computer simulation models.

### IPCC Common Methodology

The IPCC Common Methodology was developed to provide a comparable assessment of the vulnerability of coastal areas to sea level rise. The steps in the methodology are outlined in *The Seven Steps to the Assessment of the Vulnerability of Coastal Areas to Sea Level Rise — A Common Methodology*, published by the IPCC in September 1991 (Figure 1.) The methodology works to create scenarios depicting potential impacts caused by changing boundary conditions, such as a 0.3 to 1.0 m change in sea level. The advantage of this type of assessment is that the issues examined and the parameters measured are the same across countries and the region, and thus, the outcomes are comparable.

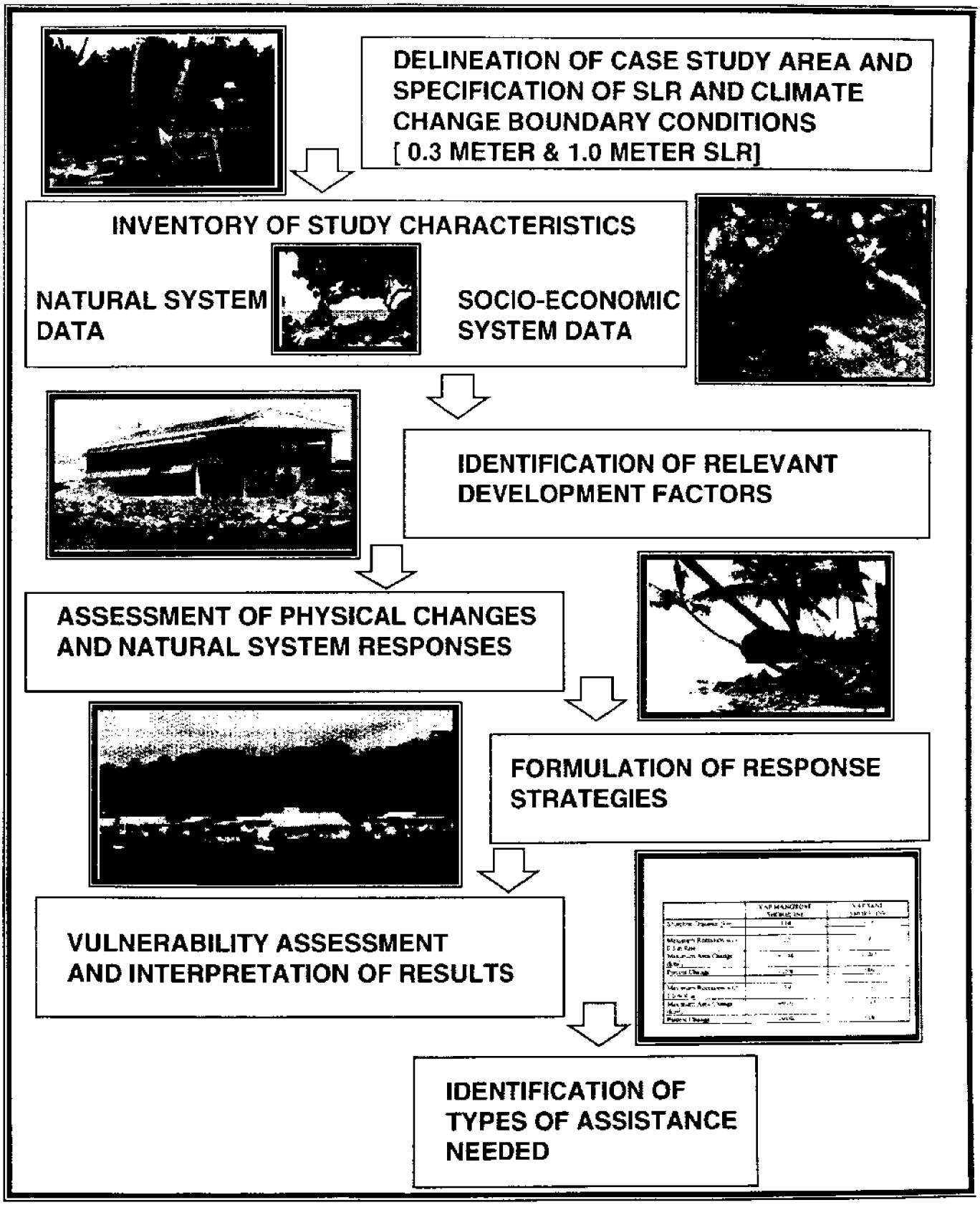


*Figure 1.* IPCC Steps to Vulnerability Assessment of Coastal Areas to Sea Level Rise *published by the IPCC in September 1991.*

There may be several obstacles to completing the steps in the methodology:

- Data needed to completely describe scenarios are not always available.
- Storm surge can be considered as a related impact, but it is often not included by countries seeking to minimize the full risk of flooding events.
- The concept of nature's ability to recover cannot be quantified.

Taking into account these limitations, the methodology can provide valuable information to governments as to the vulnerability of their lands and how to adapt response strategies to address those potential conditions.

### ENSO Application Strategy

Determining trends is an important tool to assessing where and to what extent climate change may impact the Indo-Pacific region. Determination of climate change trends depends on the collection of accurate weather-related data, both of current conditions and of historical trends and events. The ENSO Application Center in Honolulu is attempting to gather such data from sources throughout the region. Analysis of historical and current weather data can help researchers better understand and monitor changes when they occur. By studying past storms, droughts, and related weather phenomenon, researchers are better able to predict how similar conditions will affect the region today. By providing these predictions to island governments, better preparations can be made to respond to potential impacts. The problem with this assessment strategy is that historical data for many of the crucial parameters do not exist. In addition, while more weather stations are needed to provide data on a smaller, more localized scale, existing stations are being closed down because of budget constraints. As climatic observation remains one of the most important tools in assessing global climate change, this paucity of information collection needs to be remedied.

### Climate Change Models

Climate models, especially computer based models, continue to be important tools for predicting large scale changes in weather patterns. Models are built to simulate natural phenomena, which allows researchers and coastal managers to observe impacts of changes in conditions. The importance of models is that a multiple set of climatic conditions can be entered into the model and manipulated to simulate their effects. These results can then be fed back in real time to allow decision makers an opportunity to examine the range of impacts which may strike an area. The accuracy of models, however, depends in a large part on understanding the phenomenon being modeled. The results of models can be no better than the quality of the data utilized to construct it. An important feature of computer models is that they are now being designed to fit on personal computers and can be transported easily. The following conclusions were made by the group:

- Regional models depend on global models for boundary conditions. (Results will be influenced strongly by the boundary conditions.)
- Regional models are needed to scale down global results to the local level.
- Pacific island nations will depend on improvements to coupled global models, and especially the ocean component, for more realistic forecasts of sea-level rise at specific islands.

- Historical observations are critical for assessing trends, and for verifying models of decadal and longer time scale variability of climate. Interannual models (e.g., ENSO) can be tested by direct comparison of predictions with observations.

**Recommendations**

- *Institute data collection including monitoring and database development that will enhance accuracy of assessment tools. Historical and comparable current weather data is lacking for many islands in the region making regional assessment of vulnerability difficult to produce. Models are only as accurate as the data which are available for forecasting. Indo-Pacific Island state institutions should act together to obtain necessary climate information that is needed in the assessment methodologies. Developed countries need to extend the climate data capabilities into the region by creating more data collection stations.*
- *Train islanders in interpretation of data and in the development of relevant data sets. Island decision makers do not want to be the passive recipients of data from developed countries. What is needed is a trained cadre of island scientists that will understand the workings of models and how to interpret the in output. This cadre of local scientists will also assist in the development of locally relevant models or suggest changes in global and regional models to reflect local conditions.*
- *Cooperate with regional agencies to obtain and disseminate information on trends and impact predictions. Expertise to gather data and interpret outputs from models resides in regional organizations such as SPREP, SOPAC, USP, SPC, and others. National programs such as the CSP and international programs such as the IPCC should work cooperatively with regional organizations which act on behalf of island governments in the technical aspects of global climate change.*

## C. Response Strategies

Response strategies are developed to mitigate impacts on island states potentially caused by predicted global change. Several response strategies were discussed during the workshop, including coastal defense, coastal retreat, and integrated coastal zone management (ICZM.)

### Physical Coastal Protection

Shoreline protection comes in two forms: (1) shoreline hardening and (2) use of soft structures. Shoreline hardening consists of revetments, offshore breakwaters, seawall, or a combination of these. Soft structures of shoreline protection are beach fill. Shoreline hardening is expensive and requires precise engineering. Materials for hardening the shoreline, such as armor stone for revetment, may be hard to obtain in many areas. Beach fill has the advantage of its aesthetic appearance and recreational uses; however, it requires periodic replenishment, which can be costly. In areas where sand is not readily available, as in many Pacific island areas, beach fill becomes an uneconomical option.

### Coastal Retreat

Coastal areas are vulnerable to many hazards, including erosion, unusual high tides, storm surges, seasonal high waves, and tsunami inundations, as well as sea-level rise. Tropical storms, which impact broad areas, are more hazardous to coastal dwellers. Relocating most development away from coastal areas is a cost-effective and long-lasting mitigation of the impacts of coastal hazards, and would allow the shoreline to act as a natural barrier. Management agencies would need

to delineate coastal high hazard and design policy, such as zoning ordinance and land use plan meant to keep permanent structures away from these areas. Coastal retreat may be problematic on low-lying islands and atolls. In these areas relocating the population to larger islands may be considered.

**Integrated Coastal Zone Management**

ICZM is not so much a technique as it is a set of policies that may combine physical protection, coastal retreat, infrastructure planning, land use policies, etc., and other techniques for managing resources. ICZM typically is concerned with resolving conflict among resource users and determining the best use for those resources. In most Indo-Pacific Islands the whole island is considered coastal, and thus ICZM is synonymous to "integrated island management."

Traditional and community-oriented characteristics common to many Indo-Pacific island cultures may act as either constraints or catalysts for the development of ICZM in this region. Urban centers and areas of high concentrations of population and permanent physical development are few on most Pacific islands, although greater in Indonesia and the Philippines. More common are rural, more traditional cultures in which resource allocation is decided through a community-based decision making system. These populations lend themselves well to decentralized or local management of resources. In areas of high population concentration, more physical methods may be needed to protect island inhabitants from the negative impacts of global climate change.

Coastal zone management using methods similar to those of U.S. programs may have limited application in the Indo-Pacific region because of the U.S. programs' heavy reliance on top-down management by well established sectoral bureaucracies. ICZM programs must reflect and adapt to each particular island circumstances. The challenge facing Indo-Pacific islanders is to identify those appropriate approaches or methodologies or both for ICZM that are most applicable to their situation and perspectives.

**Recommendations**

- *Develop ICZM programs that incorporate rural communities and take into account traditional practices of resource management. ICZM is an appropriate response strategy for mitigating the impacts of global climate change. ICZM programs, however, must be designed to respond to local conditions, taking into account traditional methods of resource allocation and decision making, and involving rural communities in planning and implementation.*
- *Investigate the feasibility of shoreline protection methods. Use of these techniques depend on several factors, which may make it an appropriate or inappropriate option as a defense against the impacts of climate change. Cost, availability of materials, availability of alternate sites for development, and cultural considerations must be examined prior to the use or dismissal of a particular method.*

## D. Traditional Management Practices

Traditional management practices and systems are integral parts of Pacific culture and society, and a significant portion of the conference was devoted to identifying and discussing their importance in addressing the problems of climate change. Traditional management refers to social structures and arrangements that prescribe the use of natural resources in certain areas. These systems usually incorporate changing beliefs and perceptions. Some of these beliefs are based on non-scientific, supernatural myths that ensure proper respect for sacred ground or coastal areas and certain animals

and marine life. The socio-cultural conditions of the Pacific historically were such that custom and tradition were sufficient to support and enforce management practices. In the Solomon Islands, for example, it is believed that people who abuse fishing rights will be eaten by guardian sharks. In Fiji, people make offerings when visiting an area and have various totems that restrict the consumption of certain foods. In many cases, a considerable body of ecological knowledge also has been accumulated in the development of these practices over centuries.

Direct relationships exist between people and the land under the traditional community-based land and marine tenure systems found in the Pacific. Kinship networks provide for community-based resource sharing and management. Resource distribution is administered by local leaders who determine access to resources based on local custom and an individual's or family's place within the hierarchy of the land and marine tenure systems. The Matai system in American Samoa, for example, serves as the forum to mediate family disputes over land and marine resources. In Fiji, the native land trust board advises landowners on fair compensation and gives final approval of contracts involving land use. And, in Yap, outsiders must first secure permission from the owners to use land or fishing grounds.

Traditional resource management systems may include various mechanisms to control access and use of resources. Seasonal hunting and fishing bans, island harvest and crop rotation, and seasonal closure of reef areas are used by many island communities to manage resources. Multi-cropping, terracing, and irrigation are also used in agriculture to preserve soil resources and bio-diversity. Traditional fishing techniques also naturally limit the catch of individual fishermen, and more sophisticated fishing methods are reserved for chiefs or for times of fish scarcity. Fish ponds and community gatherings are also used to manage fish harvests. In some island states like Yap, traditional management systems prescribe migration patterns of people and establish family planning policies to manage population growth.

Modernization threatens traditional management systems as customary practices are discarded for contemporary exploitations methods. Management and conservation are now difficult because of the need and desire to maximize agricultural yields and fish catches. The electrification of many areas, for example, has allowed for storage of fish for export, and eliminated much of the subsistence-based lifestyle. The breakdown of traditional systems by the modern economic system has created a situation in which most Pacific societies have characteristics of both traditional and contemporary management. Some areas outside the urban areas and main islands retain greater levels of traditional management activity, whereas other more urban islands have incorporated contemporary systems. This dichotomy has created management problems related to land tenure and resource use.

**Recommendations**

- *Use traditional management practices as the basis for integrated coastal zone management programs, including those that address the problems of climate change.*

  New programs designed to address climate change and coastal management problems should take into consideration the existing knowledge and experience of traditional management systems. Any new integrated coastal zone management programs should be decentralized and flexible enough to allow individual areas the ability to establish their own mix of traditional and contemporary practices. This would allow areas with varying levels of traditional management to develop site-specific programs. Traditional management systems and practices also should be reinforced by legislation and community education programs.

Traditional agro-forestry methods could be used when agricultural lands are lost to sea-level rise. Seasonal and locational bans could also be used to limit access to resources made scarce by climate change impacts. In addition, the workshop recommended that "disaster food" could be planted in awareness of possible famine or weather related disasters.

- *Use the kinship/community networks that form the basis of traditional systems to address the intricate socio-cultural problems that would arise from climate change.*

  The management of environmental refugees and the subsequent land use and resource access problems associated with climate change could be addressed through the social structures encompassing traditional management systems. Customary practices are more suited to deal with social problems associated with access to resources than contemporary management programs.

## E. Community-Based Management

Community involvement was recognized by the conference as an essential component of integrated coastal zone management programs. Community-based management is intended to incorporate the community as resource users into management program development and implementation. It is ultimately intended to redirect the management focus from a "top-down" to a "bottom-up" approach, and to utilize local knowledge and experience.

There are various methods for incorporating community-based management in the development of management programs. Participatory Rural Appraisal (PRA) involves the collection of qualitative information by a multi-disciplinary team of experts in cooperation with members of the community. Communities recognize their needs, abilities, and resources through the process of data collection and meetings. After communities have identified the major social, economic, and environmental problems action plans are developed to organize community responses. Institutional structures also are organized to effectively manage common property resources. Guidelines are developed by resource users for the sustainable use of adjacent resources.

In American Samoa, community-based management has been implemented in the American Samoa Coastal Management Program (ASCMP). Under the Coastal Hazard and Mitigation Program (CHAMP), new regulations for construction in high-hazard areas and a system of village-based hazard mitigation were established through participatory planning. In addition, village ordinances and regulations were developed for various wetlands areas in the Community-Based Wetlands Management Project.

**Recommendations**

- *Incorporate community-based planning, consultation, and education into the development of integrated coastal zone management plans that are designed to address climate change including Participatory Rural Appraisal and public review of proposed projects related to integrated coastal zone management. The existing social systems should be used for the dissemination of information on integrated coastal zone management and the impacts of climate change. The pace of the development process should be dictated by local conditions and customs.*
- *Encourage individual villages to develop resource management plans using their specific traditional management systems.*

Existing community institutions for resource management should be used in the development of integrated coastal zone management plans. These community-based management institutions should also be backed by appropriate modern legal policies and regulations.

## F. Integrating Traditional and Community-Based Approaches into Coastal Zone Management Strategies

The conference identified ways traditional management and community-based management could be incorporated into integrated coastal zone management (ICZM) programs for climate change. Management plans must include the entire island, not just the coastal or marine areas. In addition, governments must reinforce and honor community and traditional management practices and decision making systems. Villages and their leaders must be allowed to prioritize management concerns and establish the pace and direction of management programs. Individual islands and regions must be allowed to establish their own combination of traditional and contemporary management systems, including the incorporation of new technologies.

