CLIMATE ADAPTATION IN THE PACIFIC: LESSONS LEARNED[1]

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INTRODUCTION

Changes in climate have profound implications for Pacific Island communities. Leo Falcam, President of the Federated States of Micronesia emphasized this reality in an August 21, 2001 op-ed piece in the **HONOLULU ADVERTISER** entitled *Death by Warming* when he stated: "For Pacific island states, climate change and its associated effects are our main security concern." The recently concluded Pacific Islands Regional Assessment of the Consequences of Climate Variability and Change (Pacific Assessment) recognized the importance of climate variability and change to Pacific Island communities including:

- The central role that climate-sensitive sectors (e.g., tourism and agriculture) and resources (e.g., coral reefs and fisheries) play in current and future economic development plans for Pacific islands;
- The implications of climate variability and change for the region's rich biodiversity and populations of endangered species;
- The significant effects that year-to-year climate variability (most notably ENSO) has on Pacific Island communities and the growing awareness that Pacific Island governments, communities, resource managers and businesses are interested in a continuum of climate information that spans timescales from extreme events through seasonal-to-interannual variability to projections of long-term climate change;
- A recognition that adaptation to natural climate variability can reduce vulnerability in the near-term and provide insights and experience that could enhance resilience to long-term climate change;
- The insights into climate forecasting and applications being gained through innovative programs like the Pacific ENSO Applications Center; and
- The importance of scientific research in the Pacific region to understanding the nature and consequences of climate variability and change locally and globally (e.g., long-term monitoring of greenhouse gases at the NOAA GMCC observatories at Mauna Loa and American Samoa; studies of the regional and global consequences of Pacific ocean-atmosphere interactions and studies of the ocean's role in the global carbon cycle).

Participants in a recent Regional Assessment of the Consequences of Climate Variability and Change for Pacific Islands envisioned the emergence of a Pacific climate information system that would build understanding and response capacity through a continuing dialogue among experts and diverse stakeholders in Pacific Island governments, businesses and communities (see Figure 1).

[1] Material in this paper is drawn from a number of recent documents by the author including: formal reports; research proposals; paper abstracts; and formal presentations at a variety of venues.

This vision of a Pacific climate information system is consistent with the concept of a climate "prediction enterprise" as a process of interactions among individuals, institutions, values, perspectives, interests, resources and decisions (Sarewitz et al, 2000). As suggested by Sarewitz et al, the Pacific climate information system envisioned in this project begins with an understanding of the needs of current and intended users of climate information (Ibid).

The first part of this paper provides a snapshot of some of the lessons learned for climate adaptation from the first ten years of operation of the Pacific ENSO Applications Center and related climate forecasting, applications and assessment activities. The second part of this paper highlights similar insights emerging from climate forecasting and adaptation activities in both Asia and the Pacific. Most of these broader, regional findings emerged from the formal presentations and working group discussions during a Symposium on Climate and Extreme Events held in March 2003 as part of the 20th Pacific Science Congress in Bangkok, Thailand.

THE PACIFIC ENSO APPLICATIONS CENTER (PEAC)

The 1997-1998 El Niño event offers a vivid example of what climate means to people in the U.S.-affiliated Pacific Islands and how information about potential consequences can be used to support decision-making and benefit society (Shea et al., 2001). The 1997-1998 event also provides insights into the operations of the Pacific ENSO Applications Center. The following summary of Pacific Island experience during the 1997-1998 event is excerpted from the Preparing for a Changing Climate (Shea et al., 2001) with original source material found in a discussion of PEAC prepared by Dr. Michael Hamnett and colleagues at the University of Hawaii, the University of Guam and the National Weather Service (Hamnett et al., 2000).

By May 1997, most ocean-atmosphere observations and predictive models indicated that a significant El Niño was developing. El Niño events have significant consequences for U.S.-affiliated Pacific Islands including droughts, changes in the tropical storm/hurricane patterns and changes in ocean conditions that affect economically significant resources like fisheries. For purposes of brevity, this example will focus primarily on El Niño-related changes in rainfall that led to severe drought conditions in many of the Pacific islands.

