

Final Report
ENSO Forecasting and Applications in the Pacific:
Supporting the Transition from Research to Operations
(NOAA Financial Assistance Award No. NA03OAR4310089)

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Statement of the Problem

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 El Niño Southern Oscillation (ENSO) Applications Center (PEAC) and indicates that a more formal review of PEAC could be valuable both to researchers interested in understanding the societal benefits of climate forecasts and to research institutions and operational agencies involved in climate forecasting services and applications. The latter include the U.S. National Weather Service (NWS) and the International Research Institute for climate prediction (IRI). The following summary is excerpted from 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 Federated States of Micronesia (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 (FSM) for example, a video was produced and aired on the public television station four times a day; public service announcements were aired on 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 FSM, people repaired water storage tanks 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 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 as a result of making repairs in pipes and public education aimed at conservation.

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 had 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.

While this example has focused largely on water, other climate- and ocean-related consequences were felt throughout the islands including: changes in the migratory patterns of economically-significant fish stocks like yellowfin and skipjack tuna (which provide losses for some island jurisdictions but opportunities for others); stresses on some coral reefs associated with increased temperature, extreme tides (from El Niño-related variations in sea level), and increased sedimentation from erosion in areas affected by wildfires; losses of important fresh-water shrimp, eels and fish as rivers and streams dried up; and reduced local air quality conditions in Yap, Pohnpei, Palau and Guam as a result of increased wildfires locally and haze from wildfires in Indonesia.

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 (NRC) 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). A thorough review of PEAC operations

during 1997-1998 and the currently evolving El Niño and their activities during non-event periods will help move beyond anecdotal evidence toward structured analysis of the role that climate forecasts played in mitigating the effects of recent ENSO events in the Pacific Islands. It will also help identify those characteristics of PEAC operations that were considered most important in facilitating the application of forecasts to decision-making.

In this context, a structured review of the initial operations of the Pacific ENSO Applications Center was conducted to enable scientists, decision-makers and funding agencies to develop a sense of how well this program is currently addressing some of the general design principles highlighted in the NRC report including issues related to:

- Successfully matching climate information messages with the needs of specific target groups;
- Consideration of a comprehensive information delivery system;
- Using participatory approaches to enhance information delivery (and application); and
- Combining climate information with a variety of intervention approaches (NRC, 1999).

A review of the initial operations of PEAC in light of these guidelines was designed to help identify some of the specific characteristics one might seek in an effective program of climate services in the Pacific and highlight the scientific, institutional and communications challenges associated with designing, implementing and sustaining such climate services. FY 2002 and 2003 plans for the National Oceanic and Atmospheric Administration's (NOAA) Climate Observations and Services program provided support for the transition of PEAC from research-based pilot project to operational status under the aegis of the National Weather Service's Pacific Region. Representatives of the NOAA-wide Climate Observations and Services Program and the National Weather Service Pacific Region have confirmed that a review of PEAC would contribute to their planning and program development efforts (Weyman, 2002).

In addition to the interests of the U.S. National Oceanic and Atmospheric Administration, the PEAC review project also contributed to a number of regional and international efforts aimed at improving climate information services in the Pacific, including:

- Complementary climate forecasting programs addressing South Pacific Islands being implemented by the Australia Bureau of Meteorology (BOM) and the New Zealand National Institute for Water and Atmospheric Research (NIWA) under the aegis of the South Pacific Regional Environment Programme (SPREP);
- Ongoing efforts by the IRI to establish regional partnerships in forecasting and applications;
- World Meteorological Organization (WMO) efforts to develop regional climate service center (s) for the Asia-Pacific Region and
- The emergence of an integrated Pacific Climate Information System (PaCIS) that will serve as a U.S. contribution to the WMO Regional Climate Centre for Pacific Islands.

Background on PEAC

The concept of a Pacific ENSO Applications Center emerged from a 1992 Workshop organized jointly by the University of Hawaii and NOAA's Office of Global Programs (OGP). That initial Workshop provided an opportunity for representatives of the climate research community to meet with individuals representing potential forecast user communities in the U.S.-affiliated Pacific Islands. Sectors represented at this meeting included disaster management, water and power utilities and fisheries among others. The 1992 Workshop confirmed the potential usefulness of ENSO forecasts in these sectors and Workshop participants specifically set a long-term goal to:

“Establish a Pacific ENSO Applications Center to provide:

- Routine production and delivery of tailored forecasts;
- An institutional focus for translation, interpretation, communication, education and outreach; and
- Enhanced partnership among the scientific community, government agencies and local decision makers.” (Schultz and Hamnett, 1992).