### Recommendations

- *Integrate traditional and community-based management with contemporary management technologies to form site-specific coastal management programs to address the problems of climate change.*

  The workshop recommended that the initial step in the management of coastal resources should be consultation between the government and local communities on the identification of any site-specific management problems. This includes shoreline erosion, inundation, salt water intrusion, social disruption, coral reef destruction, and deforestation. All management problems encompassing coastal and inland areas should be included. An inventory of community resources, traditional management practices, and alternative solutions should also be completed in the early phases of program development. Based on these findings, a local management program should be initiated that incorporates the community's own specific traditional management practices with contemporary management technologies. Regulations also should be developed for resource use that reinforce community-based management and enforcement. A community team should lead the planning and monitoring of management in coordination with government agency personnel. Costs of the management program should be evaluated and divided among the community. Resource sharing should be encouraged in order to avoid duplication of efforts and to share responsibility. Community education and workshops should also be reinforced by government policy and regulation.

## G. Future Regional Plans

The potential impacts of climate change could have far-reaching effects on the Pacific islands and their inhabitants. The workshop facilitated discussions on ways to integrate strategies to manage the future problems arising from climate change. Participants identified the need for additional research, training, and technical assistance on climate change and integrated coastal zone management techniques. They also identified the need to incorporate disaster preparation and relief in planning for integrated coastal zone management.

Educational programs targeted at adults and leaders of island communities were identified as important for the strengthening of long-term community-based management efforts. These include the

distribution of educational videos and brochures, as well as holding local workshops on climate change and coastal management following natural disasters. Additional training in ecological surveying, data collection and interpretation, impact monitoring, and disaster/hazard management, was also recognized by the workshop participants as vital to the region.

**Recommendations**

- *Conduct further research on the regional impacts of climate change and local technologies to address them.*
- *Conduct research on appropriate technologies including desalination, alternative energy sources, and marine resource development at a regional level by the various organizations such as SPREP, SOPAC, and USP. Modeling of coastal areas also should be launched at the regional level and then extended to more specific locations in the Pacific.*
- *Share information and provide regional cooperation throughout the area through educational training and workshops.*
- *Disseminate research results and technology developments like GIS through local communities in the Pacific. The U.S. Country Studies Program should work with climate change programs in existing organizations such as SPREP and the ENSO Application Center. Communication should be maintained between the various agencies involved in climate change and ICZM by the development of an ad hoc representative body. Results of workshops should be disseminated throughout the region newsletters and publications.*
- *Improve communications through the use of electronic telecommunication networks.*

# IV. COUNTRY REPORTS

Participants from each country presented papers on accelerated sea-level rise, climate change, and the work plans for the ongoing country studies.

## COOK ISLANDS

*by Mr. Teariki Rongo, Ministry of Planning and Economic Development*

The Cook Islands are located in the Southern Hemisphere at approximately the same position as the Hawaiian Islands in the Northern Hemisphere. There are two 20 year old tide stations located at Rowatunga and Pingrin, approximately 7° south of the Equator.

The Cook Islands government has initiated various programs to address environmental problems, and was one of the first countries to request a country study on climate change. The government has recently amended its departure tax laws to allocate $5.00 of the $20.00 departure tax to an environmental protection fund for coastal protection, protection of species, and educational activities. Insurance companies also have withdrawn coverage on properties within the four shore areas and will only cover houses destroyed by hurricanes. The development of a coastal zone management plan has started with funding from the Canadian government through SPREP.

Before 1992, the environmental management actions of the Cook Islands government agencies were not coordinated. Various government regulatory agencies such as the Conservation Service, Public Health, the building inspectors, and the Planning Division would follow individual policies and programs related to coastal zone management and environmental management with little regard to programs in other agencies.

Prior to the Rio Summit in 1992, the government established a multi-sector environmental task force with funding from ADB and SPREP. The task force was mandated to guide the preparation of the National Report to the Rio Summit and prepare a National Environment Management Strategy (NEMS). The National Report to Rio Summit served as the basis of negotiations during the prep coms and INC meetings.

A review of environmental laws and the drafting of environmental legislation was completed as part of the NEMS program. Coastal zone management was identified in the NEMS program and by the multi-sectoral task force as a priority concern. The approach to coastal zone management and environmental concerns is based on negotiation and education, because of the existing land tenure system. The cornerstone of the environmental education program is a pilot waste management program called "TTT" or "tau taku tita" (yours and our rubbish).

The focus of the coastal zone management program is the outer islands. Guidelines for the development of coastal zone management programs are initially developed for the island councils by the multi-sectoral task force. Bylaws are then developed to ensure compliance with the various guidelines.

## THE FEDERATED STATES OF MICRONESIA

*by Heidi Primo, Climate Change Coordinator, Office of Planning and Statistics*

### Geography

The Federated States of Micronesia (FSM) is a young independent country that includes the states on Chuuk, Pohnpei, Kosrae, and Yap. FSM is an island country consisting of 70 inhabited islands, of which one half are high islands. Population estimates range between 103,000 and 107,900. The nation is composed of 10 indigenous ethnic groups and several groups of expatriates. There is considerable ethnic diversity and a multitude of languages. The islands have a total of 270,786 square miles and are separated by great distances.

### Resources and Land Use

On the high islands, mixed tropical agro-forestry is practiced, whereas the smaller islands and atolls rely on coconut and taro cultivation. Many of the atolls are primarily uninhabited but are intermittently used for resource gathering. Natural resources on many of the islands are limited. Modernization and the shift toward urbanization has increased land use and changed traditional relationships to the land. The cash economy vies with subsistence agriculture and fishing as the primary source of livelihood. All islands rely on imported goods such as cigarettes, canned meats, and rice.

### Current State of Knowledge About Climate Change Issues

There are no college-educated Micronesian professional meteorologists in FSM, but some students are now being trained. The U.S. National Weather Service maintains weather stations on Yap, Chuuk, Kosrae, and Pohnpei and collects data on rainfall and wind patterns. However, this information is not archived in the FSM, and getting access to historical data is very difficult.

As a young, developing country, FSM is focusing its attention on nation-building and economic development. The public's overall awareness of climate change and its potential adverse impacts to

the people, infrastructure, economy, and the natural environment is very limited. Although some people are aware of the potential consequences of climate change, most feel powerless to control the predicted impacts of that change.

### Reasons Why Climate Change is of Concern

Each of the islands within the FSM is at risk to the negative impacts of climate change. Most of the islands within the FSM are relatively small and have limited land area suitable for habituation and farming. In addition, changes in temperature and rainfall will quickly impact water supply and demand on agricultural crops.

In Micronesia, indigenous lifestyles and values are tied directly to the land, the sea, and the coastal environment. Consequently, the physical impacts of climate change are likely to have significant cultural, social, and economic repercussions throughout the FSM. Impacts of particular concern include these:

Inundation of atolls and forced migration of residents to high islands;

Loss of land and infrastructure to inundation and accelerated erosion;

Contamination of ground water lenses and loss of subsistence crops from salt-water intrusions;

Loss of mangrove habitat due to changes in salinity;

Increased erosion and sedimentation as a result of inland migration and upland farming;

Increased energy consumption resulting from an increase in the use of fans and air conditioning; and

Increased water demand combined with a possible decrease in supply.

### Climate Change Planning in the FSM

On most FSM islands, traditional systems of authority have been converted to more centralized western decision-making models, undermining customary control of the use of resources. Traditionally, subsistence uses of resources were controlled by customary practices with local chiefs having priority use and control over distribution. Submerged lands and their resources generally were recognized to be an extension of the property controlled by adjacent landowners. This traditional extension of land to the sea tenure still functions in Yap and Chuuk, but not in Pohnpei or Kosrae. FSM has tried to redress this situation through the devolution of authority to the local governments at the state, municipal, and atoll levels.

### Institutional Approaches and Capabilities

A country with limited resources like FSM cannot do much on its own to deal with the problem of global warming and associated climate change. Government representatives have attended regional and international conferences and the Office of Planning and Statistics hired a full-time Climate Change Coordinator to implement the current vulnerability assessments. The Coordinator will also prepare a FSM Climate Change Country Study and Action Plan for the FSM. Baseline studies on shoreline changes will also be conducted and incorporated in a geographic information system.

The FSM has recently begun to address climate change at the federal and state levels. A multi-disciplinary team produced a National Environmental Management Strategy (NEMS) in 1992. The NEMS laid the foundation for the FSM to take environmental and economic development concerns

into account by adopting environmental impact assessment policies. The NEMS also served as the guide for the Second Five Year National Development Plan.

The FSM has also signed many international protocols on climate change and participated in various planning conferences including the Montreal Protocol and the Vienna Convention. Three out of the four states have also developed or are in the process of developing coastal zone management plans.

### FSM Climate Change Country Study Objectives

1. Conduct an inventory of sources and sinks of greenhouse gas emissions,
2. Increase FSM's understanding of potential vulnerabilities to climate change:
   a. Complete a case study on vulnerability to accelerated sea-level rise for Kosrae,
   b. Establish baseline climate data for the FSM.
3. Assess vulnerability of low-lying areas and examine issues related to "environmental refugees" and population migration:
   a. Compile and analyze data,
   b. Develop a geographic information system, and
   c. Circulate discussion papers for review.
4. Evaluate selected adaptation and mitigation options and develop a comprehensive framework within which to consider future needs, including costs and benefits of policies and measures required to implement any desirable options:
   a. Develop tissue culture of salt-water resistant taro (cyrotosperma),
   b. Conduct an atoll lens vulnerability study,
   c. Measure shoreline erosion of atolls.

### Conclusion

One accelerated sea-level rise vulnerability analysis study using IPCC methodology was conducted for the State of Yap by the U.S. Government. A second sea-level rise vulnerability analysis is currently underway in Kosrae. These types of studies are considered to be extremely valuable in identifying potential losses to sand beaches, infrastructure, and water resources. The FSM plans to continue with this process by developing a coastal zone management program.

## FIJI

*by Mr. Sefanaia Nawadra, Environment Officer, Department of Environment*

Fiji consists of more than 300 islands with a total area of 18,300 sq. km spread over 1.3 million sq. km of the South Pacific. The land mass is steep and unsuitable for intensive use with 83% under private land ownership. Fiji is extremely susceptible to cyclones and has a very high annual rainfall.

### Country Case Study Proposal

While the proposed study is the first to address climate change issues, a number of associated studies are currently being implemented. These include the National Environment Strategy, a remote sensing forestry inventory, a river improvement management project, an ozone depleting gases

inventory, the Australian government Tidal Gauge Project, various watershed management plans, and a disaster management plan.

The U.S. Country Study Project will be the first multi-sectional government project involving non-governmental organizations. The main Fiji coordinating agency is the Department of Environment. There are four major objectives.

1. To establish an inventory of sources and sinks,
2. To complete an assessment of vulnerability to sea-level rise,
3. To evaluate selected adaptation options, and
4. To establish a national environmental database.

The island of Ovalau was chosen as our case study. A number of tasks have been proposed to achieve the objectives:

1. Review existing legislation, institutions, and policies related to climate change,
2. Assess vulnerability of selected sites on case study islands,
3. Establish a geographic information system to centralize environmental data,
4. Conduct an aerial study of mangroves and coral reefs,
5. Compile detailed baseline survey of the reefs surrounding Ovalau,
6. Survey historical coastline changes using local anecdotal and scientific data,
7. Review ongoing coastal protection methods in Fiji, and
8. Establish pilot program for the design of coastal protection structures on Ovolau.

## INDONESIA

*by Mr. Dadang Hilman, Staff of Deputy Assistant 1, Ministry of State for Environment*

The State Ministry of the Environment has established the National Committee on Climate Change that consists of several agencies and departments such as the Ministries of Forestry, Mining and Energy, Agriculture, and the National Center for Oceanology. The National Committee guides policy on climate change in Indonesia. Our climate change project was proposed to the United States Country Study Management Team (CSMT), and is divided into five areas. Our primary focus is institutional and human resource development. Secondly, we are reviewing and updating "Strategic Anticipation of Climate Change Impact Caused by Greenhouse Gases to the Environment in Indonesia" and planning an Action Plan in combating climate change. Assistance from US-CSMT, both financial and technical, is very helpful. Thirdly, we had conducted a study on $CO_2$ emission by the energy sector, assisted by the Japan Environment Agency (JEA), so our intention of greenhouse gases inventory and mitigation, as a part of the Indonesia Country Study assisted by US-CSMT, needs technical assistance on other greenhouse gases. Fourthly, we had also conducted a study on the impact of sea-level rise assisted by JEA, so in this matter we are waiting for assistance from CSMT in developing adaptation and mitigation assessment methods. Lastly, we feel public awareness and education on climate change issue is still lacking, so a part of financial support from this project will be utilized for an educational campaign for public awareness.

## KIRIBATI

*by Ms. Tererei Abete, Environment Officer, Environment Unit*

The government of Kiribati has been involved in all forums on climate change, since climate change and ASLR became headline issues in various UN international forums such as IPCC. The primary concern is the affect of sea-level rise in the low-lying areas that are susceptible to inundation. All 33 islands of Kiribati, with the exception of Banaba, are 3 to 4 m above mean sea level, and there is evidence that sea levels have risen 40 cm during El Nino conditions. The second concern is related to inundation and salt-water intrusion into the fresh water resources. Drinking water and agricultural supplies of fresh water are threatened by even a slight rise in the sea level. Coastal erosion in combination with high tides and destructive wave action will put further strain on the already limited land mass. Fragile sea grass and coral reefs could be detrimentally affected by climate change which would affect our fisheries and economy. Lastly, a sea-level rise will affect traditional culture by displacing villages and meeting halls, reducing food supplies, and destroying historical and cultural sites.

### Overview of Workplan for the Country Study

1. Summary — This project intends to assess the effects of climate change on the various components of the natural environment.

   **Task A**. Prepare a detailed workplan for Kiribati Country Study. The workplan is being developed by the Ministry of Environment and Natural Resources for a one-to-two-year period.

   **Task B**. Inventory greenhouse gas sources and sinks. Kiribati's emissions of greenhouse enhancing gases include those from agriculture, forestry, and industry and are expected to be extremely low because of the small population (73,000) and level of industrialization. The main component of this task will be the calculation of Kiribati's sinks. The main sinks cover 3.5 million sq. km with reefs covering 800 sq. km. IPCC methodologies will be followed for testing emission sources and oceanic sinks.

   **Task C**. Establish a system for analyzing climatic trends in Kiribati. This system involves the establishment of baseline data on the climate of the Phoenix and Line Island groups. It also involves the improved coordination of research with neighbor islands, an important plan because of the continued resettlement of families from the Gilbert Group to Teraina and Tabuaeran.

   Task D. Assess coastal resources and their vulnerability to climate change. This project involves the development of an integrated coastal zone management program based on baseline data. It would:

   1. Assess current biological resources,
   2. Assess the vulnerability of coastal resources,
   3. Initiate a mangrove conservation project, and
   4. Assess the current status and vulnerability of freshwater resources.

## REPUBLIC OF THE MARSHALL ISLANDS

*by Mr. Jiba Kubua, Secretary of Foreign Affairs/Chairman of EPA Board, Ministry of Foreign Affairs*

The Republic of Marshall Islands is taking various actions with respect to the climate change country study. The Marshalls was one of the first countries selected and awarded funding for the U.S. Climate Change Study. NOAA completed a Vulnerability Study of Majuro, which was presented at the 1992 Rio Summit.

A coastal zone management law has not been developed in the Marshall Islands, but a law covering zoning has been enacted. This law will be difficult to implement because of the traditional, private land tenure system that exists on our islands. The land tenure system will be incorporated in the process.

There is a lack of environmental and engineering expertise in the country. So, outside experts are being hired to assist in the development of various programs including the climate change study. Environmental education is also a focus of the country's program, because traditional values and cultural practices are not being utilized in the modern system.

## PAPUA NEW GUINEA

*by Mr. John Poawai, Fisheries Coordinate, Department of Environment and Conservation*

Papua New Guinea is one of the biggest islands in the South Pacific. Geographically, Papua New Guinea is in one of the worst areas for natural disasters and recently a volcanic eruption affected about 150,000 people. Land in Papua New Guinea is approximately 85% to 89% privately owned and managed. There is a modern legal system as well as a strong traditional moral system.

Because of the strong traditional systems, the government has little influence regarding land use and management of natural resources. Attempts have been made to develop management programs, but have had limited success without extensive local participation. Therefore, education and negotiation are very valuable in the management process.

Currently, the country is developing coastal zone management programs, and intends to have a plan completed by December 1994. The coastal zone management strategy integrates concerns of the coastal areas, upland forests, and the agricultural sectors.

## THE REPUBLIC OF THE PHILIPPINES

*by Dr. Rodition Buan, Acting Assistant Weather Services Chief, PAGASA*

The Philippines consists of 7,107 islands with a total land area of 299,765 sq. km and a coastline of approx. 18,000 km. The territorial waters cover about 2.2 million sq. km of which 88% (1.936 million km$^2$) is oceanic and 12% (0.264 million km) coastal. The coastal zone covers a total area of about 11,000 km of land and 267,000 km of coastal waters. Approximately 55% of the country's population, 70% of the 1,525 municipalities, and 10 of the largest cities are located in the coastal zone.