In June 1997, PEAC alerted governments in the U.S.-affiliated Pacific Islands that a strong El Niño was developing and that changes in rainfall and tropical storm patterns in late 1997 through June 1998 might be like those experienced in 1982-1983. In September 1997, PEAC issued its first quantitative rainfall forecast saying that severe droughts were likely beginning in December. PEAC also told governments that the risk of typhoons and hurricanes in the Marshall Islands, eastern islands in the FSM, and in American Samoa would be higher than normal. With the exception of Hawaii, all Pacific Island governments served by PEAC developed drought response plans, aggressive public information and public education programs, and drought or El Niño task forces. The public information campaigns informed the public of what they might expect from El Niño and measures that could be taken to mitigate damaging consequences including water conservation, boiling water to prevent outbreaks of certain diseases associated with drought conditions, and reducing the risk of wildfires which often increase during drought conditions. In Pohnpei State (Federated States of Micronesia) for example, a video was produced and aired on the public radio station four times a day; public service announcements were aired on local television and radio stations; information hotlines were set up; brochures were prepared and distributed; and presentations on El Niño and drought were made in local schools. Water management agencies in

Majuro, Pohnpei, Chuuk, Kosrae, Yap, Palau, Guam and Saipan developed and implemented water conservation plans.

In Palau, the Department of Public Works surveyed the water distribution system in Koror and completed repairs on about 80% of the system before the drought set in. Throughout the Federated States of Micronesia, people repaired water catchment systems and local vendors were able to supply new household catchment systems to meet the demand that developed in response to the public information campaign. The FSM government made deliveries of water to outer islands in Chuuk and Yap. In November 1997, the Congress of the Federated States of Micronesia appropriated $5 million to address the potential impacts of anticipated drought conditions, and the U.S. Ambassador to the Republic of the Marshall Islands requested assistance from the U.S. Commander-in-Chief-Pacific (CINCPAC) to secure equipment and replacement parts to refurbish pumps for wells and increase storage capacity.

Even with these precautionary measures, the 1997-1998 El Niño produced such extensive drought conditions that water rationing became necessary in many areas. Water hours were imposed on most islands with conditions on Majuro being the most severe. During April and May 1998, the water utility on Majuro was only supplying seven hours of water every fourteen days until pumps for wells on Laura islet were repaired. In Palau and Pohnpei, municipal water was available every day but only for a couple of hours at the height of the drought. In the outer islands of Pohnpei State, water was supplied by ship and tanker trucks supplied water at schools in rural areas on the main island. Water supplied to the Koror-Airai area in Palau was reduced from 111 million gallons per month to 9.3 million gallons per month during the height of the drought.

Agriculture suffered from the droughts everywhere except Guam. In the Commonwealth of the Northern Mariana Islands, citrus and garden crops were most affected and the local hospital had to buy imported fruits and vegetables rather than rely on local suppliers. A limited damage assessment was done on Pohnpei and serious losses of both food and cash crops were sustained. Losses of staple crops of taro and breadfruit in FSM exceeded 50%. Over half the banana trees evaluated, for example, had died or were seriously stressed. Kava (Sakau) was probably the most serious economic loss because it has recently become a major cash crop. On Yap, taro losses were estimated at 50-65% and betel nut prices increased more than 500%, although only 15-20% of the trees were lost. In Palau, food shipments increased from twice a month to once a week.

PEAC scientists and residents of the Pacific Island jurisdictions served by PEAC believe that advance warning through forecasts coupled with PEAC's focused program of education and outreach helped mitigate the negative impacts of the 1997-1998 El Niño. While acknowledging the anecdotal ("indirect") nature of such knowledge, the National Research Council's report entitled "Making Climate Forecasts Matter" points to 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 forecasts (National Research Council, 1999).

NOAA's Office of Global Programs initiated PEAC as a research pilot project following a 1992 workshop at the University of Hawaii that brought together ENSO scientists and representatives of key climate-sensitive sectors throughout the American Flag and U.S.-affiliated Pacific Islands. In 1994 PEAC began issuing a quarterly newsletter describing ENSO-relevant ocean-atmosphere conditions and providing Pacific Island jurisdictions with information regarding the implications of those conditions for rainfall and other key factors. Disaster management officials and water resource managers were among the first users of PEAC products but that client base now also includes representatives of agriculture, public health and fisheries sectors. PEAC also continues an active program of education, outreach and dialogue with users to clarify information needs and make PEAC products more useful and usable. PEAC is now supported as an operational activity of the National Weather Service but continues to represent a partnership among the National Weather Service, the University of Hawaii, the University of Guam, the Pacific Basin Development Council and NOAA's Office of Global Programs which continues to support targeted applications research programs such as the climate and health project described earlier.