With NOAA/OGP funding, the PEAC pilot project began in 1994 as a partnership of the University of Hawaii, the University of Guam, NOAA (NWS and OGP) and the Pacific Basin Development Council (the Governors of the four American Flag Pacific Islands). Initially, PEAC focused on: improving historical datasets with an emphasis on rainfall; expanding access to and interpreting ENSO forecast products being developed by NWS, the IRI and other forecasting and research institutions in the region; expanding public awareness and understanding of the ENSO cycle and the potential societal benefits of forecast applications; and identifying specific applications opportunities. The 1997-1998 event provided an opportunity for the PEAC team to undertake efforts aimed at assessing the consequences of ENSO for the jurisdictions it serves. Initial steps toward the transition of PEAC from research to operations began in 2000 with discussions in the Pacific Region, at the National Weather Service National Centers for Environmental Prediction (NCEP)/Climate Prediction Center (CPC) and OGP. The ten-year anniversary of the initial workshop and, in 2004, the initiation of the PEAC pilot project, provides a timely opportunity to review progress to date and will help to guide the continued transition to operational status in the context of NOAA's emerging climate services program. A more detailed summary of the PEAC experience during the 1997-1998 El Niño can be found in the full Pacific Assessment report, and additional information can be found on the PEAC website (<http://www.soest.hawaii.edu/MET/Enso/reports/97ENSO.html>).

PEAC Review Project: Objectives and Methodology

The PEAC Review project was designed to address the following objectives:

- Assessment of the effectiveness of PEAC's approach to establishing and sustaining an interactive process of dialogue among scientists, forecasters and users; and
- Identification of critical information gaps and future research needs associated with improving the development and application of climate forecast products for Pacific Island jurisdictions.

The project provided important information about the programmatic and institutional aspects of PEAC's organization and operation as a partnership between NOAA (research and operations), universities and the intended users of PEAC products. In this context, the project has contributed to the development of specific recommendations for future climate forecast products, education and outreach programs based on a client-based evaluation of the quality, usefulness and usability of past PEAC products and activities.

The project employed a written survey, informal interviews and targeted, small-group discussions culminating in a June 1-3, 2004 workshop designed to engage PEAC users, scientists and forecasters in an evaluation of past performance and the identification of future opportunities.

Review Oversight Committee

The Principal Investigator was supported by a "PEAC Review Oversight Committee" which provided overall scientific guidance for the project and served as the organizing committee for the final project workshop. This Committee included the following individuals:

- Michael Coughlan, Australia Bureau of Meteorology
- Mickey Glantz, National Center for Atmospheric Research
- Holger Meinke and Graeme Hammer, Queensland Department of Primary Industries, Australia
- Atu Kaloumaira, South Pacific Applied Geosciences Commission (SOPAC)
- James Laver, NOAA/NWS/NCEP/CPC
- Roger Pielke, Jr., University of Colorado
- Rajendra Prasad, Fiji Meteorological Service
- Techur Rengulbai, Bureau of Public Utilities, Ministry of Resources & Development, Republic of Palau
- James Salinger, New Zealand National Institute of Water and Atmospheric Research
- Edward Sarachik, University of Washington
- Andrea Volentras, South Pacific Regional Environment Programme (SPREP)
- Steve Zebiak, International Research Institute for Climate Prediction (IRI), Columbia University.

Surveys and Interviews with PEAC Users and Partners

One of the most important factors in this project's success involved effectively engaging current and potential users of PEAC products and services in a discussion of PEAC design and performance. In this context, we explored issues related to:

- an overall evaluation of PEAC performance in the context of user needs and expectations;
- an assessment of the content and format of PEAC forecast products in the context of user information needs and expectations;
- an evaluation of PEAC forecast dissemination and delivery techniques, including the identification of user preferences;
- an evaluation of PEAC education and outreach programs;
- documentation of how PEAC forecasts have been/are being used in key sectors (including, but not limited to, disaster management, water resources, agriculture and health) including identification of metrics that demonstrate the societal impacts (benefits) of PEAC forecast products;
- identification of possible future forecast applications in key sectors and related information needs; and
- identification of scientific, technical and institutional challenges to past – and future – PEAC operations.

Individuals and institutions currently receiving PEAC forecast products were formally queried with an opportunity for users of the PEAC website to complete survey instruments either in writing or online. To the extent possible, the Principal Investigator contacted participants in the original 1992 ENSO Applications Workshop since many of those individuals were expected to be among the first users of PEAC forecasts and services. A copy of the survey questionnaire is included in this report as Attachment A.