### Meteorological and Geological Conditions

The Philippines is considered to be "climatically deprived" and is vulnerable to extreme meteorological events such as typhoons, storm surges, tsunamis, floods, and droughts. It also suffers from earthquake and volcanic eruptions that have caused significant changes in its land configuration

and coastlines. Damage to property caused by disastrous typhoons is equivalent to about 1% of the gross national product (GNP), and floods and droughts (droughts generally caused by ENSO events) contribute to a loss of about 2% to 3% of rice and corn production annually. The devastating impact of the Mt. Pinatubo eruption cannot be quantitatively accounted for presently. In others words, the Philippines cannot sustain its economy in present climatic and geologic conditions.

**Man-Made Environmental Problems**

The degradation of mangrove forests and their conversion to other uses such as fishponds has caused significant environmental problems. The destruction of coral reefs by pollution and destructive fishing practices has combined with over-fishing to reduce fish yields and compromise the longterm susceptibility of Philippine fisheries. Occurrences of "red tides" are also major problems. The seawater quality has also rapidly deteriorated over the past decade primarily a result of sewage and industrial effluent from urban areas, tailings from mining activities, oil spills, fertilizer and pesticide residue run-off, and erosion from deforestation.

**Impact of Climate Change and Sea-Level Rise on Coastal Zone Management**

Due to the combined impacts of present day climatic conditions and human activities there is extreme pressure on the coastal area. Impacts of climate change, specifically ASLR, can be predicted to include submergence of small islands and reclaimed areas (in metro Manila and metro Cebu), submergence of beach resorts, rise in sea level in Laguna de Bay, submergence of lake shore areas, increased flooding, increased salinity of ground water, accelerated coastal invasion/inundation, dislocation of population, possible loss of mangrove forest, losses in aquaculture, dislocation of population, and damage to the infrastructure.

**Coastal Zone Management Strategies**

For this purpose, the following coastal zone adaptation and management options based on retreat accommodation products are recommended:

- develop a comprehensive national coastal zone management plan,
- identify specific coastal areas at risk for possible protection,
- strengthen research on the impacts of global climate change or sea-level rise,
- strengthen emergency preparedness,
- develop coastal zone defense mechanism,
- establish an information and educational campaign (IEC),
- commodity based coastal resource management, and
- prepare site-specific fishery resource management plans based on the inventory of resources and assessment of sustainable fishing yields.

**National and Regional Action Plan**

The Philippines' major concern is calculated response to severe weather events such as typhoons, floods, and droughts. In addition, rapid deterioration of coastal zone ecosystems caused by pollution from urban centers is also a major concern. A projected sea level rise scenario of 1 m by the 21st century will compound the problems by further affecting coastal zone areas. Strengthening of the present disaster preparedness program and its response capabilities is recommended. The plan also calls for increased regional cooperation and information sharing.

## THE SOLOMON ISLANDS

*by Mr. Moses Biliki, Chief Environment and Conservation Officer, Ministry of Forests, Environment and Conservation*

Climate change is not a priority in the Solomon Islands even though the climate change treaty has been signed, but not ratified. The issue is not a priority in the Solomon Islands because there is a lack of information and knowledge concerning the issue. There is also a lack of basic resources necessary to address climate change issues. The Solomon Islands needs to do an inventory of its resources, but lacks the expertise in many scientific areas.

In terms of coastal management programs, there is no national management program based on comprehensive data. The Western Solomons do have a community based coastal management program that is being coordinated by an international non-governmental organization. A hawksbill (turtle) rookery is being developed as part of a marine conservation initiative; however, a management plan has not been completed for the project. In addition, a local community in Ontong Java has established its own successful management plan. The Solomon's plan is to continue with small management programs, because of a lack of resources for a large national plan.

## TONGA

### "Adaptive Management Strategies on Climate Change — The Perspectives in Tonga"

*Compiled by Paula Taufa, Senior Environmentalist; revised and presented by 'Etueni Tupou, Deputy Secretary, Ministry of Lands, Survey & Natural Resources, Kingdom of Tonga*

The Kingdom of Tonga is an independent constitutional monarchy in the South Pacific consisting of 170 small islands. The total land area is approximately 700 sq. km with a total population of about 100,000. Tonga-tapu is the main island with an area of 255 sq. km and about 70% of the total population. The capitol Nuku'alofa is situated on the main island.

The economy has traditionally been based on agriculture. Tourism and high-value manufactured goods have been given a high priority in the development of the Kingdom. Additional supports for the economy come from overseas remittances from Tongan nationals living abroad and also from a variety of internationally funded aid projects.

### Concerns Regarding the Effects of Accelerated Sea-level Rise and Climate Change

1. Integrated Coastal Zone Management

   Tonga has yet to complete a Coastal Zone Management Plan, but a preliminary study on the impacts of sea-level rise on the main island of Tongatapu was completed in 1993.

2. Protection of the Kingdom's Biological Diversity

   Biodiversity has a high priority in international and regional environmental programs. Tonga was included in the South Pacific Biodiversity Conservation Programme initiated by SPREP.

3. South Pacific Sea Level and Climate Monitoring Project

   Tonga is equipped with the Sea Level Time Resolution Acoustic Measuring Equipment (SEAFRAME) and has sensors that measure

   - water level,

- wind speed and direction and maximum wind gusts,
- air and water temperatures, and
- atmospheric pressure.

4. Sustainable Development Projects

   The Environmental Planning Section of the Ministry of Lands, Survey and Natural Resources in Tonga is implementing various projects including the following

   - the Giant Clam Project,
   - the Bird Conservation Park,
   - Education Handbook,
   - the Public Awareness Programme.

**Overall Goals and Objectives**

- Promote economic and social development in Tonga on a sustainable basis;
- Promote sustainable utilization of critical resources such as groundwater, soil, flora, and fauna as well as marine-based resources;
- Foster cooperative partnerships among existing planning and environmental management institutions;
- Promote research on both renewable and non-renewable resources;
- Promote public awareness of matters directly concerning the sustainability of the development process.

**Impacts of a Sea-Level Rise in Tonga**

With regard to the main island of Tongatapu, there are two types of inundation that need to be distinguished: (a) direct inundation, or sea-level rise, and (b) indirect inundation caused by the relative rise of the groundwater table in the inland areas. The permeability of the coral limestones will cause a corresponding rise in the groundwater table. The rise in the groundwater table could cause inundation of low-lying areas.

**Impact on Human Habitation**

According to the Greenpeace Pacific Campaign paper, "rapid sea level rise would change the coastal ecology and much valuable dry land would disappear under water." A 50 cm rise in sea level would cause Nuku'alofa (where 20% of Tonga's total population live) to lose 15% of its' land area. If Nuku'alofa becomes inundated either directly by sea-level rise at the coast or indirectly by rising groundwater, then both the people and the infrastructure would have to be relocated. The relocation of residents out of Nuku'alofa to higher grounds would increase pressure on agricultural land surrounding Nuku'alofa. The relocation of people from low-lying areas to higher grounds would cause social problems related to land ownership. It can be expected that any relocation programs undertaken by the government may be met by apathy and reluctance. This has been demonstrated by the case of flooding in the low-lying areas of Halauvave in Nukalofa. Many families refused to accept new land on higher grounds and preferred to remain at their original localities despite the potential hazards of continued flooding. In addition, some social tensions can be anticipated between those families who still have land and those who have lost their lands. Other specific concerns are health problems, especially respiratory diseases and malaria, that could be anticipated in residential areas

encountering a sea-level rise, many social and cultural sites in low-lying areas, such as burial sites, could be destroyed by a sea-level rise, and biological diversity, particularly in relation to mangroves, may be affected by a sea-level rise.

# V. CLIMATE CHANGE TRENDS

**"Climate Change Reality: Current Trends and Implications"**

*Ms. Eileen Shea, Staff Director, National Research Council Program on Global Change, Washington, D.C.*

"The same parts of the earth are not always moist or dry, but they change... rivers come into existence or dry up. And so the relation of land to sea changes too... but we must suppose these changes to follow some order and cycle."

*-From the meteorological commentaries of Aristotle, Greek philosopher, about 350 B.C.*

The underlying view of the U.S. Global Climate Change Research Program is that the earth is a single, integrated system whose behavior can be anticipated in order to support national and international policy formulation and decisions relating to natural and human induced changes in the global environment and their regional impacts. The program seeks to anticipate climate change and assist in redirecting national and international policy in response to program findings.

**Sources of Climate and Global Change**

Global climate change is impacted by two sets of variables: The natural variability of climate changes and human activity. Natural variability includes solar variability, volcanic activity, biological evolution, and large-scale regional phenomena such as the El Nino Southern Oscillation (ENSO). Human activities include energy usage, land use practices, industrial activity, and population growth which underlie increases in all these human activities. Natural variability has historically caused a shift in localized and global weather patterns. Human activities have speeded up the process of change.

**The Global Greenhouse**

Incoming solar energy in the form of sunlight passes through the atmosphere and is absorbed by the earth. As the earth radiates the heat back, some is trapped by atmospheric carbon dioxide and other gases (ozone, nitrous oxide, methane, and chlorofluorocarbons) known as greenhouse gases, which result from numerous activities such as deforestation, agriculture, industrial processes, and energy use. Increases in the level of greenhouse gases in the atmosphere enhance the atmosphere's ability to trap radiated heat, thus warming the earth's surface.

Warming, which may result from the increases in greenhouse gases may lead to climatic changes such as changes in the precipitation pattern, reduction of sea ice, and arctic winter surface warming among other potential effects (see Table 1 on page 5). The Intergovernmental Panel on Climate Change (IPCC) Impacts Assessment Working Group on Oceans and Coastal Zone impacts stated that the principal impacts of global warming will include (1) accelerated sea level rise, (2) modified ocean circulation, and (3) changes in marine ecosystems. NOAA's Office of Technology Assessment reported in 1993 that climate change poses two potential resource management problems: an increased unpredictability and an increased risk of surprises.

**Recommended Action**

The IPCC Impacts Assessment Working Group on Ocean and Coastal Zones recommended the following long-term actions be implemented to protect against the impacts of global climate change:

- Integrate monitoring of terrestrial and marine ecosystems
- Monitor global sea-level changes, particularly island nations
- Identify population and agricultural and industrial productions at risk
- Integrate climate change impact information into planning process

The IPCC further recommended that short-term adaptation actions be implemented:

- Develop emergency and disaster preparedness policies and programs
- Assess areas at risk from sea level rise
- Develop comprehensive management plans to reduce vulnerability of coastal populations and development.

Any adaptation strategy adopted to protect coastal areas from the impacts of global climate change should enhance *flexibility*, by providing a buffer against negative impacts, and *robustness*, minimizing risk by making systems less sensitive. Adaptation strategies can be limited by factors such as the lack of information about climate change, available technologies to ameliorate the impacts, governing institutions which may be unable to respond to change in a timely manner. Successful adaptation strategies will be those that overcome these limitations.

**Impact of Large-scale Natural Climatic Events**

Large-scale natural events such as El Nino can cause significant impacts on agriculture and human settlement. A major ENSO event in 1982–83 has been linked to several natural disasters which caused billions of dollars in damages including flooding in the Gulf states, Bolivia and Cuba; droughts in Mexico, Australia, Indonesia, and the Philippines; and hurricanes in Tahiti and Hawaii. The importance of understanding the natural climatic variability is to be able to forecast the occurrence and impacts of large-scale climatic fluctuations such as ENSO and to mitigate their impacts through the selection of appropriate countermeasures.

**Recommended Actions**

Enhanced predictive information in areas such as droughts, rainfall and flooding, tropical storms, and fisheries could improve local/regional decision making. The international scientific community is on the verge of a breakthrough in predicting long-term climatic conditions. A partnership exists among institutions and individuals with interest in the Pacific including the University of Hawaii, University of Guam, NOAA's Office of Global Program, National Weather Service, Pacific Basin Development Center and others to

- Expand access to existing information
- Improve local/regional historical climate databases
- Enhance public awareness of and education about the impacts of natural climatic variation
- Develop tailored information on local and regional consequences of climate change with translating and interpretation for local decision makers
- Improve communications through the use of electronic telecommunications networks

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# VI. CLIMATE CHANGE IMPACTS

### "Social and Economic Impacts of Climate Change"

*by Dr. Michael Hamnett*

The social and economic implications of global climate change impact, like so many other decisions faced by governments, determine what those governments will do about them. If island leaders perceive that economic dislocation will occur in the short term then they will assign resources to respond to the problem. However, the optimal set of land-use changes, physical barriers, and relocation may not be affordable or culturally acceptable to island inhabitants.

Pacific people face a great many uncertainties about the future and climate change is one of those uncertainties. Global climate change impacts can be placed on an uncertainty continuum from short-term and very likely to occur to very long term and highly uncertain. Those problems which are closer to the very likely to occur will receive attention whereas those farther off will receive little attention.

An important point to keep in mind is that many of the impacts predicted to occur because of global climate change are already manifest in the Pacific including these:

- coastal inundation
- salt-water intrusion into aquifers
- drought
- floods
- erosion
- tropical storms, cyclones, typhoons and hurricanes
- coral bleaching and degradation of coastal ecosystems

Global warming might change the intensity, frequency, and distribution of these events but Pacific island countries and territories deal to some degree with the phenomena now. Thus, Pacific islanders are familiar with many of the social and economic impacts that are forecast for global climate change and to some extent are already dealing with them. However, if the distribution of these impacts change, the results could be very disruptive. If for example, Kiribati or Tuvalu begin to experience typhoons as frequently or intensely as in Guam or the Philippines, they would find it more difficult to recover. Physical damage would be greater proportionally in the atoll islands than in larger volcanic islands and fewer natural resources would be available to be used for recovery. How the pattern of natural hazards would change throughout the region is an important issue.

How Pacific islanders presently respond to natural hazards is another important issue. The answers varies from island group to island group but in general, most islanders can improve their hazard management capabilities. To the extent that island countries and territories increase their capacity to respond to present natural hazards they will increase their capacity to respond to predicted hazards caused by global climate change.

**"Climate Change: Current Trends and Their Applications"**

*by Dr. Fred Mackenzie, Department of Oceanography, University of Hawaii*

There have been a number of recent findings relevant to global climate change. These will influence many of the policies and programs countries adopt to deal with coastal management problems, particularly in the Pacific.

1. Records of temperature anomalies over the land and sea surface, at the 850-300 millibar level of the troposphere, and microwave sounding unit temperatures from the NOAA-11 satellite show that global mean temperature (corrected for ENSO and volcanic events) from 1958 to 1993 increased by about 0.1 degree centigrade per decade.
2. The eruption of Mt. Pinatubo in 1991 led to significant cooling of the planet and changes in the biogeochemical cycles of the greenhouse gases. In particular, the global mean temperature anomaly decreased by about 0.5 degrees centigrade and the original $CO_2$ anomalies were increasing, recovering from the cooling brought about by the eruption of Mt. Pinatubo.
3. In the late 1980s and early 1990s, the rates of accumulation of greenhouse gases in the atmosphere were slowing — a result of the Mt. Pinatubo eruption and global cooling; decreased emissions from natural and human sources; and in the case of the freons CFC-11 and CFC-12, the Montreal Protocol has led to decreases in emissions of these gases to the atmosphere.
4. Decreases in stratospheric ozone levels may have resulted in a decrease in radiative forcing equivalent to the potential radiative forcing contribution of the CFCs to global warming.
5. It is very likely that the cooling effect of sulfate aerosols resulting from sulfur emissions to the atmosphere by fossil fuel combustion and other activities of humankind has affected and will continue to affect greenhouse warming in the Northern Hemisphere.
6. It is very likely that during the 1980s, the northern hemispheric terrestrial biosphere acted as a net sink of fossil fuel combustion and deforestation $CO_2$ fluxes to the atmosphere because of simulation of plant growth by increased atmospheric $CO_2$ levels and/or fertilization by nitrogen derived from human sources.
7. If global temperatures continue to rise, it is very likely that gross respiration in the northern hemispheric biosphere will exceed gross photosynthesis, and this area will become a net source of $CO_2$ to the atmosphere.
8. The GRIPS ice core drilled in Greenland shows the possibility that even during an interglacial stage of the Pleistocene Ice Age (our present stage), rapid and significant changes can occur naturally in global mean temperature. This record plus others imply the strong possibility for surprises in the physical climate system and the biogeochemical cycling of greenhouse trace gases.

Various conclusions can be derived from this information. Any policy action taken by a country or region should not be so inflexible that it cannot be modified in light of new evidence on global

climate change. Countrywide assessments of greenhouse gas sources and sinks are a condition of the Framework Convention on Climate Change ratified in 1994. For Pacific island nations, this may entail evaluation of their coastal zones as a source or sink of atmospheric $CO_2$. Simple models of land-coastal margin ecosystems can provide some indication of the behavior of these systems under the influence of human-induced or natural global climatic change and human forces of population change, deforestation, fertilizer use, etc. Sea-level rise and its effects on Pacific Island Nations can be assessed through the use of the available data base and modeling[1].

