LIVING WITH A CLIMATE IN TRANSITION: PACIFIC ISLANDS EXPERIENCE

Eileen L. Shea
East-West Center*

1. INTRODUCTION

Island communities are identified among the jurisdictions considered most vulnerable to climate variability and change, for example:

- Changes in rainfall associated with the ENSO cycle put added pressure on already stressed water resources;
- Changes in sea level threaten low-lying community infrastructure, coastal agriculture and unique natural ecosystems;
- Economic development is dependent on climate-sensitive sectors (e.g., agriculture, tourism, fisheries) and the resources that support them (e.g., coral reefs);
- Pacific Islands are home to valuable and unique ecosystems and a number of threatened and endangered species many of which are climate-sensitive; and
- Climate-related extreme events, such as droughts, floods and tropical cyclones can have devastating immediate effects and recovery from these events can consume significant percentage of an island's GDP.

Pacific Island communities are already addressing significant challenges presented by natural variability in the climate system, most notably the El Niño-Southern Oscillation (ENSO) cycle. This experience is helping build resilience for the future and providing insights into the evolution of a sustained climate information system for the region.

The insights described in this paper are drawn from a number of related scientific activities including: an initial assessment of the consequences of climate variability and change for Pacific Islands; the use of ENSO-based climate forecasts to support decision-making in Pacific Island communities served by the Pacific ENSO Applications Center; and the newly-established Pacific Islands Regional Integrated Assessment (Pacific RISA) program. The paper will focus primarily on issues related to providing access to freshwater resources. In this context, the author will:

- Review the nature of Pacific Island vulnerability to climate variability and change as described from recent climate assessment work in the region;
- Summarize some of the recommendations for enhancing resilience that have emerged from experience with natural variability and dialogue with stakeholders in key sectors; and
- Use this experience to provide some guiding principles for the emergence of a sustained program of climate services in Pacific Islands.

2. CLIMATE VULNERABILITY IN PACIFIC ISLANDS

National, regional and international climate assessment studies consistently identify small island developing states, including Pacific Islands, as among the most vulnerable to climate change for a variety of reasons including:

- Pacific Island communities face significant challenges associated with current patterns of natural variability and, conversely, these same communities have begun to demonstrate the opportunities associated with the use of ENSO-based climate forecasts to support decision-making;
- Economic plans for Pacific Islands communities are dependent on climate-sensitive sectors (e.g. agriculture and tourism) or resources (e.g., fisheries and coral reef ecosystems);
- Pacific Island communities are home to a number of unique ecosystems and rich in biodiversity; and
- Lifeline facilities and coastal infrastructure (water, health, transportation, etc.) are already stressed in some areas.

Shea, et al. (2001) discusses the vulnerability of Pacific Island communities in the context of six critical areas: (1) providing access to fresh water; (2) protecting public health; (3) ensuring public safety & protecting community infrastructure (particularly from risks associated with climate-related extreme events such as droughts, floods, and the hazards of tropical cyclones); (4)

**Corresponding Author Address*: Eileen L. Shea, East-West Center, 1601 East-West Road, Honolulu, HI 96848-1601

sustaining tourism; (5) sustaining agriculture and (6) promoting the wise use of coastal and marine resources.

"Water is gold" was a recurring refrain during the November 2000 workshop on the consequences of climate variability and change for Pacific Island communities with participants reinforcing the cascading effects that the availability of fresh water has on public health and key economic sectors. Factors such as limited storage capacity, existing stresses on distribution infrastructure (e.g., age and disrepair), dependence on rainfall with considerable year-to-year variability, increasing demands associated with both population growth and economic development in water-intensive sectors (e.g., agriculture, tourism, fisheries), and a number of institutional challenges in both government and the private sector combine to increase the vulnerability of Pacific Islands to changes in the climate. Among the most vulnerable are communities on low-lying coral atolls where freshwater lenses are extremely limited or, in some cases, virtually non-existent. Sea level rise presents further complications in terms of both saltwater intrusion and increased storm surge risks to coastal agriculture and communities (Shea, et al., 2001).