Similarly, the Principal Investigator used interviews to provide an overall evaluation of PEAC performance from the current partners in that endeavor at the University of Hawaii, the University of Guam, the Pacific Basin Development Council and NOAA, including the National Weather Service Pacific Region, NCEP/CPC and the Office of Global Programs. In addition to their perspective on current and future applications, all of these individuals were asked to evaluate PEAC's performance in terms of program plans and documentation as well as their own expectations as individual and institutional partners in this shared endeavor.

PEAC Survey Results

Although the number of completed surveys was not sufficient to be statistically significant, the results of surveys and interviews with PEAC users and partners were analyzed and summarized during a presentation to participants in the June 2004 PEAC Review regional workshop. Sixty percent (60%) of the survey respondents identified themselves as a "PEAC user"; twenty-five percent (25%) of the respondents indicated that they were "unfamiliar with PEAC"; twelve percent (12%) of respondents identified themselves as a "direct PEAC representative" or representative of a "supporting institution"; and three percent (3%) of the respondents indicated "no relationship" with PEAC.

Thirty-one percent (31%) of those respondents who identified themselves as a “PEAC user” represented a government agency; twenty-six percent (26%) indicated they were in the private sector; sixteen percent (16%) indicated that they were from non-government organizations (NGO); eleven percent (11%) indicated they were from universities; eleven percent (11%) indicated that they were from Pacific regional organizations) and five percent (5%) identified themselves as employees of a national weather service in the region.

When asked about prioritizing climate risks, survey respondents identified the following issues associated with ENSO; these issues are presented here in descending order of priority based on number of total responses and number of responses that identified the issue as a high priority:

- tropical storms and cyclones;
- high winds;
- droughts;
- storm surge;
- extreme rainfall events;
- floods;
- sea level variations and extreme/high temperatures, emphasizing extreme/high sea surface; and
- temperatures

The survey questionnaire was designed to elicit input on both PEAC products (see Question B-12 in the survey) and the process PEAC used to engage users and identify and respond to their information needs (see Question B-13 in the survey). Using a scale of 1-5 where 5 represented the highest score, PEAC *products* received high marks for: clarity/readability (4.3); relevance (4.2); scientific and technical credibility (4.1); content (3.8) and accessibility (3.8). With an average score of 3.4, survey respondents indicated that the timing of PEAC products and services could be improved. In terms of the *process* that PEAC used to develop and provide its services, the survey respondents gave relatively high marks to PEAC in terms of: responsiveness to questions and queries (3.8); engaging participation of users (3.7); providing opportunities for evaluation of products (3.6); and providing opportunities to identify additional needs (3.6). With scores of 3.5 and 3.3, respectively, survey respondents suggested that there was room for improvement in terms of understanding and responding to local concerns and developing new products. It is interesting to note that most of the respondents who indicated less satisfaction with both PEAC products and services were either unfamiliar with PEAC prior to the survey or became aware of PEAC products and services during a period when PEAC did not have a full-time outreach and education officer highlighting the importance of sustained support for an individual (or group of individuals) that would provide a focal point for user engagement and dialogue.

When asked to identify additional climate products that would be useful, survey respondents identified the following: sea level forecasts (now a part of PEAC forecasts); hydrological forecast and information; wind predictions; winter swell predictions; an update to the Pacific Rainfall Atlas (currently in progress); longer lead forecasts; information on long-term climate variability (e.g., Pacific Decadal Oscillation); information on the skill of current seasonal forecasts (i.e., validation); summary articles describing the current models used to produce seasonal forecast; and information on innovative ways in which other people are applying seasonal-to-inter-annual forecasts.

PEAC Regional Workshop

From June 1-3, 2004, the East-West Center convened a *Pacific ENSO Applications Center (PEAC) Regional Workshop: A Look to the Future*. As was the case with the initial 1992 workshop, the June 2004 Workshop included: representatives of existing and potential user communities; the climate forecasting and applications research community, including but not limited to the PEAC team; and representatives of institutions and programs actively engaged in the development and application of climate forecasts in and for Pacific Islands (e.g., Australia BOM, New Zealand National Institute of Water and Atmospheric Research (NIWA), Fiji Meteorological Service, SPREP). Pacific Island jurisdictions served by PEAC were represented by invited teams that included local NWS offices, government agencies responsible for climate-sensitive sectors (e.g., disaster management, water resources, agriculture, fisheries), and other users of PEAC products in the public and private sectors. Participation by NOAA/NWS/NCEP/CPC, NOAA's emerging Climate Services program and NOAA/OGP as well as the NWS Pacific Region ensured that Workshop results would be integrated into operations and program plans. Representatives of the International Research Institute for Climate and Society (IRI) were designated to support efforts to establish sustained regional partnerships in the Pacific. Representatives of other regional climate forecasting and research institutions and organizations as well as the WMO provided important regional and international perspectives and contributed to the ongoing discussion of climate information services in and for the Pacific. A List of Participants in the June 2004 Workshop is included as Attachment B to this report.