With support from the OGP, the author has recently initiated a formal review of the first ten years of PEAC operations. A number of early insights have already emerged from the author's own work and the continuous, ongoing dialogue with users that has characterized the philosophy adopted by the individuals and institutions that comprise PEAC. In the context of this Workshop, the following paragraphs highlight some of the most salient of these insights.

One of these insights of particular relevance to this Workshop is that the communities, businesses, government agencies and resource managers who use PEAC forecasts are interested in a *continuum of information* that spans timescales from extreme events (droughts, floods, tropical cyclones) through seasonal-to-interannual variability to projections of long-term climate change. *Recognizing and exploring the linkages across/among these timescales* is an important factor in supporting climate adaptation, at least in the Pacific. PEAC scientific partners and users as well as participants in the Pacific Regional Assessment consistently highlight the fact that current patterns of climate variability (most notably ENSO) already present significant challenges in the region and that significant benefits can accrue from the application of ENSO-based forecasts. Forecasts of climate variability not only assist Pacific Island jurisdictions in addressing today's problems but provide valuable insights into vulnerability and adaptive capacity that can help support community planning and economic development in the long term (this idea is further developed in the discussion of the Symposium on Climate and Extreme Events).

From the beginning, PEAC was designed as a *highly collaborative, participatory process* through which scientists and decision makers developed a sense of both joint ownership of and shared responsibility for the PEAC programs and products. In a recent paper comparing ENSO forecasting systems in the Pacific and Southern Africa, David Cash and colleagues suggest that the broad, "collaborative participation" that began with the 1992 Workshop "galvanized an *iterative process* that fostered periodic evaluation of the needs of the users of forecasts and the capabilities of the climate scientists and forecasters" (Cash, et al, 2003). The first decade of PEAC operations reinforces this author's fundamental belief that *interactive dialogue with users is essential and should be continuous* if climate information services are to effectively support adaptation to changes in climate. PEAC's first decade of operations emphasizes this concept of *co-production of knowledge* – what Figure 1 and this author call shared learning and joint problem solving.

A closely related criterion for success appears to involve *developing and sustaining trust and credibility* in the people, processes and products that comprise PEAC. One of the early members of the PEAC scientific team often emphasized the importance of *"eyeball-to-eyeball" contact* – regular communication with users – as an essential requirement and that building such trust was a long-term effort. Another apparent key to PEAC's early success appears to involve the identification and *engagement of trusted information brokers* -- individuals and institutions that are already perceived as credible sources of climate (and other scientific) information within the region.

The initial scientific partners in PEAC – NOAA/OGP, NOAA/NWS, the University of Hawaii (Social Science Research Institute and School of Ocean and Earth Sciences and Technology), the University of Guam (Water and Environmental Research Institute) – were well established as sources of high-quality, credible scientific information on climate (and other environmental) issues in and about the Pacific. Part of that credibility was institutional but part of it was also personal – the individuals who took the initiative in creating PEAC had already established themselves as reliable members of the Pacific scientific community whose individual work and contributions had demonstrated value to the communities and governments of the region. This author also believes that an early *commitment to engage the local National Weather Service forecasting offices as full partners in PEAC* was an important element of the program's success. Local forecast offices are often the first point of contact on weather and climate questions from governments, communities and businesses and enhancing their capacity to respond to those questions can be an essential component of establishing and sustaining credible climate information services.

The engagement of the Pacific Basin Development Council – a council comprising the Governors of the four American Flag Pacific Islands (Hawaii, Guam, American Samoa and the Commonwealth of the Northern Mariana Islands) -- as another initial institutional partner helped established the *political and public policy bona fides* of PEAC among some of the governments in the region. Similarly, PEAC actively sought to engage individuals and institutions that were considered *trusted information brokers in key sectors* – e.g., local emergency management/civil defense agencies – as early and sustained partners. Thus water resource managers and disaster managers served to broker PEAC forecast information to their colleagues, their governments and their communities and helped guide the development of *useful and usable climate information products*.