**"Climate Change: Impacts on Island Infrastructure and Land Use"**

*by Dr. Chalapan Kaluwin, Climate Change Officer, SPREP. Paper was prepared by Dr. Chalapan Kaluwin, and read by Dr. Andrew Smith.*

This paper touches on three areas: climate change impacts on islands infrastructure; climate change impacts on land use; and vulnerability and resilience study methodologies. It is primarily based on a case study of coastal vulnerability and resilience to sea-level rise and climate change in Fiji.

The term "infrastructure" needs to cover a broad range of structures in terms of size and monetary value as well as social cultural values. Infrastructure is the national infrastructure system such as roads, port facilities, shoreline protection structures, utilities (water, power, sewage), as well as airplane runways, and building complexes. Communal infrastructure includes structures such as churches, meeting houses, cooperative owned buildings, some seawalls and jetties. It may also include communally developed water supplies and waste disposal systems, and others. There is also privately owned infrastructure such as private buildings, kitchens, shops, and workshops.

In all of the Pacific islands the existing infrastructure and associated facilities have been long established along the coast, near ports, and other transport facilities such as wharves and jetties. All were established along the coast for easy access and less manual effort in carrying out life's activities. Permanent and expensive church buildings, for example, are built close to the coast.

Most people are familiar with urban infrastructure, but I'd like to briefly refer to the Fijian case study to give an indication of what type of infrastructure is involved away from the urban setting. Nacula Island is in the central part of the Yasawa group. What are some of the climate changes that are being predicted and what sort of impact will they have on infrastructure?

Sea-level rise is most commonly referred to impact. A rise in sea level would result in overtopping of outer reefs resulting in changes to coastal processes and sediment mobility, which would result in shoreline erosion with consequent implications for infrastructure adjacent to those shorelines. Ocean-surface warming will bring its own set of problems, especially in coastal marine ecosystems.

Climate change interacting with sea-level rise will possibly pose problems not normally considered in the wealthier, continental countries. For example, much of the agriculture in the Pacific region is currently marginal in the sense that it is conducted on lands which are steep or have nutrient-deficient soils. Additionally, much of the agriculture in the Pacific is wasteful of both soil and water resources. Consequently, its sustainability is questionable.

[1] Miller, D.L.R. and F.T. Mackenzie. 1988. *Implications of Climate Change and Associated Sea-Level Rise for Atolls.* Proceedings of the 6th International Coral Reef Symposium, v. 3, 519–522.

It is possible that some areas of the Pacific will become more wet, which will increase soil erosion. Other parts of the Pacific islands may become drier, necessitating the use of irrigation for subsistence crops. Certain crops may no longer be viable due to changing precipitation conditions. A rise in temperature will cause a rise in evapotranspiration rendering various types of agriculture (currently being practiced) impossible without water conservation measures. A rise in temperature will also mean that some crops and semi-subsistence plant species may no longer be able to grow. So, dependence on these crops will have to be changed. For example, the northernmost islands of Tonga (Niuatoputapu group) are tropical and the southern most (Tongatapu and 'Eua) are subtropical. Certain crops in the south cannot survive in the north because of their intolerance to high temperatures. If temperature rises and the southern islands become tropical, then the people there will need to change their subsistence and export agricultural habits. The frequency of catastrophic events, such as an increased frequency and intensity of tropical cyclones/ typhoons, is of concern. In themselves they would be bad enough, but when combined with sea-level rise, the effects would be exacerbated. These are just some of the possible effects of climate change.

As Fiji is perceived to be comprised of a number of high islands it often has been regarded as comparatively immune from the deleterious effects of accelerated sea-level rise and climate change. Although the effects won't be as rapid nor as destructive for high islands as it will be for atolls, there will still be considerable disruption. Despite the fact that Fiji is made up of high islands the communities on the low-lying coastal areas are in most danger. Most economic activity including industry, manufacturing, agriculture, and commercial enterprises is concentrated on the coastal plains.

Sea-level rise alone will have a very negative effect on agricultural productivity in Fiji. This is the single largest sector of the economy, accounting for about 20% of the GDP and 80% of employment. Most of the fertile land is in low-lying alluvial areas in river valleys and deltas, which will be subject to inundation and increased flooding. Increasing salinity of the ground water and salt spray will also have negative impacts. This could have extremely negative impacts on the sugar cane industry, which contributes $300 million to the economy each year.

Subsistence agriculture is also important in Fiji, with most Fijians practicing classical slash and burn agriculture. Most available land is under cultivation and under increased pressure from an expending population. Fallow periods are shorter between crops and there has been increasing use of steep upland areas for commercial and subsistence agriculture. Sea-level rise will, of course, exacerbate these problems. The positive "fertilization effect" of higher carbon dioxide levels in the atmosphere will most likely be negated by more heat stress, a greater incidence of weeds and pests, and more damage by floods and droughts.

The Fijian lifestyle, which is dependent on the relationship of people to the land and their ancestral homes in the coastal areas, will also be affected by climate change and sea-level rise. Forced movement from the coastal areas could cause a number of social and cultural problems.

There are various methods for assessing vulnerability to sea-level rise and climate change. The IPCC methodology that was tested by SPREP in Tahiti, Tonga, Kiribati, and the Marshall Islands does not work well in the Pacific islands, and other assessment criteria need to be used in addition to the economic factors used in IPCC. In 1993–94 SPREP coordinated two projects in Fiji and Western Samoa to modify the common methodology. The projects included factors such as subsistence economy, land tenure, family structure, remittances, religious beliefs, and village decision-making structures into the methodology. This methodology, which incorporates the specific conditions of the Pacific islands, seems more appropriate for assessing the impacts of climate change and sea-level rise.

**"Impact on Marine Resources: Fish, Corals, and Ecosystems"**

*by Dr. James Maragos, Senior Fellow, Program Environment, East-West Center, Honolulu*

Global climate change impacts would include accelerated sea-level rise, increased storm activity, increased droughts, and increased flooding. These impacts would have substantial effects on Pacific islands especially on the atoll island nations such as the Marshall Islands, Kiribati, Tuvalu, Tokelau, and the atolls of high-island governments and nations.

Most reef scientists agree that reef growth will eventually keep up with the upward movement of sea level. Many scientists, however, believe that the growth will not follow the same pattern as the rise. The nature of coral growth on shallow reef flats is often accompanied by periods of lateral growth prior to upward growth. In addition, algal growth, sand and loose rock accumulations will further inhibit coral growth. This lag in the growth period may last for decades depending on local conditions. Increased tropical storms activity will add to the problem of coral regeneration, causing setbacks during and after storm episodes. The net result may be prolonged periods where initial sea-level rise, episodes of high tides, and frequent storms may postpone meaningful upward reef growth and cause considerable damage to low island communities and even abandonment of the most vulnerable areas.

Sea-level rise would cause an inland shift of coastal ecosystems. Where no structural development has taken place, the shift would encroach on previous land areas until a new equilibrium is reached. Where non-removable structural development has taken place near the shoreline, physical barriers such as sea walls and rip-rap may be used for protection. This will cause a horizontal compression of nearshore marine ecosystems because shoreline barriers would prohibit the landward migration of the nearshore environment. Associated with ecosystem compression would be a loss of biodiversity as some environmental niches are squeezed out. The losses will occur in areas that are among the most important to islanders including estuaries, sea grass beds, mangroves, and coral reef flats. These areas often include the most important fisheries and other important resources such as mangrove wood, beach sand, and coral aggregate for building materials and recreational and tourism areas.

Steps can be taken now that will prevent or mitigate many of the impacts that may occur. Most importantly, governments need to establish wider shoreline setback zones. In rural and uninhabited areas, the zone between the upperwash of the ocean and the setback line can be set aside as a buffer zone to allow coastal ecosystems ample space to reach new equilibrium as sea level rises. Government needs to encourage the relocation of new and possibly existing development away from the shoreline, obviating the need to fortify the shoreline. Planners will also have to take into account predicted sea-level rise when siting coastal infrastructure such as boat harbors, sewage treatment facilities, fish processing, and other facilities.

In areas where shoreline buffers are not feasible, such as low-lying atolls, then shoreline hardening and relocation of some development may be the only options possible.

## VII. CLIMATE CHANGE ASSESSMENT TOOLS

*Dr. Roger Lukas, Moderator, Department of Oceanography, University of Hawaii*

People mean different things when they use the word "assessment." "Assessment" means to evaluate the current situation, for example with sea-level rise or sea-surface temperature changes. In

an environmental policy forum such as this, assessment takes on a larger meaning. It actually involves elements of prediction that foretell the future conditions of sea level rise by the year 2050. What will the trend be at that time? Will sea-level keep rising or will it start falling again? What is the sea-surface temperature now? What was it a hundred years ago? Historical data are very valuable, because in some cases it provides a long time-series of information. However, it is very limited in spatial coverage and very limited in the types of variables that have been observed. Modern observations may be much more complete in terms of their coverage but are very short in duration. Global, regional, and coastal models help to bridge the gap between modern observations and historical observations through analysis of data.

**"IPCC Methodology"**

*by Mr. Ben Mieremet, International Affairs Office, NOAA*

Many countries are concerned with sea-level rise and climate change. Sea-level rise is of particular concern because 140 of 180 countries in the world have coastal zones. The Pacific islands, the United States, and other countries face potentially major losses from climate change and sea-level rise. Because of the potential impacts from climate change and sea-level rise, it was necessary to develop a common methodology to provide comparable assessment data of the vulnerability of coastal areas. There were three working groups involved in the development of the IPCC methodology Science Working Group 1, Impact Working Group 2, and Response Strategies Working Group 3. Within workgroups there was a sub-group which dealt with coastal management and sea-level rise.

The sub-group developed a seven-step common methodology to help countries assess their vulnerability to sea-level rise. The methodology creates scenarios depicting potential impacts by changing boundary conditions, such as a 0.3 to 1.0 m change in sea level. This change allows for the comparison of data between various countries and regions.

The role of vulnerability assessment using the IPCC Common Methodology[1] (refer to Figure 1, p. 9) is to examine a coastal nation's ability to cope with the consequences of global climate change, including accelerated sea-level rise. This includes identifying the populations and resources at risk, investigating the costs and feasibility of possible responses to adverse impacts, and examining the institutional capabilities of implementing those responses. Until a country assesses the costs and benefits of alternative responses, it has no way of knowing the possible long-term implications of climate change for the management and development of its coastal zone.

The objectives of the IPCC Common Methodology are to:

- Identify and assess physical, ecological, and socio-economic vulnerabilities to accelerated sea-level rise and other impacts of global climate change on coastal zones;
- Understand how development and other socio-economic factors affect vulnerability;
- Clarify how possible responses can mitigate vulnerability and assess their residual effects, and
- Evaluate a country's capacity for implementing a response within an ICZM framework[2].

[1] IPCC-CZMS. 1991. The Seven Steps to the Assessment of the Vulnerability of Coastal Areas to Sea-Level Rise – A Common Methodology. Intergovernment Panel on Climate Change, Response Strategies Working Group. Tidal Waters Division, Rijkswaterstaat, Ministry of Transport, Public Works and Water Management, The Hague, The Netherlands.

[2] IPCC-CZMS. 1992. Global Climate Change and the Rising Challenge of the Sea. Report of the Coastal Zone Management Subgroup, IPCC Response Strategies Working Group, Rijkswaterstaat, The Hague, The Netherlands.

The IPCC Common Methodology includes three scenario variables: global climate change, local development, and response options. It considers national or local development extrapolated 30 years from the present situation. The methodology encourages coastal nations to consider a full range of response options, but at least the extreme options of retreat and total protection. In assessing vulnerability to sea-level rise, the methodology considers potential impacts on population, on economic, ecological, and social assets, and on agricultural production.

For those nations who follow the methodology, it provides the IPCC with the opportunity to make global assessment using comparable data and information. Figure 1 on p. 9 shows the vulnerability profiles for selected countries, based on case study results[3].

The IPCC Common Methodology was intended to be used by countries as a first order assessment, completed in a relatively short time and using largely existing data or data which could be obtained easily. Some of the obstacles investigators and countries have encountered, however, in conducting vulnerability assessment based on the methodology include the following:

- Some of the data called for in scenario development, particularly socio-economic data, is not readily available, especially in developing and rural countries. Determining land at loss and people at risk under 0.3 and 1.0 m sea-level rise scenarios is difficult, especially when projecting into the future.
- Other factors which affect sea-level rise, including subsidence and uplift of land, can be accounted for as called for in the methodology, but are often difficult to determine, especially with tide gauge records.
- Extreme events such as major storm surges, are often not included in the assessments, thereby minimizing the full risk of future flooding events.
- Some researchers have criticized the methodology as being static and not being able to factor in resiliency of natural systems or of sciences.

**"Coastal Models Assessment and Planning Tools"**

*by Dr. David Liu, Resident Consultant, RAND System Research Institute, Malibu, CA*

Coastal models can be used to predict change on land caused by at sea-level rise. Coastal models use output results of large scale models as boundary conditions. Coastal models can range in size from very large scale such as a model of the China Sea from the equator to the northern part of China, to a small area such as a model of the city of Taipei. However, as resolution is increased so is the cost of running the model.

Coastal models are used to assess quantitative sea-level rises or other changes or distribution of temperature or changes of area of upwelling or new types of wind fields that may impact fisheries or fish migration patterns. Another potential use for models is predicting changes of tidal heights caused by sea-level changes which may cause flooding in low-lying areas; changes in salinity, pollution in intertidal zones; changes in nearshore current patterns; and other stresses to estuaries.

The first model I designed in 1963 for San Francisco Bay, California was a relatively crude model compared to those I am now designing. Computers have become relatively more powerful in

[3] Nicholls, R.J. 1994. Synthesis of Vulnerability Analysis Studies. In: WCC '93, Preparing to Meet the Coastal Challenges of the 21st Century. Proceedings of the World Coast Conference 1993, Noordwijk, Ministry of Transport, Public Works and Water Management, The Hague, The Netherlands.

the last 35 years by about five orders of magnitude, which is increased by one order of magnitude every seven years. What once required a large mainframe computer can now be done on a desktop. Computer models are now portable and can be used anywhere where there is a power supply.

One example of how models can be used is to prepare planners for designing shoreline structures. Holland, a low lying country in Europe, has much reclaimed land protected by dikes that are designed to resist forces of present oceanic conditions. Planners need to know what the potential impacts on the dikes would be if sea level were to rise 1 m or more. The models can simulate the changes allowing planners to redesign the dikes. Models can be designed to predict conditions on small islands. They could be used for example to predict changing conditions brought about by El Nino events so that island managers could be prepared for the changes.

**"Possible Changes of ENSO Effects Due to Increased $CO_2$ in Global Coupled Ocean-Atmosphere Climate Models"**

*by Dr. Gerald A. Meehl, Scientist, National Center for Atmospheric Research, Boulder, CO*

Even though much attention in the Pacific region has focused on threats from sea-level rise due to global warming, the possible changes in climate effects associated with El Nino Southern Oscillation (ENSO) events could have serious consequences for water supplies and agriculture. As with sea-level rise, atoll communities dependent on rainfall for fresh water could be most at risk due to precipitation variability associated with ENSO events. Results from global coupled ocean-atmosphere climate models show that ENSO events continue to occur with an increase of $CO_2$, but mean sea-surface temperatures (SSTs) in the tropical Pacific rise. With increased $CO_2$ the relative pattern of moisture anomalies in the tropics is similar between the present-day ENSO events and those that occur in the increased $CO_2$ climate. But the rise in mean SST in the tropical eastern Pacific means that when an ENSO SST anomaly is superimposed, there is increased low-level moisture convergence, greater precipitation over the warm SST, and an intensification of atmospheric anomalies in the tropics involved with the strengthened large-scale east-west (Walker) circulation. Consequently in the models, when comparing present-day and possible future ENSO events in an increased $CO_2$ climate, precipitation anomalies indicate that most anomalously dry areas become drier (implying risk of increased moisture deficits in those areas). Additionally, results from one recent global coupled ocean-atmosphere climate model show that the mean $CO_2$ climate change signal resembles conditions during an ENSO event. The implication for areas that are anomalously dry in the western tropical Pacific during present-day ENSO events is that those conditions could occur more on average, with even more intense moisture deficits during ENSO events.

**"ENSO Application Service, Tools for Assessing Changes in Global Weather Patterns"**

*by Dr. Thomas Schroeder, Department of Meteorology, University of Hawaii, Honolulu*

The ENSO Application Center assists the U.S. affiliated Pacific island governments with initiating information and interpretation of products produced by federal agencies like the Climate Analyses Center. A prototype program has been set up involving the University of Guam, University of Hawaii, Pacific Basin Development Council, and NOAA. This program translates and interprets information on climate change for the various island governments. The ENSO Application Center examines various issues including precipitation, droughts or floods depending on where you happen to be, sea surface temperature distributions and their effect on fisheries, and tropical cyclones.