As used in the Pacific Assessment, vulnerability was used to refer to the combination of a Pacific Islands' exposure to climate-related risks, its sensitivity to those risks and its ability to adapt to changing conditions (resilience). Shea, et al. (2001) recommended a number of actions that might enhance resilience in Pacific Island communities. These recommendations included:

- Improve infrastructure and enhance capacity
- Evaluate existing assets and develop unused/alternative sources
- Provide incentives for water conservation and wastewater recovery and reuse
- Encourage public-private partnerships among large-scale users (tourism, agriculture, military)
- Pursue watershed protection and restoration
- Emphasize integrated water and land use management, including exploration of traditional integrated resource management practices such as the ahupua'a resource management system in Hawaii
- Emphasize self-sufficiency in long-term planning
- Promote public awareness, education, dialogue and capacity-building
- Be proactive with a particular focus on planning for extremes (particularly droughts)
- Integrate climate information into decision making.

The 1997-1998 El Niño event provided real-life experience in implementing these recommendations, particularly the integration of climate information into decision making.

3. LESSONS LEARNED FROM CLIMATE VARIABILITY: THE 1997-1998 ENSO EVENT

The following selected impacts from the 1997-1998 El Niño event offer vivid examples of what changes in climate mean to people in the U.S. affiliated Pacific:

- Water rationing in Majuro, Republic of the Marshall Islands at one point limited to seven hours of water every 15 days in February 1998;
- Crop losses in the Federated States of Micronesia, Republic of the Marshall Islands, the Commonwealth of the Northern Mariana Islands and the Republic of Palau;
- Job losses in the fishing sector in the Federated States of Micronesia;
- Wildfires in the Federated States of Micronesia, the Republic of Palau, Guam and the state of Hawaii; and
- Environmental impacts throughout the region including streams drying up and coral bleaching.

According to Techur Rengulbai, Chair Bureau of Public Utilities in the Republic of Palau's Ministry of Resources and Development, the Republic of Palau experienced a nine-month

drought during the 1997-1998 El Niño (Rengulbai, 2003). As a result of the dry conditions and saltwater intrusion associated with temporary elevations in sea level, approximately one-third of the nation's taro crop failed with economic losses estimated at $0.74 million. Wildfires destroyed 20% of Palau's forest, savannah, and agricultural lands and elevated sea surface temperatures were associated with the destruction of 30% of Palau's coral reefs which support valuable commercial and subsistence fisheries and serve as the foundation for much of Palau's tourism industry.

As described by Hamnett, et al. (2000), scientists and government officials throughout the Pacific agree that advanced forecast information provided by the Pacific ENSO Applications Center (PEAC) coupled with a sustained program of education and outreach helped to mitigate the negative impacts of the 1997-1998 event. Initiated in 1994 as a research pilot project, the Pacific ENSO Applications Center is a partnership of NOAA (the Office of Global Programs and the National Weather Service Pacific Region and NCEP/CPC), the University of Hawaii, the University of Guam and the Pacific Basin Development Council (the Governors of the four American Flag Pacific Island jurisdictions of Hawaii, Guam, American Samoa and the Commonwealth of the Northern Mariana Islands). Initially, PEAC focused on: improving historical datasets with an emphasis on rainfall; expanding access to and interpreting ENSO forecast products being developed by the U.S. National Weather Service, the International Research Institute for climate prediction (IRI) at Columbia University and other forecasting and research institutions in the Pacific region; expanding public awareness and understanding of the ENSO cycle and potential societal benefits of forecast applications; and identifying specific forecast applications opportunities in key sectors such as disaster management and water resources. Initial steps toward the transition of PEAC from research to operations began in 2000 with responsibility assigned to the National Weather Service Pacific Region and funding through the Climate Observations and Services program managed by the National Weather Service and continued support for applications research through the NOAA Office of Global Programs. A NOAA Corps Officer billet for PEAC education and outreach was re-instated in November 2003 and a full time PEAC researcher was hired at the University of Hawaii's School of Ocean and Earth Science and Technology (UH/SOEST) in December 2003. Close collaboration with the University of Hawaii and the University of Guam remains an integral part of PEAC operations. Additional information can be found on the PEAC website (http://lumahai.soest.hawaii.edu/Enso/). With support from the NOAA Office of Global Programs, the author is currently undertaking a review of the first decade of operations of the Pacific ENSO Applications Center and much of what follows is drawn from this ongoing study; details on the PEAC review can be found at: (http://research.eastwestcenter.org/climate/PEAC) . According to James Weyman, National Weather Service Pacific Region, the results of this study will provide a strategic plan or "roadmap" for the future of PEAC. Emerging lessons learned from PEAC is the subject of a poster at this Annual Meeting (P4.2 scheduled for Wednesday, January 12 at 2:30 p.m.).