A related lesson from the PEAC experience involves a decision to *start where predictability is high, applications are obvious and user communities are "ready"* to adopt the new technology of climate forecasting. Emergency managers and water resource managers in the Pacific Island jurisdictions served by PEAC were already familiar with the nature and impacts of weather as a factor in their operations; extension of their decision making framework to include consideration of forecasts of climate variability was a fairly straightforward proposition. Demonstrating success with those users/applications not only directly supports those sectors but also provides a community of local users familiar with the technology who can assist in the identification and promotion of new applications in other sectors (e.g., capitalizing on the close link between water resource/drought management and both agriculture and public health). A more generalized corollary of this lesson is that the design of climate information systems to support adaptation should recognize that individual communities, sectors and nations differ in their capacity to develop and utilize forecasts of climate variability and assessments of climate change.

SYMPOSIUM ON CLIMATE AND EXTREME EVENTS IN THE ASIA-PACIFIC REGION

As described in their summary of an NSF-sponsored Workshop entitled *Extreme Events: Developing a Research Agenda for the 21st Century*, Daniel Sarewitz and Roger Pielke, Jr. make a strong case for studies of extreme events linked to societal vulnerability as a valuable research focus with an emphasis on understanding the decision processes that influence that vulnerability (Sarewitz and Pielke Jr., 2001). Understanding and responding to climate-related extreme events was also highlighted as a high priority during Pacific Regional Assessment and is emerging in the context of climate risk management discussions among national and international development, disaster management and humanitarian relief agencies. As suggested by Sarewitz and Pielke, Jr. (2001), understanding the process of preparing for, anticipating and responding to extreme events can also provide valuable insights into the decision-making context for the development and use of climate information.

During the past decade, a number of research programs designed to enhance our understanding of the nature and consequences of climate-related extreme events in the Asia-Pacific region and explore the application of climate information to support decision-making have emerged. Some of the more prominent examples include: the Extreme Climate Events (ECE) program implemented by the Asian Disaster Preparedness Center (ADPC); Climate Information Applications in Bangladesh based on models developed by the University of Colorado's Program on Atmospheric and Oceanic Sciences (PAOS); the Pacific ENSO Applications Center (PEAC); regional climate assessments such as the East-West Center's recently completed Pacific Islands regional contribution to the first U.S. National Assessment; and the Pacific Islands Climate Change Assistance Program (PICCAP) coordinated by the South Pacific Regional Environment Programme (SPREP). In parallel, regional organizations like ADPC, the South Pacific Applied Geosciences Commission (SOPAC) and the Pacific Disaster Center (PDC) have been developing integrated assessment techniques and new technologies to support the development of comprehensive emergency management programs in the region.

National governments, regional organizations and international scientific, development and donor agencies are increasingly recognizing the importance of enhancing resilience to climate-related extreme events as an integral component of sustainable development planning. The United Nations Development Programme (UNDP), the Organization for Economic Cooperation in Development (OECD), the International Union for the Conservation of Nature (IUCN), the World Bank, the Asian and Inter-American Development Banks and other partners have begun a dialogue on how to integrate adaptation to climate variability and change into poverty reduction programs.

As described in a UNDP report entitled "A Climate Risk Management Approach to Disaster Reduction and Adaptation to Climate Change" (UNDP, 2002), the concept of "climate risk management" – reflecting a more effective integration of climate adaptation with comprehensive emergency management programs -- continues to take shape with UNDP Bureau of Crisis Prevention and Recovery, the International Federation of Red Cross and Red Crescent Societies, the International Strategy for Disaster Reduction (ISDR), disaster management agencies and humanitarian relief organizations actively leading those discussions. Early discussions of planning for the IPCC Fourth Assessment Report suggest increasing attention on regional consequences with the effects of extreme events highlighted as a particularly important focus. One common element of all of these discussions is a recognition that adaptation to natural climate variability not only promises to reduce vulnerability in the near-term but also provide insights and experience that will prove valuable in enhancing resilience to long-term climate change as well.

To that end (and with support from the NOAA Office of Global Programs), the Pacific Science Association, the East-West Center and the Asian Disaster Preparedness Center convened a Symposium on Climate and Extreme Events in the Asia-Pacific: Enhancing Resilience and Improving Decision-Making as part of the 20th Pacific Science Congress. Individual presentations on national and sectoral experiences were combined with working group and plenary discussions organized to address the following integrating themes:

- *Communication* issues related to information content, format and dissemination as well as the identification of critical information gaps based on past experience;
- *Participation* issues related to effective engagement of relevant stakeholders and establishing an effective, interactive dialogue with users of climate information;
- *Information use* issues related to how climate information has been and can be used to support decision-making including discussions related to responding to individual events and the routine integration of climate information in development and planning in the region;
- *Institutional capacity* issues which include discussion of institutional barriers as well as opportunities to enhance the capabilities of current or emerging boundary organizations in the Asia-Pacific region; and
- *Scientific and technical* issues with particular attention to identify critical information gaps and future priorities.