There has been a shift in the location and formation of tropical cyclones during ENSO events. In 1982/1983 the Southwest Pacific including Tahiti experienced tropical cyclones. These were the first cyclones to hit the area in 75 years.

The consequences of the increased frequency and intensity of cyclones and hurricanes in the Pacific are important. These include the cost of storm damage on island communities and the risk of increased insurance rates like those in Hawaii and Florida. There is also the possibility that insurance will no longer be available.

One of the major problems facing ENSO research is examining the variability of tropical cyclone formation, numbers, and intensity. The Application Center is using data from 1966 to the present to study the histories of storms in the northeast and central Pacific. This includes analysis of storm intensity and the correlation of sea temperature rise and storm development. Ships can be used to gather data on sea surface temperatures and compare those to temperatures gathered by satellite.

The use of historical data is important for the analysis of ENSO events in the Pacific and can be used with the various models to better understand the changes which are occurring in the Pacific area from climate change.

## VIII. RESPONSE STRATEGIES

### "A Brief Look at the U.S. Coastal Zone Management Program"

*by Mr. Ben Mieremet, International Affairs Officer, NOAA*

As Panel 1 discussed the potential impacts of climate change and Panel 2 discussed some of the assessment tools available to forecast those impacts, this panel discussed adaptation response strategies. Once the potential impacts of island environments and shorelines are identified, including your infrastructure, food supplies, and cultural heritage; the severity of the problem can be determined; then good tools for beginning the process of adapting to climate change impacts are needed. Some of the response tools available include developing the capability to retreat, accommodate, or protect. This is best done within the framework of comprehensive and integrated coastal management planning. Before our speakers begin, let me describe, in short, what the United States has done in developing response strategies.

In describing the U.S. development of response strategies, we are really attempting to describe what 35 coastal states and territories from Alaska to American Samoa, including all the islands (i.e., Hawaii, Guam, Commonwealth of the Northern Mariana Islands, Virgin Islands, Puerto Rico) are doing. There is great diversity in the approaches taken over a 20-year record of trying to deal with natural hazards and other issues in a comprehensive fashion. The U.S. Coastal Zone Management Program functions on a national, state, and local level with the federal government providing mostly financial and technical assistance to the coastal state and territorial agencies which are responsible for coastal land/water management. The states like Hawaii and territories like American Samoa are required to meet certain minimum requirements in the approval of the programs prior to receiving federal approval and support. It is a voluntary program so they make the decision to participate on their own. This means that the federal program must be dynamic in changing with the circumstances of management needs, and be able to adapt to ensure that local conditions can be considered and responded to.

For example, although states have always dealt with natural hazards (e.g., flooding, hurricanes, tsunami, inundation) along with other issues such as public access, protection of wetlands, urban waterfront renewal, energy facility siting and so forth, the concept of climate change and accelerated sea-level rise was not well known or discussed as a serious issue until the mid-1980's. In 1990, the

Coastal Zone Management Act[1] was amended by the Congress to include a provision for the coastal states to take accelerated sea-level rise into account. Some states had already taken action through studies and workshops reviewing policy issues, but now Congress felt they should consider it as a part of their comprehensive program. Since the 1990 amendments to the federal act, many states have been doing planning for sea-level rise and have taken this into account in their permit processing and engineering work related to infrastructure such as roads and port facilities. South Carolina, for example, conducted a major blue-ribbon panel study on shoreline erosion/retreat. They found that nearly two-thirds of the state's economy was dependent upon beaches, so they always wanted to have attractive beaches; however, because of the high erosion rates, people want to build seawalls to protect their private property. These seawalls changed beach dynamics and the beaches were disappearing or in need of renourishment. Thus, when South Carolina was losing its beaches, its economy was being adversely affected. It passed a law[2] to prohibit further seawall development and when homes and structures were more than 50% damaged, they could not be rebuilt but could be relocated backwards, thereby beginning a major retreat adaptation strategy. This strategy has not been without controversy, but it has been a conscientious coastal management decision to ensure long-term protection of the state's economy. There are many other examples that demonstrate U.S. national, state, and local government initiatives.

**"Response Strategies to Climate Change in the Pacific Insular Region"**

*by Dr. Andrew Smith, Coastal Management Officer, Western Samoa*

Conference Statement of The World Coast Conference held in The Netherlands (November 1993):

"ICZM has been identified as the most appropriate process for addressing current and long-term coastal management issues, ... and adaptation to sea level rise and other impacts of global climate change."

SPREP believes that the adoption of Integrated Coastal Zone Management (ICZM) will be the most effective response strategy to climate change impacts in the Pacific islands region. What needs to be understood is that in the Pacific islands context, effective ICZM can only be achieved through the adoption of "island appropriate" methodologies and approaches.

**Concepts:** There has been considerable discussion in the literature concerning the terms to be used and their definitions. The vast majority of this literature derives from, and largely relates to, the developed, continental situation. In Pacific islands, particularly where the traditional culture predominates, much of the standard coastal zone management terminology is quite alien.

**Coastal Zone:** Continental and large island states recognize their coastal zones as distinct regions with resources that require special attention, resulting in the well established sectoral approach to these areas. Where coastal zone management has been attempted in small developing islands it has been based on the developed, continental countries' models of sectoral management. This has been caused by at least three factors: political structures in small islands based on former colonial systems; coastal management techniques and methods developed in and for the larger developed countries; and overseas development assistance for coastal management being driven by the experiences of developed countries.

[1]The Coastal Zone Management Act of 1972, as amended, P.L. 101-508, November 5, 1990.

[2]South Carolina continues to be a leader in mitigating the effects of coastal hazards by implementing the 1988 Beachfront Management Act and the 1990 Amendments to the Act. The Act, as amended, regulated construction on the oceanfront via setback requirements.

The "coastal zone" in many small islands, from a systems and ecological perspective, is for all intents and purposes the whole island. Layered on top of this are a range of political, cultural, and legal arrangements which affect the utilization and management of resources. Thus, the definition of the "coastal zone" needs to be developed on an island by island basis.

Where the definition of the coastal zone includes the entire island, then successful coastal zone management would essentially be synonymous with the sustainable development of those zones. ICZM is designed to promote sustainable development of coastal resources. Ideally, ICZM in the small islands context should be viewed as being synonymous with "integrated island management."

**Constraints and Opportunities:** It is not sufficient to simply look at constraints when considering the adaptation of developed, continental nations ICZM concepts to the Pacific islands context. It is important to recognize constraints to this process and plan to overcome or avoid them, but it is equally, if not more important, to recognize those unique features of the Pacific islands that offer particular opportunities for the development of appropriate models for ICZM.

Pacific islands generally exhibit a high level of community involvement in resource management across the coastal zone, partly because of the restricted size of island coastal zones, but also because of the involvement of people in organized families and wider communities in the range of resource management activities from ocean to water catchment. Islands with a high level of subsistence economic activity and especially those with strong customary land and marine tenure systems will be particularly involved in land and resource management.

Pacific islands with strong indigenous cultures also have traditional decision making and management mechanisms for natural resource management. While some of the concepts of ICZM may be new to such authorities, many will have mechanisms that may not have been used for some time that can adapt to new circumstances. This is a distinct advantage over western cultures where local resource management is vested in organizations and institutions with a less intimate connection with their immediate environment.

Most Pacific islands demonstrate a high degree of subsistence use of coastal resources. This dependence on local resources should be able to be translated into a vital interest in, and commitment to, their sustainable development and conservation management.

Many island cultures and communities are more closely attuned to the concepts of family and community, which will generally assist an easier understanding of the importance of allowing for the needs of future generations. Coastal management and the larger concept of sustainable development is a goal which requires active community participation and commitment.

The areas of concentrated human impact on coastal resources in most Pacific islands are relatively small. In addition, the range of human activities is likely to be somewhat less than in more populous developed countries. The urgency for some model or form of successful coastal management has escalated in most Pacific islands as population and development have increased. The economic, environmental, and social costs of not adopting an integrated approach to management and planning far outweigh the costs of developing such a process.

It is as important for Pacific islands that ICZM reflects the particular island circumstances and the ethics and directions of development initiatives in developing countries, as it is to seek to reflect developed countries' models of ICZM. That is, small island problems require small island solutions. The challenge for Pacific islands ICZM under such circumstances, therefore, is to bring together the

essential concepts of ICZM in ways which meet community and cultural needs and aspirations. This will dictate a largely process-oriented approach, but the bottom line is that unless this is achieved there will only be a limited possibility of interesting, involving, and committing the very communities whose actions are at the center of the coastal management equation and who dictate the day-to-day resource management over their part of the coast. Nonetheless, the challenge for traditionally oriented Pacific islands is considerable: to put in place appropriate and acceptable new structures to assist local authorities to appreciate, manage, and cooperate/coordinate with each other to meet the new threats.

The positive side of this is that many such Pacific islands are living examples of traditional cultures successfully and continually adapting to modern circumstances. The level at which ICZM in Pacific islands should be developed needs to be identified. Fully national programs may be the most appropriate for some countries, but others, especially those with strong customary tenure systems, may find it more effective to begin at the sub-national/community level – that is, at the level of cultural appropriateness. The scale at which success is most likely should be the entry level for establishing ICZM in Pacific islands. However, no matter what the entry level is determined to be, it will be extremely beneficial to have official sanction from the highest possible political level.

For Pacific islands with dominant traditional cultures a different conceptual approach to ICZM development should be encouraged. The customary systems, structures, and processes should form the basis of ICZM rather than merely including customary processes into ICZM. Such an approach would require the initial development and implementation of ICZM to be based on the scale of the most "effective management unit," be it the village, district, or whole island. This type of approach may be slower in the short term and more difficult to develop, but it should prove in the long-term to be far more effective, especially when scaled up to encompass larger areas.

One main tenet is that "appropriate" methodologies and approaches must be adopted and used for effective ICZM to occur in Pacific islands. What is deemed appropriate will vary considerably among islands. As for the development of ICZM in Pacific islands, it will be the process of implementation that is critical. For example, in the Pacific islands region, the decision making processes involve a considerable number of meetings – both as a means to provide information, and as the prime means to arrive at a consensus decision. This is the "Pacific Way," and it will be flexibility, not rigidity, in implementing ICZM in the Pacific islands that is required.

### "Strategic Retreat Through Coastal Acquisition and Redevelopment Downsizing is Key to Reducing Coastal Hazards"

*by Dr. Charles H. Fletcher, Department of Geology and Geophysics, University of Hawaii, Honolulu*

Several independent research groups have predicted future sea-level rise on the order of 15 to 50 cm by the middle of the next century, and between 30 and 110 cm by 2100. Because of insufficient data describing global-scale hydrological phenomena, we lack a complete understanding of the components of sea-level change. Present estimates of the various contributions to trends in sea level do not agree with physical measurements of sea-level history which hampers our ability to make accurate predictions of the hazard associated with future sea-level movements.

Sea-level rise is not the only hazard with a significant impact on coastlines. High winds, storm surge, stream flooding, tsunami inundation, seasonal high waves, coastal erosion, and volcanic and seismic hazards are known to occur on time-scales that are relevant to society. It is important to delineate and map the historical occurrence and intensity of these hazards along populated coastlines

so that informed management and development decisions can be made to reduce the potential for future hazard losses.

Various study groups recommend that the most cost-effective and long-lasting mitigation of coastal hazards is to implement a policy of planned retreat from the coast on a schedule dictated by natural events and processes. Management agencies should delineate coastal high-hazard zones and design appropriate planning policies governing future development in these zones. Compliance with hazard zone standards should determine landowner participation in incentive programs. Federal, state, local, and private interests in coastal lands should respond to the inevitability of natural hazards with innovative land management practices that convert high-hazard lands to low-risk usage.

Continued development at the water's edge must cease, and redevelopment (replacing older structures) must be downsized and incorporate strategic retreat from hazard-prone areas. Landowners can participate in the retreat with the aid of an incentive system. We must disallow replacing old homes sited along the seaward edge of hazard-prone lots with large new homes in the same hazardous position.

Suggestions:

- Put limits on redevelopment and offer incentives to downsize new structures within 200 ft of the ocean.
- Convert high-hazard single-structure lots to reduce redevelopment status with an accompanying favorable tax assessment.
- Allow special tax assessments for land in high risk zones where owners donate conservation easements or adopt uses compatible with preserving natural beaches. Allow such owners special infrastructure uses.
- Create a graduated property transfer tax to fund acquisition of important coastal resources, beaches, and beach access as already done in Florida and Massachusetts.
- Prohibit unmovable buildings whose life-spans will at any time place them in the path of a retreating shoreline.
- Replace the monolithic beach house with more modest and readily movable structures that are environmentally compatible.
- Adopt zoning and land-use controls that encourage development in safe areas by providing property owners who have to move back from the shore with development incentives elsewhere (cluster development, transferable development rights, extra building height, or total area).
- Enable county government to create transfer development rights programs.
- Assign a nonconforming status to high risk uses of land just as zoning codes consider certain uses nonconforming. Regulations could prohibit nonconforming uses from being rebuilt after a certain level of damage is sustained.
- Require new subdivisions to set aside lands in safe areas for those who must retreat from the shore elsewhere.
- Establish a fund to acquire property exempt from development. Create a tax check-off system, or provide for ear-marking tax receipts for public purchase of property in high-risk zones.
- Create a viable, comprehensive, long term, interagency program of coastal land acquisition.

The Hawaii Office of State Planning has a new report, *Methods and Strategies for Acquiring Coastal Lands*, that could set the tone for our coastal future. The State of Hawaii can follow the example of Maine, North Carolina, South Carolina, Florida, and California (and others) by implementing an effective coastal lands acquisition program with the following components: broad funding and political support achieved with public education programs; interagency coordination and centralization of offices concerned with coastal resources; enhanced partnerships between government and private nonprofit organizations; and increased enforcement of existing coastal regulations.

The future of the Hawaiian coast depends on quality growth management, coastal water quality protection, compatible economic development, environmental education, protection of our natural heritage, protection of public trust rights, and improved implementation and enforcement of successful programs.

**"Hardening Shorelines in the Pacific"**

*by Mr. Stanley J. Boc, Hydraulic Engineer, U.S. Army Corps of Engineers, Pacific Ocean Division, Hawaii*

Man has been battling the sea for land for a long time. As early as 780 A.D., the French were developing dikes as a form of protection from the sea. In the early 1300s, the Dutch adopted the dike concept and began to reclaim the land from the sea. By the 1700s, the Dutch had added windmills to the dike system to aid in the reclamation of land. Their systems are very elaborate and continue to be developed.

In the Pacific, with the predicted sea-level rise, this battle of man against the sea continues. The attack weapon of the battle is shore protection which comes in two forms: (1) shoreline hardening and (2) the use of a soft structure. Shoreline hardening usually consists of revetments, offshore breakwaters, seawalls, or combinations of these structures. A soft structure of shore protection is the beach fill.

The beach fill which has been and continues to be widely used on the east and west coasts of the United States is not widely used in the Pacific Basin. The main reason is because of the lack of adequate sand supplies. A beach-fill project is not a one time placement of sand, rather it is an ongoing project that needs re-nourishment from time to time. The coastal environment of most of the islands in the Pacific is one of small pocket beaches and coral reefs that has no major river systems to act as a source of sand. In addition, there are no major navigation channels that are sinks of sand that, when dredged, become a source of sand for beach-fill projects. This lack of sand sources usually makes beach fills an uneconomical option.

Shoreline hardening is the line drawn in the sand where man makes his stand against the sea. Seawalls and revetments are used frequently throughout the Pacific Basin as a form of shoreline hardening. The seawall is usually a vertical or near-vertical gravity structure made of concrete. Revetments are sloping structures commonly made of rocks. They can be dumped or engineered. An engineered revetment acts as a filter to retain the land that is designed to protect and also acts as an energy dissipator so that the wave energy is dissipated on the armor layer of the revetment and not on the eroding shoreline. Rocks for these structures are obtained from upland quarry sites or from offshore reef quarry sites such as those in Majuro and Kwajalein. In areas where rock is not available in suitable sizes or quality to satisfy engineering and environmental concerns, the use of concrete armor units such as dollose and tribars, among others, are used. An example of concrete armor unit structure is presently being constructed at Ofu Harbor in American Samoa.

Offshore breakwaters are designed piles of rocks that are placed in the surf zone to intercept the incoming wave energies before they hit the shoreline, creating a low energy environment in the lee of the structure so that if the sand is available in the littoral system, it will deposit in the lee of the structure and develop a wider protective beach. Offshore breakwaters work in conjunction with natural sand in the littoral system or with beach fills.

As sea level continues to rise we need to either follow the path of the Dutch and build higher and higher walls or move to higher and higher areas.

# IX. TRADITIONAL MANAGEMENT METHODS UTILIZED TODAY IN THE PACIFIC

## "Applying Traditional Pacific Island Coastal Resource Management Approaches to Today's Needs"

*by Dr. Graham Baines, Principal Consultant, Environment Pacific, Brisbane, Australia*

There is growing recognition of the traditional coastal resource management systems and practices developed by Pacific islands societies. These are increasingly being promoted as an appropriate base onto which to develop modern regimes for coastal resource management. The idea is basically sound. It is important, however, to be clear about what "traditional management of coastal resources" *is*, and what "traditional management of coastal resources" is *not*.