By February 1997, observations of Pacific Ocean conditions and some forecast models provided early indications of the evolution of an El Niño and by May 1997, PEAC forecasters issued a scenario warning based on what appeared to be a growing consensus among forecasting centers. The June SST and SOI indices indicated a strong event was underway. By August 1997, PEAC scientists were alerting Pacific Island governments and developing rainfall forecasts for each individual jurisdiction served by PEAC. In-country briefings began in September 1997 and rainfall forecasts were provided in the 3rd quarter newsletter. Pacific Island governments established national government-wide El Niño (or drought) task forces and PEAC scientists engaged in enhanced dialogue with those bodies and supported their public education and outreach programs. In-country briefings for all jurisdictions served by PEAC were completed by November 1997. The 4th quarter newsletter, issued in December 1997, updated the rainfall forecasts and although Typhoon Paka brought heavy rain to Guam and the Marshall Islands, drought conditions began throughout the region. Special issues of the PEAC newsletter were produced in January, February and March 1998 providing updates and summaries of rainfall and tropical cyclone conditions and impacts.

As described by Rengulbai (2003), actions undertaken in the Republic of Palau provide an example of how Pacific Island jurisdictions served by PEAC used forecast information to enhance resilience. The national drought/El Niño task force established in Palau (as in most other

jurisdictions) involved high-level representation across government ministries; in the case of Palau, the Vice President chaired the task force. The task force provided an opportunity for broad engagement including disaster management and water resource ministries as well as key sectors such as tourism, fisheries (marine and near-shore) and agriculture. The Task Force also provided a forum for regular discussions with forecasters and periodic adjustments in decisions based on changing conditions. According to Techur Rengulbai (2003), water resource managers responded to the forecast of an evolving El Niño to invest in identifying and fixing leaks in the main distribution system and employed temporary measures to increase dam capacity and catchment during the latter part of the rainy season. Like many other jurisdictions, the Republic of Palau initiated a public education and outreach campaign involving local community leaders, non-governmental organizations, educators and other trusted sources of information and advice as well as government officials, forecasters and scientists.

In the Pacific – and elsewhere in the world – recent events such as the 1997-1998 El Niño have provided evidence that climate forecast and assessment information is leading to enhanced resilience in some sectors: water resource management, disaster management including drought, flood & fire management as well as tropical cyclones), agriculture, health, fisheries, tourism. While acknowledging the anecdotal ("indirect") nature of such knowledge, the National Research Council's report entitled *Making Climate Forecasts Matter* points to the the usefulness of information on the responses of weather-sensitive sectors and actors to past climate forecasts as a guide to the future use of climate information (National Research Council, 1999). Although work on the review of the first decade of PEAC (and similar experiences in other regions) is still ongoing, a few key "lessons learned" about climate forecasting and applications are already emerging:

- **Early and continuous partnership and collaboration with users is essential -- shared learning & shared responsibilities**:
    - Among partners in climate information system
    - Across local, national, regional and international
    - Between/among providers and users
    - Among user communities
    - Dynamic nature of climate and policy
    - Continuous evaluation and revision—FEEDBACK essential

- **Education, outreach and dialogue activities play a critical role:**
    - Raising awareness and understanding
    - Identifying impacts and exploring solutions
    - Building trust and credibility

- **Building trust and credibility is a long-term endeavor**:
    - Establishing and sustaining "eyeball-to-eyeball" contact
    - Build on existing institutions and trusted information brokers
    - **Maintaining awareness between events – i.e., focus on establishing a sustained, *climate information system* not just an event-based early warning system**
    - Accommodating relative successes and failures (e.g., 1997-1998 vs. 2001-2002)

- **Forecasts or projections of future conditions must be set in an appropriate context**:
    - Problem to be addressed
    - Historical events, patterns and trends
    - Traditional knowledge and practice
    - Useful and usable information appropriate to the intended application and decision-making community

- **Decision makers in many sectors are interested in climate information on a continuum of timescales** from extreme events through seasonal and interannual timescales to projections of changing conditions on timescales of decades and longer

- Exploring linkages across timescales important
- Extreme events can be a galvanizing focus for planning, response and capacity-building

- **Early experience points to a number of scientific, technical and institutional constraints in specific places/sectors**, including:
  - Communications – systems and language
  - Difference in forecast skill with season, place and parameter
  - Political and institutional boundaries – for both users and providers of climate information
  - Forecasts remain limited by observations, data and computational constraints
  - Understanding of consequences, vulnerabilities and options for risk management still fairly limited.

4. GUIDING PRINCIPLES FOR CLIMATE INFORMATION SYSTEMS

During a September 2004 Workshop on El Niño Early Warning for Sustainable Development in Pacific Rim Countries organized by the National Center for Atmospheric Research (www.exploratorium.edu/el_nino), this author suggested that lessons learned such as those summarized above may be pointing toward a set of guiding principles that might be considered in thinking about climate services and information systems. An early version of these guiding principles was provided as part of the synthesis of a March 2003 Symposium on Climate and Extreme Events in the Asia-Pacific: Enhancing Resilience and Improving Decision-Making (Shea and Subbiah, 2004) and are summarized here as discussed during the Galapagos workshop:

- Focus on the **integrated climate-society system** (Glantz, 2003)

- **Utilize a collaborative, participatory process with involving both users and providers of climate information**
  - Science-applications partnerships
  - Continuous, interactive dialogue
  - Co-production of knowledge
  - Public education campaign an essential component

- **Use a problem-focused (vs. forecast-focused) approach**:
  - Understand place, context, history and decision making process;
  - Responsive to user needs
  - Understand vulnerability and focus on building resilience

- **Produce, communicate and apply useful and usable information**
  - Scale, timing, format, language and content appropriate to a particular application community
  - Products and dialogue processes appropriate to user needs
  - Near-term decisions and long-term planning
  - Tools and technologies (e.g., analytical products and discussion/decision support tools) that are appropriate to the user community and application

- **Recognize the importance of climate information on a continuum of timescales**

- **Address both process *and* products** in the design of climate information systems

- Recognize the need for an **integrated program of observations, monitoring, forecasting, assessment, education and applications** – *with continuous evaluation and adjustment*

- **Build on existing systems, institutions, programs, relationships & networks**
  - Recognize the vital role of trusted information brokers

- **Facilitate proactive decision making and iterative, reflective, flexible and adaptive approaches**

- **Climate risk management – and the information systems that support it –**

should be set in a sustainable development context

- Responding to today's variability
- Adaptation to long-term change
- Economic planning & community development
- Mainstreaming climate information & adaptation

These guiding principles are still very much a work in progress and they are offered here to help support continued discussion of our shared journey toward sustained climate information systems and the mainstreaming of climate information to support adaptation in the face of climate variability and change.

5. REFERENCES

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