A final report on the Symposium is currently being prepared but the author's synthesis presentations during the course of the Symposium may provide some insights that are relevant to this Workshop on adaptation. Individual presentations on national and sectoral experiences with the development and use of forecasts of climate variability confirmed the exposure and sensitivity of the Asia-Pacific region to climate-related extreme events and highlighted opportunities in a number of key sectors (agriculture, food security, drought, flood and fire management, disaster management, tourism, health, water and other natural resource management, tourism and fisheries). The individual presentations and working group discussions during the Symposium reinforced many of the PEAC lessons described earlier – particularly those related to the establishment and maintenance of a participatory, iterative process and the need to develop a climate information system that addresses continuum of timescales. In addition, the Symposium discussions highlighted the following additional suggestions that might be considered as "guiding principles" for a climate information system to support adaptation:

- Address the *integrated "climate-society system"* (Glantz, 2003), understand vulnerability and focus on enhancing resilience;
- The *central importance of water resources* in most Asia-Pacific communities and the potential significance of enhancing resilience in this area for promoting adaptive capacity in many other sectors;
- Climate-related *extreme events can be a valuable focus* with opportunities to address today's problems while planning for the future;
- *Climate risk management could be a valuable framework* for building partnerships and guiding climate information systems;
- *Emphasize pro-active planning* in the near- and long-term (e.g., climate risk management in a sustainable development context);
- *Start with a clear understanding of context and existing decision making framework(s)* to help guide information design, development, delivery and applications;
- Establish and sustain a process of *shared exploration of climate information products, forecasting and assessment tools and applications* (co-production); utilize a *team/network approach* with partners (including decision makers) engaged in an iterative, participatory process;
- Choose *tools, technologies and information sources that are appropriate* in a given place and context (traditional, high-tech and in-between);

- Emphasize process as well as products;
- Promote opportunities to *enhance communications* within individual teams/networks and **among** teams/networks in various regions and/or sectors;
- Build on/leverage existing systems, institutions, programs, relationships and networks;
- *Document and share experiences* in order to more fully develop an understanding of early lessons learned and guiding principles and facilitate shared access to expertise, tools and technologies;
- *Training, education and outreach* as essential components of a successful program; and the
- Importance of an *integrated, multi-disciplinary ("end-to-end") program* of observations/monitoring, forecasting, assessment, applications.

The list above is, of course, provides only a shorthand version of some of the rich discussion that characterized the March 2003 Symposium discussions. Symposium presentations and additional material can be found on-line at (http://www2.EastWestCenter.org/climate/extreme).

During his Opening Keynote at the March 2003 Symposium, Mickey Glantz highlighted the importance of addressing the integrated *"climate-society system"* (Glantz, 2003 Opening Keynote at Symposium on Climate and Extreme Events in Asia-Pacific). If we are, in fact, interested in improving the effectiveness and efficiency of this integrated system, then we are compelled to undertake a collaborative program that is as interested in societal context, decision-making frameworks and information needs as it is interested in enhancing the ability to monitor, understand and anticipate changes in the physical climate system. Creating and sustaining the kinds of partnerships required for such an endeavor is both a grand challenge and an unprecedented opportunity for the multi-disciplinary community of scientists interested in climate adaptation as well as the governments, resource managers and businesses for whom adaptation to changes in climate represents a matter of survival and sustainable development.