Traditional management of coastal resources is a system based on social structure, incorporating practices which reflect social arrangements, changing beliefs and perceptions, some of which may not be accurate, and often represent a considerable body of traditional ecological knowledge.

Applying traditional management systems and practices to today's needs is not a simple technical or technological matter. It is primarily a social matter. It is easy for enthusiastic supporters of the idea that traditional systems should be applied to modern management needs to develop a merely superficial idea of these systems. Support interventions based on misunderstandings might actually weaken a community's traditional, management arrangements, and even give rise to social disputes. One common "outsider" misunderstanding to be discussed in this presentation is that a customary fishing rights area is "owned" by a village. The fact is that the "ownership" of such an area is usually vested in a group which shares common ancestry. Not all members of a village share the same ancestry. A village community is made up of several such ancestral groupings. Only one of those in any village will "own" a fishing area under customary arrangements.

Change and adaptation are important features of traditional systems such as customary marine tenure (CMT). Traditional Pacific islander coastal resource management systems and practices can be applied to today's management needs. They provide a sound basis for ICZM, and support for these systems also serves good social ends, reinforcing cultural identity. Furthermore, traditional ecological knowledge emerging from traditional management systems can be used to boost scientific research and surveys for modern resource management.

However, such "improved" traditional systems cannot function effectively in isolation. They must be established as an integral part of an island's national policy, backed by legislation.

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## "Traditional Management Practices Used in the Pacific"

*by Mr. Joeli Veitayaki, Coordinator, Ocean Resource Management Programme, University of the South Pacific, Suva, Fiji*

As the twenty-first century approaches, human beings are troubled by the quest to ensure that the natural resources on which they depend are available in acceptable quality and quantity. Threatened by environmental problems such as climate change, sea-level rise, depleted resources, and a greatly altered and polluted environment, humans have widely accepted that environmental resources need to be used without unnecessary degradation or threat to critical habitats and species. Given the present capabilities of humankind, their improved capacity, and growth of their numbers, the majority of the world's environmental resources are likely to be depleted in the near future unless proper management systems are used. The global community, fully aware of the situation, has agreed to the noble aim of sustainable development and the search continues for development and management models that work. In the meantime sustainable development, appropriate management, and conservation are treated as vital aspects of development planning and policy formation.

The future is uncertain because most of the major environmental management measures undertaken so far have proved inadequate and unsuccessful. The new systems of management employing scientifically based methods have not been any better, as shown by the collapse of important fisheries such as the cod of Newfoundland, Canada in 1992. In rural communities such as those in the Pacific islands, the changes associated with modernization are threatening traditional systems of management that were used in the past and are making marginal important lore and tradition associated with them. This knowledge, which had taken centuries to accumulate, is rapidly discarded or becoming redundant as people adopt contemporary exploitative methods. The value of traditional management practices in rural communities has recently become an important interest area as people throughout the world became aware that traditional management systems should be put to good use before they are lost forever. It is fascinating to note that nearly all of the management systems now being tried in contemporary societies were used in some form in traditional systems. Closed seasons, prohibition, closed areas, size limit, equipment control, limitation of the number of users, and quotas were all used in the traditional Pacific island societies.

The Pacific islands were only recently modernized and as such can be studied for the remnants of traditional management practices. With the advent of new technology and equipment the state of equilibrium that allowed the people to survive in these islands before the arrival of Europeans was rapidly changed. As the quest continues for appropriate systems of resources management it will be worthwhile to consider some of the practices that enabled these communities to be sustainable in their environment. We, however, must remember the many differences that will prevent our transfer of such practices to contemporary societies. More importantly, we should never be impoverished to start all over again. These practices which were useful in the past should be employed as the basis of management practices we formulate to allow us to properly develop and manage our environmental resources in the future.

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## "Examples of Traditional Methods in Yap State, FSM"

*by Mr. John Iou, Chief, Yap Marine Resources Management Division, and Dr. Andrew Smith, Coastal Management Officer, South Pacific Environment Programme, Apia*

Yap is one of the four states of the Federated States of Micronesia. It is composed of four closely associated high islands (Yap proper) and 15 low Caroline Islands (outer islands). The 1987 census of Yap state was approximately 10,200 with 6,600 in Yap proper and 3,500 in the outer islands. Despite different cultures and languages, Yap and the outer islands have traditionally been linked by political, economic, and religious ties. The trivia system, instituted sometime around the turn of the century, obliged the outer islands to send gifts to the chief, as well as religious gifts to specific religious leaders, and families.

The following are brief outlines of traditional Yapese and outer island social organizations as they relate to marine resources and tenure. These systems presently are being used in the Yap State, but are being weakened by the effects of Western political, economic, religious, and educational systems. In particular, the introduction of Christianity, especially after World War II, altered a number of traditional marine resource systems. The increased economic exploitation of the environment also contributed to the weakening of traditional marine management systems.

In Yap society, power and authority are defined in terms of land. Men assume their social and political voice through inheritance of land under the Tabnaew. The concept of Tabnaew is exceedingly complex with many different meanings. Several families may decide on lands belonging to a single group of stonehouse families. These lands ideally include all important resources such as cotton plots, parcels of taro patches, sections of lagoon for fishing, and house lots.

Yapese villages are distinctly defined. The village is run by a council consisting of the paternal heads of the Tabnaew. Villages are grouped into networks of villages of chiefs and lower ranked allies. Marine resources are managed to serve and support the hierarchical system of each network. They are also exploited for subsistence use to support the network's head and any cooperative efforts within the network. Access to fishing grounds and fishing gear is managed within the hierarchical system. In general, fishing methods involving the more elaborate equipment such as canoes and special gear, are limited to higher groups. They are controlled by fishing masters who observe fishing practices, often by request from their chief. In addition, particular species are the property of certain high-ranked people. The inshore waters of each village are within the jurisdiction of the village, except in the case of certain fishing areas. Outsiders are prohibited from exploiting inshore resources. Some fishing areas are available to all fisherman within a village, and fishing rights to other areas are retained by certain families. The lowest ranking villages have no land or fishing rights.

The servant class has land but the title belongs to a high chief. Residents of the land give fresh fruits and other tributes to their chief. The outer island systems of social organizations, especially if they relate to fishing rights, vary slightly between the different outer islands. These, however, vary significantly from the social organization on Yap proper. The major socio-political groupings are based on natural healing plants. Planters for major clans are found on all the outer islands, and some are restricted to only a few highlands. These clans are ranked upon the sequence of their arrival on the different islands. These rankings differ on different islands. Generally, the older son of the most senior woman in each clan becomes the chief. However, under some circumstances, the eldest man on the most senior branch of a clan may become the chief. These clans are subdivided into sub-clans following religious and descendant lines.

Systems of control and tenure of the marine areas and resources fall into three broad and overlapping categories. Marine areas are not owned by the chiefs, but are managed for the benefit of the whole by them in consultation with other clans' elders. In Ulithi, one of the outer island atolls, all the reefs and lagoon areas belong to the highest ranking clan. This chief also presides as the permanent chief of Ulithi. The marine areas of the atoll, however, are divided into a number of regions. Some of these regions have been given to the chiefs of each island to be controlled by them, but only on behalf of the permanent chief. There are a number of sections within its regions which are controlled by the chiefs of each clan. The member of any clan has the right to fish in any section within the atoll that belongs to their clan. Another difference can be seen in the comparison between Teluai and the system on Wooleai atoll. On Wooleai the reef and the lagoon are divided and controlled by the residing clan on each island or village. There is no permanent chief who has jurisdiction over Overlai. The head of each ranking clan, in consultation with the other elders, will control its own areas determining seasonal closures, communal fishing rights, and fishing access of the clan.

A third form of tenure is found on Satawal, the far easternmost island of the outer island chain. The chiefs of three ranking clans divide responsibilities for island affairs. One of the chiefs has control of the sea and has the rights to control the uses of marine resources and fishing methods. Use of the fringing reef area is open to any man, but use of all other fishing areas requires permission from the chief of the sea. Priority right to use the food resources of the fishing areas, other than the fringing reef, belongs to the chief of the sea.

The customary marine management system is in a process of change. Most of the reef ownership boundaries, at least in the municipality and village areas, are fairly well known, yet many people ignore them. The reef owners' permission for fishing is only occasionally acquired by community

members. Traditional restrictions on fishing gear ownership, especially nets, appear to be completely disregarded. Customary exchanges or tribute of fish between villages no longer take place. Furthermore, large scale distribution of catches on the village level infrequently occur, because fishing trips rarely require more than four or five fishermen. Some villages are using modern variations of communal fishing. Certain family, village, or municipality members are still responsible for solving village disputes over infractions of customary fishing law. However, the customary practices of dispute resolution are only rarely exercised for various reasons. Customary laws have been overwhelmed by recent changes in fishing activities so little control over customary usage rights currently exists. Some aspects of customary law, such as the use of beatings as a punishment, conflict with the state constitutional law. Village leaders are also occupied with other non-related community issues.

In contrast to Yap proper, customary resource management still occurs on a regular basis on the outer islands. The marine tenure systems regulating fishing rights, catch distribution, dispute resolution, and punishment are still observed, which can be attributed to the islands' remoteness, small size, and greater community reliance on subsistence fishing. There has, however, never been a general relaxation in the enforcement of fishing rights, and there is a lack of small scale commercial fishing like that on Yap proper. There is a concern on the outer islands that commercial fishing will not leave enough reef fish for subsistence purposes.

**"Traditional Management Methods Utilized in the Pacific Islands American Samoa"**

*by Mr. Apelu Aitaoto, Senior Planning Facilitator, American Samoa Coastal Management Program*

American Samoa is a group of seven islands comprising five volcanic high islands and two coral atolls. The land area is 76 sq. mi. The major inhabited islands are Tutuila, which is the largest island and center of government and business, Aunu'u, and the Manu'a group consisting of Ta'u, Ofu, and Olosega.

American Samoa is affected by many different types of natural phenomenon. Hurricanes or cyclones and tropical storms are serious and persistent problems in this part of the world. Six major hurricanes hit American Samoa over the past 25 years. As a result, landslides, flooding, storm surges, high waves, high winds, and shoreline erosion are our worst problems during serious storms. American Samoa is also susceptible to floods, tsunamis, earthquakes, and storm surges. The most serious coastal hazards are landslides, flooding, storm surges, shoreline erosion, earthquakes, and tsunamis. Sea-level rise is also considered as a serious potential threat to Samoa's shoreline.

The traditional management of lands and resources in American Samoa is administered by the chief of each family, known as the Matai. The senior Matai of each family is obligated to make sure that all family lands and resources are looked after and distributed accordingly. Land is considered by most Samoans as their inheritance from God, therefore, it is sacred. Consequently, management of land is done with great diligence. Seasonal crop rotation and bans on fishing are traditional methods of managing resources in American Samoa. The infiltration and adoption of western forms of management into the American Samoa coastal management program has increased public participation in the planning process. The idea behind this effort is to instill in people's minds that the management of the environment is not solely the duty of the government and its agencies, but also the responsibility of the community. The objective is to adapt and blend modern concepts of management with the traditional systems of the Fa'a-Samoa.

### Coastal Hazards Assessment and Mitigation Program

The American Samoa Coastal Management Program's (ASCMP) Coastal Hazards Assessment and Mitigation Project (CHAMP) was initiated and is designed to reduce coastal hazards. CHAMP was recognized by the community in 1991 as an essential project for the reduction of the disruptive effects and impacts caused by natural disasters in the territory. The rationale for this decision was based on various factors: (1) risks from coastal hazards are acute because of the high population density in the narrow coastal areas; (2) the citing of traditional village and commercial development in coastal areas has taken place because the traditional tenure system severely restricts access to land by anyone but customary title holders; (3) population growth and the expansion of commercial activity have resulted in the extension of residential, government, and commercial building into areas more vulnerable to coastal hazards; and (4) in Tutuila, the average human population density on lands less than 39% slope is 2,900 people per square mile.

The major objectives of the CHAMP are (1) to direct existing and future public and private development and redevelopment away from hazardous areas prone to landslide and flooding hazards; (2) to preserve and restore the protective functions of natural shoreline features such as beaches, dunes, and wetlands; (3) the development of new regulations and permit processing for hazard mitigation through the PNRS (Project Notification and Review System); and, (4) the development of village hazard mitigation plans, village regulations, and village based enforcement procedures.

### CHAMP's Process

CHAMP uses a community task force to review the territory's existing disaster plans. This program develops new regulations for construction in high-hazard areas. These are developed through a participatory planning process that includes Western-style regulatory and traditional Samoan systems.

### Efforts for Public Awareness

There are various public education programs including a parental guide on coastal hazards for children. This guide was developed primarily for villages and schools, and was published in English and Samoan. There are also television shows that focus public awareness on coastal hazards. Representatives from the National Weather Service and the Territory Emergency Management Coordinating Office also participated in community education programs. "Coastweek" is an annual event launched by ASCMP for public awareness. It includes a presentation of the parental guide as well as various education activities. Mitigation workshops are also used in public awareness campaigns. Lay people and chiefs from various villages meet for 2- to 3-day workshops on coastal management and planning.

## X. COMMUNITY-BASED RESOURCE MANAGEMENT IN THE PACIFIC

### "Community-Based Resource Management in American Samoa: Successes and Lessons Learned"

*by Mr. Lelei M. Peau, Manager, American Samoa Coastal Management Program*

This paper describes the process through which a coastal program has been introduced into a socio-cultural environment which is now based on a mixture of existing traditional values and borrowed western values. The emphasis of this paper highlights the challenges of making a regulatory

program effective within this cultural context. The case focuses on the development and implementation of the Coastal Zone Management Act's (CZMA) Enhancement Program and the American Samoa Coastal Management Program's (ASCMP) land use permitting system, know as the Project Notification and Review System (PNRS).

Section 309 of the U.S. Coastal Zone Management Act of 1992 (CZMA) as amended by the Coastal Zone Act de-authorization of 1990 was designed to address growing concern about the declining condition of national coastal resources by establishing the Coastal Zone Enhancement Grant Program. This program encouraged states, territories, and commonwealths to develop new laws, rules, and regulations for coastal hazard planning, wetland protection, marine debris, ocean resource management, cumulative and secondary impacts, public access, major facility siting, and special management areas. ASCMP began its efforts by assessing the status of its coastal resources and then creating strategies for action in each of the priority areas. The assessment ranked coastal hazards, marine debris, and wetlands as the most significant of the section 309 enhancement areas, and programs for their management were introduced through a participatory planning process at the village level.

New regulations for construction in high hazard areas and village-based hazard mitigation plans were proposed under CHAMP. These plans incorporate a western-style regulatory approach and traditional Samoan system of land management in a participatory planning process. The Community Based Wetlands Management project involves the development of village ordinances for protection of wetland areas under the Marine Debris Project. ASCMP proposes to develop new legislation that requires importers to pay an "advance disposal fee." Fines are also being increased for illegal dumping and solid-waste accumulation. There are also plans to establish community-based management and enforcement of policies for littering. Public awareness campaigns are a major portion of these efforts.

The ASCMP strategy is based on the "participatory planning" concept in which the village is informed about an issue and is urged to develop a plan to address it with the ASCMP's assistance. This decentralized approach is intended to foster village-level management of coastal resources and help rectify the dichotomy between the traditional Samoan lifestyle and modern population growth and resource use. The development of master plans for Samoa is hampered by the conflict between traditional patterns of life, which focus on present needs, and the necessity to establish long term planning objectives. The ASCMP's goal is to empower people to adequately manage their own resources under policies consistent with ASCMP legislation and the Coastal Zone Management Act.

The ASCMP's bottom-up approach is supported by the PNRS, which was established as a coordinated interagency decision-making process for the review of land use/building permit applications. The revised PNRS was designed as a "one-stop shopping" process for all permits and has been efficient and effective in creating coordination between government and the villages. The three major benefits of the PNRS process are

1. Timely review of land use permit applications by a coordinated agency review process;
2. Meaningful environmental review of proposed projects by a group of professionals;
3. A reduction in public expenses by requiring early project reviews at the initial planning stages.

The ASCMP made significant progress in raising general environmental awareness during the development of plans under the Coastal Zone Management Act. The assessment process strengthened

public involvement in coastal management and enabled the Territory to set priorities. The process also showed that there is natural conflict between government regulations and traditionally based cultural norms. It has been important to integrate coastal management with traditional decision-making networks.

**"Some Pacific Islands Initiatives in Community-Based Coastal Resource Management in the Pacific"**

*by Dr. Graham Baines, Principal Consultant, Environment Pacific, Brisbane, Australia*

A community-based approach to coastal resource management can greatly improve prospects for the success of integrated coastal zone management (ICZM). However, efforts to implement effective programs can be a difficult and frustrating exercise for all concerned. It is important that these difficulties be understood and given careful consideration in program or project design and implementation. Experience arising from some of the Pacific island communities which have been given external support in adapting traditional coastal resource management systems to today's circumstances suggests that these points are of vital importance:

- The basis of traditional coastal resource management is *social structure*, which must be properly understood and provided for in projects and programs;
- The strength and character of community *leadership* and a sense of community *cooperation* are key factors in success;
- The *pace* at which the process of establishing a modern form of community-based resource management system proceeds must be set by the community and not forced by outsiders;
- Existing *community institutions* for resource management are almost always the best; seek to reform these if necessary, but avoid the temptation to introduce new arrangements;
- An appropriate *modern legal basis* has to be introduced to provide backing and status for community-based coastal resource management systems, and to link these with national provisions for resource management;
- Some efforts by Solomon islander communities to establish modern management regimes on a traditional base are presented, as based on the previous discussion.

**"Participatory Rural Appraisal and Community-Based Planning on Pohnpei, FSM"**

*by Mr. Christopher Dahl*

**Introduction**

The FSM Division of Forestry, part of the state government's Department of Conservation and Natural Resource Surveillance, has been working since 1987 to implement legislation that establishes a reserve area to protect forest resources in the central part of this volcanic, tropical island. Because of a long history of indigenous use of forest resources, it soon became apparent that resource users, through the communities in which they live, would have to be intimately involved in the designation and protection of a forest reserve (Raynor, 1993). After the initial failure of a top-down regulatory approach to reserve management, an island-wide education program was carried out in 1992–93. This effort was quite successful and generated grassroots support for the broad goals of forest resource conservation. With the completion of the education phase, the Division of Forestry is beginning a community-based planning process that will result in institutions and practices of natural resource management in which communities have a central role. In this endeavor the Division of Forestry is receiving technical and financial support from The Nature Conservancy, an American non-

government conservation organization; the Asian Development Bank; and the South Pacific Biodiversity Conservation Programme, a part of the South Pacific Environment Programme.

Participatory Rural Appraisal (PRA) has been chosen as a key strategy to facilitate the development of a watershed management program involving resource users at the community level. This methodology rejects conventional top-down approaches; instead it fully involves the beneficiaries of development programs in their design and implementation. Within this context methodologies were developed to gather information about the social and economic status of, and technologies employed by, the target group. These rapid appraisal methods generally involve the collection of qualitative information. They are meant to be a systematic way of quickly and cheaply gathering and analyzing information. One definition of rapid appraisal is

> "A study used as the starting point for understanding the local situation; carried out by a multi-disciplinary team; lasting at least four days but not more than three weeks; and based on information collected in advance, direct observation, and interviews where it is assumed that all relevant questions cannot be identified in advance." (Beebe, 1985, p. 2)

Rapid appraisal, although involving local people as an information source, has generally presumed that a team of experts will conduct the survey and analyze the results as a basis for further research, program design, or evaluation. Participatory approaches open up the process so that the target audience and local villagers actually participate in all phases of the exercise. Participatory rural appraisal is often used for more than just preliminary research. Many techniques are designed to help villagers reach agreement about their needs, recognize the resources at their disposal, and jointly determine what actions must be taken to address the identified problems. PRA is thus well suited for use in the kind of community-based planning and management program envisioned by the Pohnpei Division of Forestry.

Participatory rural appraisal should not be seen as a substitute for a broader program to manage watershed resources (and, if appropriate, other renewable resources in coastal and marine areas). However, PRA can be seen as a collection of techniques that can be used in many of the planning phases of a community-based watershed management program. In addition, the philosophy of PRA that local people should be actively involved in the planning and implementation of programs that affect them, fits with a community-based approach.

**Goals of the Community-Based Approach**

Based on previous planning efforts and consultation with participants a set of broad goals for the community-based approach were formulated as follows:

1. Communities have identified and addressed the major social, economic, and environmental problems that are affecting them. Village action plans will summarize action-oriented responses that address these problems.
2. An institutional structure has been organized that allows communities to effectively manage the common property resources that they have at hand.
3. A set of guidelines has been developed by resource users for the sustainable use of adjacent forest areas.
4. Communities have agreed on a core area of upland forest that will be a reserve where activities affecting biodiversity and ecological integrity are not allowed.

## Discussion

What we call the planning process is the set of activities that occur between the time a need is recognized and effective and durable institutions are put in place to meet the need. Defined this way, planning probably never really ends because effective and durable institutions evolve over a very long time. In the short term we can identify a phase where such institutions do not really exist at all and they must be designed and put in place. This is, of course, the task that confronts the watershed management program in the Division of Forestry in the near term. The four goals set out earlier suggest the steps involved in the planning process. PRA techniques will be important in each of these steps, which are briefly outlined below.

1. Issue identification and village action plans

   It is recognized that natural resources use is closely connected to other social welfare and development issues within the community. Attention must be given to these problems in the process of developing a management program. PRA is used to identify key problems confronting the community as perceived by the community. Recommendations are worked out to address these problems with attention given to the resources available within the community and assistance available from outside institutions. A "village action plan" should be prepared to summarize the points raised during this process.

2. Institutions for management

   The institutions that will be responsible for the on-going effective management of forest areas (and perhaps other renewable resources as well) are an absolutely crucial component of a successful program. Watershed Area Management Committees (WAMCs) will be a basic unit of management covering discrete management units comprised of one or more adjacent streamsheds. WAMCs may be compared to what Ostrom (1992) calls appropriator organizations, in which membership rights and responsibilities as to access to common pool resources, the decision making process related to management, and how conflicts will be resolved are clearly defined and well understood.

   People will only organize common property resource management institutions if they believe that it will be worth their trouble. The education program carried out by the Division of Forestry in 1992–93 alerted the public that forest resources are in danger of serious harm. The challenge is to create organizations that can legitimately regulate access and use and do not result in so much social conflict as to be unworkable. There is also a risk that WAMCs will generate a level of conflict that could be their undoing. Conflict may be more likely *between* WAMCs that have a specified territorial extent rather within individual WAMCs.

   Appraisal techniques can be used to gain a better understanding of the existing social structure within a community so that the internal structure of WAMCs can be appropriately defined. An exploration of resource patterns will provide crucial information for designing WAMCs. Territorial extent will be a defining characteristic.

3. Sustainable use of forest resources

   The most difficult aspect of watershed management will be managing use outside of a core reserve area. It is likely that much of the forestation at high elevations (above 350 m) can remain fairly undisturbed. More intensive use is occurring close to settled areas. Best use management practices can be developed for these areas based on documentation of traditional agroforestry practices, which likely minimize some of the most detrimental impacts of

forest conversion, integrated with Western knowledge by employing land suitability criteria. These criteria would be formulated in a set of guidelines that would be comprehensive, covering not only agroforestry activities but also other activities such as open field agriculture, house construction, and road building.

The development of use practices, linked to land suitability, provides the basis for management within a community context. In other words, a land-use guide can be translated into a set of management rules implemented by the WAMCs.

4. Reserve designation

The designation and implementation of a strict reserve was the original goal of the watershed legislation. The complexity of resource use within a cultural context has made achieving this goal more involved but to conserve plant biodiversity and habitat, the watershed program must hold the line on forest conversion and other intensive uses. Broadly, there are two components to this task. First, an acceptable boundary must be delineated. Then some agreement must be reached about accepted use within the reserve. This process should be linked to the development of land-use guidelines, as it is in some sense a sub-component of that set of activities. Appraisal techniques can be used to address these two aspects of reserve designation.

The reserve should be an island-wide commons to minimize conflict between WAMCs over activities in the reserve. Under a federal structure, boundaries to the upper limit of WAMC managed commons land would be negotiated with each WAMC but agreement on activities and management within the reserve would be considered by an island-wide representative body.

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# XI. INTEGRATED COASTAL ZONE MANAGEMENT (ICZM) AS A STRATEGY FOR RESPONSE TO CLIMATE CHANGE

### "Integrated Coastal Zone Management: Policy and Methods"

*by Dr. Kem Lowry, Professor of Urban and Regional Planning, University of Hawaii, Honolulu*

Coastal management programs vary among states and countries. There are some basic elements that underlay most CZM programs including:

- Identification of coastal problems
- Identification of problem priorities
- Analysis of coastal problems

- Identification of potential management to mitigate coastal problems
- Analysis of organizational arrangements
- Identification of coastal management areas

Coastal problems can include land or water issues, such as dredging, that degrade or deplete coastal resources; the adverse consequences of particular land or water uses; conflicts over coastal resource allocations such as whether a coastal site should be used for a hotel or park; or failures of public management, such as poor enforcement of laws regulating construction in flood hazard zones. Determining which coastal problems will be addressed by the CZM program, what management technique can be used to mitigate those coastal problems, and what existing organizational arrangement is already in place will dictate the form and content of the program.

Sri Lanka provides an appropriate case study in that it is a small island state faced with many of the same problems that Pacific islanders face. Sri Lanka's 1,585 km of coastline include 24% of the total area of the country, 32% of its population, 65% of its urbanized land, 66% of its factory output, 80% of its tourism infrastructure, and fisheries that produce 30% of the country's annual protein consumption. The overriding problem that was facing the government was coastal erosion that threatened the tourism industry and impacted both fisheries and coastal residential development. The cause of erosion were a number of activities including beach sand mining, river sand mining, inland coral mining, collection of coral from beaches, reef breaking improperly sited harbors, improperly sited coastal building, and improper removal of coastal vegetation.

Sri Lanka developed its CZM program as a response to the problem of coastal erosion. The plan featured a coastal development permit process that was aimed at stopping or mitigating the worst features of the proposed development. I also divided the coastal area into zone in which limits on development were placed. The result is that coastal erosion is occuring at a slower rate than before the ICZM program initiation.

The following are several key management approaches which either singularly or in some combination form the key elements of coastal management plans

- Planning (e.g., special area plans)
- Research (e.g., coastal engineering studies)
- Monitoring (e.g, coastal water quality)
- Persuasion (e.g., education program)
- Incentives (e.g., tax relief for industrial location)
- Development (e.g., construction of sewage plants)
- Regulation (e.g., permits, facility-siting guideline)

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## "The ICZM Program of the South Pacific Environment Programme (SPREP)"

*by Dr. Andrew Smith, Coastal Management Officer, SPREP, Apia*

It is impossible to overstate the importance of coastal areas to the Pacific island peoples, cultures, and economies. The coastal areas of all islands in the Pacific are the location of the vast majority of human habitation, the focus of subsistence and commercial agricultural and fisheries activity and the target of most economic development. Increasingly, this combination of factors is resulting in coastal habitats being degraded, natural resources being over-exploited, and growing conflicts in resource use, especially around the rapidly growing urban centres of the Pacific.

Coastal areas of the Pacific are also subject to the damaging effects of natural hazards such as cyclones (typhoons, hurricanes), high storm waves, and abnormally high tides. Low elevation islands and the low-lying coastal areas of the larger, higher Pacific islands are particularly at risk. Global warming now threatens to exacerbate these hazards through accelerated sea-level change, increased frequency and intensity of storms, and other changes to climatic and oceanographic conditions.

These coastal management problems are widespread in the region and in some areas require urgent attention. The potential for sustainable development of coastal areas and resources is being permanently lost or compromised. Coastal management needs are particularly pressing in the very small islands, especially low elevation islands, and the coastal urban areas of the Pacific. However, much of the degradation of coastal habitats, depletion of resources and destruction of coastal areas could be avoided, reduced, or mitigated through integrated coastal management and planning.

Among the region's unique characteristics are significant opportunities for the introduction of a workable process of Integrated Coastal Zone Management (ICZM). Opportunities include a high level of customary land tenure, strongly institutionalised decision-making for local resource usage, a high level of subsistence dependence on natural resources from coastal areas, a significant degree of social status attached to the provision of resources – especially coastal resources, and a high level of community involvement in coastal resource management. Together, these characteristics require a special approach for ICZM in this region. This is necessary in order to adapt ICZM into forms appropriate to the "Pacific Way", and to significantly increase the potential to meet the region's needs for sustainable development.

### Statement of Purpose

The ICZM programme of the SPREP aims to promote the sustainability of coastal areas and resources for Pacific islands through ICZM by integrating the management of human activities and natural processes that affect coastal systems, and by recognizing that those activities and processes do not conform to administrative boundaries.

### Goals

ICZM for the Pacific Islands Region should:

- Provide adequate and cost effective ICZM and planning technical assistance to Pacific island countries and territories.
- Develop, promote, and apply approaches to ICZM appropriate to the "Pacific Way."
- Promote regional coordination and cooperation in addressing and resolving coastal management and planning needs.

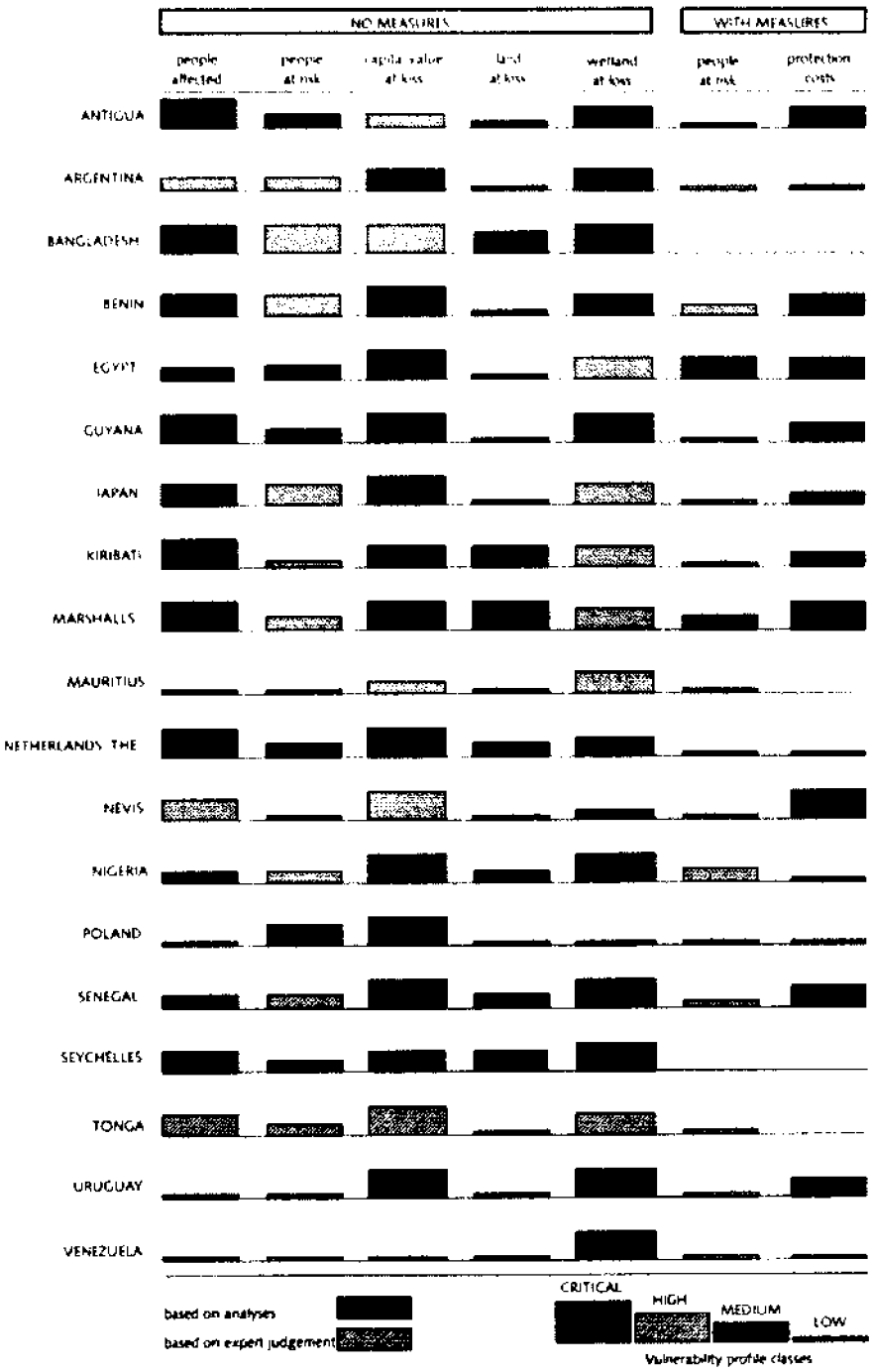


*Figure 2.* *Vulnerability profiles for selected countries, based on country case studies. The factors were derived from each study report or expert judgement. Only integer values are used. (Adapted from Nicholls, 1994).*

- Develop national level coastal management and planning capability through relevant training and education.
- Establish national level ICZM pilot programmes which provide practical demonstrations of the benefits of appropriate ICZM.

***Components of the ICZM Program***

The project has been divided into regional and national components. The regional components are directed towards facilitating the development of ICZM within all SPREP member states. The national level components relate specifically to five proposed pilot programs. Both the regional and national components are, however, interrelated and cannot be successfully implemented without the integrated support provided by the other outputs.