CONCLUSIONS

When it comes to adaptation, I am unconvinced that maintaining a distinction between climate variability and change has any *practical* meaning from the standpoint of the communities, businesses, individuals or ecosystems who are doing the adapting. Social and natural systems are vulnerable to changes in climate – regardless of the source of those changes. From the standpoint of adaptation, unlike mitigation, the source of those changes doesn't really matter. What matters is having the ability to understand, monitor and, where possible, anticipate those changes in order to manage the risks and capitalize on the opportunities associated with those changes in climate. Experience in the Pacific suggests that effectively responding to changing climate conditions is most effective when it is supported by both directed research and a continuing assessment of vulnerability (exposure, sensitivity and resilience). I'd like to suggest that developing and sustaining a capacity to monitor, anticipate, understand and respond to ENSO-related changes in rainfall, temperature, tropical cyclones and ocean conditions is an example of adaptation – at least in the Pacific. Increasingly, national and regional climate change planning documents highlight the use of ENSO-based forecasts as part of climate adaptation programs. Since changes in natural variability represent some of the principal ways in which any of us will "feel" climate change, adaptation to natural variability becomes an element of adaptation to climate change over the long term.

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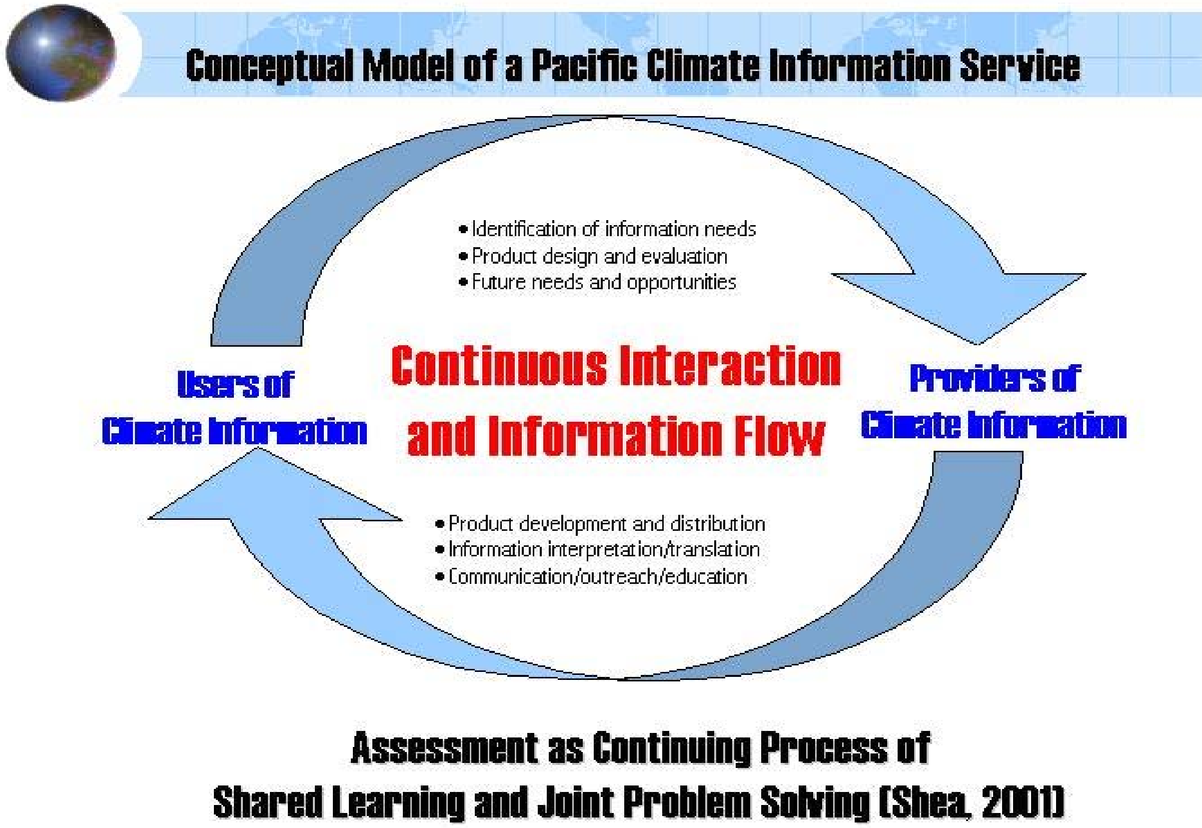
Conceptual Model of a Pacific Climate Information Service
• Identification of information needs
• Product design and evaluation
• Future needs and opportunities
Users of
Climate Information
Continuous Interaction
and Information Flow
Providers of
Climate Information
• Product development and distribution
• Information interpretation/translation
• Communication/outreach/education
Assessment as Continuing Process of
Shared Learning and Joint Problem Solving (Shea, 2001)

Figure 1