**Regional Components**

***Overview***

Despite the Pacific region being large in area with a diversity of cultures and political systems, there are a range of coastal management related issues and problems that are common to all the states. These common issues, when combined with a history of being able to cooperate regionally, provide a positive basis upon which to develop a cost effective regionally based ICZM project to assist in satisfying national needs. SPREP was set up with the aim to "...assist Pacific island countries and territories protect and improve their shared environment, and to manage their resources to enhance the quality of life for present and future generations."

The particular combination of geographical, social, cultural, and economic conditions found in the Pacific islands region necessitates the development of ICZM approaches specifically tailored for this region. We believe that small island problems require small island solutions. Because of the variability among countries, and as we are proposing a regionally based project, it will be necessary to identify a range of approaches. Each ICZM program will need to be specifically developed for each country's particular circumstances.

National integrated coastal zone management programs cannot hope to succeed if the region's decision makers and the general public do not understand the interrelated nature of their islands' ecosystems and the effects their policy decisions and actions have. An extensive and directed education and awareness program concerning the need for and benefits of ICZM is required. Additionally, specialized training will be required to increase the level of expertise of coastal planners and managers in the region.

***Strategies***

The following strategies to be used in the implementation of this project were identified and developed through a technical working group meeting, instructions, and advice from SPREP member countries and territories, and SPREP's accumulated experience with coastal management and other environmental planning and management projects in the region.

- Emphasis on coordination of activities within the region.
- Utilization of the expertise of personnel in coastal management disciplines within the region.
- Emphasis on proactive approaches rather than reactive approaches.

- Considerable emphasis incorporating the unique circumstances in the Pacific in identifying and developing appropriate approaches for ICZM, such as
  - Including traditional and customary management systems and decision making processes.
  - Translating the high degree of subsistence use and dependence on coastal resources into a vital interest in, and commitment to, sustainable development.
  - Encouraging the high level of community involvement in resource management across the coastal zone.
  - Emphasizing the importance of concepts of family and community, which will assist an easier understanding of the importance of allowing for the needs of future generations.
  - Recognizing the relatively small size of the areas of concentrated human impact on coastal resources in most islands.
- Taking advantage of the increasing awareness of the region's leaders of the need for sustainable development, of which ICZM can play a significant role.
- Orientation training, education, and awareness programs and materials in and for the Pacific.

## National Level Components

### *Overview*

The long-term goal of this project is to establish national ICZM programs within the countries of the region. Because of the varying levels of coastal management and planning within countries and territories in the region, however, it would neither be practical, nor necessary, for this project to propose to implement full ICZM programs in all island states. The emphasis will be on developing the awareness of ICZM needs and benefits within the region, identifying approaches to ICZM appropriate to the region, and then demonstrating its use in varying situations and circumstances through selected pilot programs.

### *Strategies*

All the strategies outlined for the regional components also apply to the national level components. The following are additional strategies:

- This project proposes to adopt strategies which encompass a bottom-up approach to management, which includes Non-Governmental Organizations (NGOs), particularly women's groups, in any decision making process.
- Independence of local communities from central government, which is a key aspect of the special requirements for implementing ICZM in the region, will be balanced by appropriate sanctions for the process from the highest level of central government.
- Wherever possible, this project will utilize the National Environmental Management Strategies (NEMS) task forces already set up in countries to facilitate the initial implementation of ICZM programmes. In countries that do not have NEMS task forces, an appropriate multi-sectoral mechanism will be suggested as the preferred means to initiate the ICZM process.
- Selection of pilot programme countries and locations will initially be based upon needs already identified in the NEMS.
- Support for in-country human resources capacity building will underlie all pilot programme activities.

**Objectives**

1. Strengthen SPREP's capacity to provide adequate, appropriate, and cost-effective coastal management and planning technical assistance to all member states.
2. Develop greater coordination and cooperation between regional organizations and also between Pacific island governments on coastal management related issues and problems.
3. Develop and promote approaches to ICZM appropriate to the Pacific islands region.
4. Develop and support appropriate coastal zone management and planning training, education, and awareness programmes.
5. Establish five national level ICZM pilot programmes in a range of environmental and cultural situations.

# XII. CLIMATE CHANGE INFORMATION AND MODELLING

**"Regional Information and Modelling"**

*by Dr. David Liu, Resident Consultant, RAND/System Research Institute, Malibu, CA*

It is important to understand how models can be used to plan for the potential impacts associated with climate change and sea-level rise. In order to provide a clear example of how models are being applied, the operational models from counties such as the Netherlands, the United States, the PRC, Taiwan, and Japan are discussed in general terms. In more specific terms for the Pacific islands, the paper will address issues such as small harbor design and sea-level rise. It will show how models can run many different scenarios based on quantitative data and provide intelligent risk factors for designers of structures in coastal areas.

The most vulnerable nation to sea-level rise is Holland. Sixty percent of their best land and 90% of their capital wealth is lower than high tide. If the sea level rises or there is a storm surge, substantial damage will occur. In 1953, there was a low pressure patch throughout Europe that resulted in storm surges on the Thames River and in Holland. They now have storm surge barriers to prevent this from happening again.

Holland's coastal protection project lasted 35 years and found that shallow areas are very vulnerable to storm surge, wave action, and circulation. Changes of sea level in shallow waters are more important than in deep water, because of the changes in circulation. In this geographic area, it is important because fresh water from the Rhine River has to be taken out by manipulating the series of docks through high tide and low tide. If the mouth is closed, strong currents will develop. Transportation is also affected by the construction of coastal structures in this area. Therefore, it was important to build a model for construction in Holland that covered the entire system including freshwater supply and transportation in the equation. This complex coastal management process started in 1971 and is still used today. They have a freshwater supply for irrigation and drinking, transportation (the largest port in the world) and agriculture.

Before 1971, the Dutch were using a hydraulic model. When the wind blew over the hydraulic model, it did not have the same effect as the real ocean conditions. Earth's rotation is very difficult to include in the hydraulic model as is simulation of the density gradient. Therefore, the result of this model is very difficult to measure.

Harbors should be designed in irregular shapes and patterned for the worst wave conditions, highest trade winds, and monsoons. Under these conditions harbors have different places for different ships including small ships, fishing ships, and large vessels. Under different conditions of harbor design, waves will create oscillation in the harbor. Harbors should be designed so that under the strongest wind conditions oscillation in the harbor avoids the ship units.

Development of regional models is important in the Pacific. Regional models are needed to scale down global results to the local level. In these models, boundary conditions are important, but are difficult and expensive to obtain on a regional and local level. The purpose of these models is to give design parameters to coastal engineers for the planning and designing of the coastal features. For example, when you have a typhoon surge there is a river flow change which impacts cities built on the river. Dikes for city protection must combine the storm surge height at the mouth of the river and the high-tide information. Big cities prefer flood walls over dikes, because dikes take more land for construction. However, flood walls are the most dangerous, because of the extensive damage that could result from its collapse. Dikes are safer, but require more land and capital expense.

Pacific island countries will depend on improvements in models to assist in the development of response strategies to climate change. It is important to promote the development of regional models that are based on local boundary conditions.

**"Climate Information and Modelling"**

*by Dr. Gerald A. Meehl, Scientist, National Center for Atmospheric Research, Boulder, CO*

The models presented by Dr. Liu are very specific regional models that deal with impacts from certain forces. Where does this data on climate changes, sea-level rise, surface air temperature, and warming come from? These numbers are generated by global climate models, the most recent versions of which couple dynamical atmosphere with dynamical ocean models. These are called global coupled ocean-atmosphere general circulation models. The atmospheric model components of the coupled models are similar to the operational models used for daily weather forecasts, however, they have been modified and streamlined to perform long-term climatic simulations.

The Pacific island people play an important role in the development of these climate models by applying their understanding of the present day climatic conditions to the development of models. Many times there is a misunderstanding in the analysis and observation of present day climate changes and patterns. Historical observations by local people help determine how climatic fluctuations have occurred and if the models are accurate. The various Pacific weather stations are gathering data on climatic conditions and relaying it to a central processing station in Washington, D.C., using the Global Telecommunication Systems (GTS). There, and at a center in England, weather observations from the Pacific region are added to those from all over the planet. These observations are used for global weather forecasting purposes, and archived for further study and analysis. It is only in this way that data from the real climate system can be used to help verify and further develop models used for climate change experiments. Results from those models are then used to provide indications of a possible global climate change, including those for the Pacific region.

Through the National Weather Service there is a centralization of information for the Pacific in Hawaii. The Weather Service Modernization Program will enhance cooperation between the academic and operational weather forecasting communities. Statistical studies will be conducted on regional climatology in relation to ENSO events. Public outreach and information will also be included in the program. Predictive models for ENSO events are also being developed at the University of Hawaii in cooperation with this program.

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## "Information Needs for Model Development"

*by Mr. Marcelino Actouka, National Planner, Office of Planning and Statistics, Palikir, FSM*

What local information is needed on climate change and modelling? Information is needed on rainfall, groundwater sources, and temperature that can be gathered locally and made accessible to the local populations. These data should then be put into models that will reflect local conditions.

The Pacific islands need to develop a capacity to use and evaluate raw data. This capacity must include the training of local personnel in data collection and interpretation. Results from models and studies from outside sources on ENSO events or other climatic changes must be summarized and made accessible to local populations and decision-makers. The findings of studies must be put in terms of local conditions and problems.

To facilitate the development of information for the local communities, SPREP and SOPAC should coordinate local research studies. They should also assist in the customizing of models for local conditions.

# Appendix A: Workshop Agenda

## *U.S. Country Studies Climate Change in the Pacific Workshop*

## September 26 – 30, 1994

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### Monday, September 26: Climate Change: Impacts, Tools, and Responses

**Venue: Pacific Room**

Morning session chaired by Dr. Joseph Huang, Coordinator for Island Nations, U.S. Climate Change Country Studies Program

8:30 – 9:15

**Welcome**

Dr. Barry Raleigh, Dean of the School of Ocean and Earth Science and Technology, University of Hawaii

Dr. Ron Benioff, Technical Director of U.S. Country Studies Management Team

9:15 – 9:30

**Introduction to Workshop:**

I. Dr. Joseph Hang, Coordinator for Island Nations, US CSMT
   - goals of workshop
   - expected products

II. Ms. Sharon Ziegler, Pacific Island Network (PIN) Coordinator
   - workshop format
   - daily schedule
   - responsibilities of presenters and participants

9:30 – 10:00

Keynote speaker: **Climate Change Reality: Current Trends and Implications**

Ms. Eileen Shea, National Research Council

10:30 – 12:00

**Panel 1: Climate Change Impacts**

- Dr. Mike Hamnett, SSRI, Moderator plus will talk on the social and economic impacts of climate change
- Dr. Fred Mackenzie, UH, Climate Change: Current trends and their applications
- Dr. Chalapan Kaluwin, SPREP, Impacts on island infrastructure and land use (presented by Dr. Andrew Smith, SPREP)
- Dr. James Maragos, EWC, Impacts on Marine Resources: Fish corals and ecosystems

**Monday, September 26** (continued)

1:15 – 2:45

**Panel 2: Climate Change Assessment Tools**

– Dr. Roger Lukas, UH, Moderator

– Mr. Ben Mieremet, NOAA, IPCC Methodology

– Dr. David Liu, Coastal models as assessment and planning tools

– Dr. Tom Schroeder, UH, ENSO Application Service, Tools for assessing changes in global weather patterns

– Dr. Gerald A. Meehl, IPCC, Coastal models as assessment and planning tools

3:00 – 4:30

**Panel 3: Response Strategies**

– Mr. Ben Mieremet, NOAA, The U.S. Coastal Zone Program

– Dr. Andrew Smith, SPREP, Response strategies to climate change in the Pacific Insular Region

– Dr. Chip Fletcher, UH, Retreat from the shoreline: buffer zones and green belts

– Mr. Stan Boc, ACE, Engineering solutions to protect insular areas

## Tuesday - Friday, September 27 – 30

**Training: Adaptive Management Strategies to Climate Change: ICZM**

This three-day training will be conducted with organized teams of participants divided into small groups for discussion. The presentations will be either to all of participants or to individual groups, depending on the topic of the discussion. The break-out sessions will be directed by a trained facilitator with assistance from a regional specialist. The aim of this training is to have the participants learn from each other and specialists and to work with each other to incorporate the information presented on climate change with their discussions of traditional management and enforcement systems, community-based management methods and ICZM to develop specific ICZM strategies that address climate change.

**Venues: All large group presentations and discussions will be in the Pacific Room**

All small, break-out group discussions will be in two rooms:

**Group A: Kamehameha Room**

**Group B: Tagore Room**

**Facilitators:**

**Dr. Mike Hamnett, Center for Development Studies, SSRI**

**Ms. Wendy Schulz, Center for Development Studies, SSRI**

**Mr. Ray Tabata, UH Sea Grant Extension**

**Tuesday, September 27**

8:30 – 10:15

**Presentations**

Presentations by participants from each of the countries with on-going country studies on:

1. Concerns regarding the effects of accelerated sea-level rise and climate change
2. An overview of their work plans for their country study

10:30 – 12:00

**Small group discussions**

Break-out groups develop a prioritized list of concerns relating to the climate change and discuss what is needed for a country studies work plan to address these concerns

1:00 – 2:45

**Presentations**

**Title: Traditional management methods utilized today in the Pacific islands**

Dr. Graham Baines, Traditional management methods in the Pacific and their applications to modern day management strategies

Mr. Joeli Veitayaki, Traditional management practices used in the Pacific

Mr. John Iou, Yap MRD, Examples of traditional methods in Yap State, FSM and Dr. Andrew Smith

Mr. Apelu Aitaoto, Examples of traditional methods in American Samoa

3:00 – 4:30

**Small group discussions**

Break-out group discussions to identify traditional management practices in the different countries, their current relevancy, and how they could be adapted to address contemporary management issues such as climate change

## Wednesday, September 28

8:30 – 10:15

**Presentations**

**Title: Community-based resource management in the Pacific**

Mr. Lelei Peau, AS, Community-based resource management in American Samoa: Successes and lessons learned

Dr. Graham Baines, Community-based resource management approaches in the Pacific: some case studies

Mr. Christopher Dahl, Community-based approach for watershed management in Pohnpei, FSM

10:30 – 12:00

**Small group discussions**

Break-out group discussions on the use of community involvement in implementing coastal resource management programs. The groups will then apply a community-based approach to specific examples of one or two work plans from participating country study teams.

1:00 – 2:30

**Presentations**

**Title: Integrated Coastal Zone Management (ICZM) as a strategy for response to climate change**

Dr. Kem Lowry, UH, ICZM policy and methods

Dr. Andrew Smith, The ICZM program of the South Pacific Environment Programme (SPREP)

3:00 – 4:30

**Small group discussions**

Break-out sessions on how to incorporate the information learned about climate change adaptive strategies into a comprehensive ICZM program: the adaptation measures recommended, the existing traditional practices and their role in resource management, and the strategies developed for involving communities with enforcement of those measures.

## Thursday, September 29

8:30 – 10:15

**Regional Information and Modelling**

Dr. David Liu, Rand Corporation

Presentation on model utilizations as dynamic tools for coastal zone management and sustainable development and information needed for model generation

10:30 – 12:00

**Model Demonstrations for Practical Applications**

Dr. David Liu, Rand Corporation

Demonstrations on model utilizations for climate change vulnerability assessment and coastal zone management and planning

1:00 – 2:30

**Discussion on Climate Information and Modelling**

Summary of modelling strategies for predicting impacts of climate change both for regional and for each of the island types and discussion of information needed for models

– Dr. David Liu, Rand Corporation

– Dr. Gerald A. Meehl, IPCC

3:00 – 4:30

**Information needs for model development**

Identify what information models can provide for the Pacific island region and specific island areas, including identification of information available from islands and regional organizations, gaps in available data, strategies for collecting information, application of information, and best methods to present useful information and results to individual countries

Mr. Marcelino Actouka, FSM

## Friday, September 30

8:30 – 10:00

**Strategic planning presentations**

Group will review their work during the training and summarize their recommended ICZM strategies. A facilitated discussion will review similarities and differences of strategies developed by the two break-out groups, identify additional information and studies needed, and make recommendations for further regional climate change and ICZM efforts.

10:30 – 12:00

**Future Regional Efforts**

Discussion of which needs identified in previous sessions can be addressed on a regional level. Development of an action plan for addressing those regional needs including work plan assignments for future regional cooperation.

*For example*

1. ICZM Information Exchange
2. Regional Climate Information Centers
3. Community-based ICZM protocol development
4. Regional information modelling programs
   - Summarized by Andrew Smith, SPREP
   - Discussion facilitated by Andrew Smith and Joseph Huang with assistance by facilitator, Mike Hamnett

1:00 – 2:00 **Review**

Review of proposed changes to current work plans (facilitated)

Evaluation of workshop

Set up publication schedule and review group

Facilitators

Mr. Peter Rappa, SG

Ms. Sharon Ziegler, SG/PIN

2:00 – 2:30 **Summary and wrap up**

Dr. Joseph Huang

# Appendix B

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