Recalling the general design principles highlighted in the National Research Council (NRC) report "Making Climate Forecasts Matter" (NRC, 1999), Workshop plenary and small group discussions provided opportunities to explore:

- How effectively PEAC products have served the information needs of intended user communities and how well plans for future PEAC products are aligned with identified information gaps and user needs;
- How effectively PEAC's structure and activities contribute to a comprehensive information delivery system for the region and what could be done to strengthen that system as well as PEAC's specific contributions;
- Lessons learned from PEAC experiences in engaging scientists, forecasters and users in a participatory process of forecast design, delivery, application and evaluation; and
- PEAC's role in the emergence of an integrated climate information system for the Pacific region.

The Final Agenda for the Workshop is included as Attachment C and the following summary provides a snapshot of the workshop organization.

Opening Day sessions included:

- Welcome, opening remarks and an overview of Workshop objectives and design;
- A brief review of the history of the Pacific ENSO Applications Center; and
- Personal reflections on the first decade of PEAC experience with panels representing: the initial PEAC scientific team, early users of PEAC products and partner institutions throughout the region.

Following a brief review of the PEAC Survey and some of the key findings to date, Day Two (Wednesday, June 2) and the early morning of Day Three (Thursday, June 3) were devoted to Working Group discussions of strengths, weaknesses, opportunities and constraints of PEAC's first decade in the context of:

- *Application of PEAC forecasts*, including identification of current and potential partnerships focused on using PEAC information to support decision-making, exploration of early success stories in addressing regional issues in key sectors and identification of new sectoral opportunities;
- *User engagement and participation*, including exploration of PEAC as a collaborative effort that effectively engages users and scientists in development, delivery, application and evaluation of PEAC products and services (i.e., issues of co-production of knowledge);
- *Development of new applications, tools and services*, including discussion of scientific and technical issues related to developing new forecasting capabilities, the collaboration of forecast users and producers in developing new services, and identifying information gaps/needs to guide future products and applications; and
- *Communications, education and outreach* including issues related to the form and content of PEAC products & services.

Guidelines for Working Group Discussions are included as Attachment D to this report.

Individual Working Group discussions were followed by presentation and discussion of key findings and recommendations in plenary. Mid-morning on Day Three, participants had an opportunity to explore outstanding issues and crosscutting themes.

Following lunch on Day Three (Thursday, June 3), Workshop participants were given an opportunity to review and comment on current plans for revising/improving the PEAC website, newsletter and other products and services.

Workshop participants then heard presentations on a broader regional context for Pacific Island climate information services including a discussion of emerging plans for National Weather Service Pacific climate services and an update on planning for a regional climate centers under the auspices of the World Meteorological Organization (WMO).

The final Workshop session was devoted to a presentation and plenary discussion of key lessons learned and Workshop recommendations as summarized by the Workshop Chair.

The Workshop Background Paper, presentations, working group summaries and other materials associated with the PEAC review project are posted on the EWC climate website under Stakeholder Dialogue at (<http://research.eastwestcenter.org/climate/peac/>).

At the conclusion of the Workshop, Eileen Shea, Workshop Chair and Project Principal Investigator summarized some of the key *Lessons Learned and Recommendations from the workshop; these are included here as Figures 1 and 2.*

The Workshop Chair also identified a set of *Guidelines for the Future* including:

•Building on the success of PEAC’s first decade and strengthening/enhancing the keys to its initial success:

- Partnerships including user engagement and dialogue; education/training, historical context, forecast interpretation and tailoring

•Defining PEAC’s role in the context of the emergence of a Pacific climate risk management system:

- WMO Regional Climate Centre(s)
- National climate services
- Support for climate adaptation and mainstreaming

•Recognizing climate impacts are set in a multi-stress context:

- Start with the problem; understand decision-making context
- Additional users may require more integrated products

• Embedding climate information programs in the context of broader sustainable development, poverty reduction and environmental goals

•Creating and sustaining a flexible/adaptable PEAC

Figure 1 – Chair’s Summary of Lessons Learned from PEAC Review Workshop

- **First decade highlights a number of success stories:**
 - Water resources with direct benefits to communities and secondary benefits to industry (e.g., tuna canneries in American Samoa)
 - Power and utilities
 - Emergency management
- **Early & continuous collaboration/partnership with users was/is key**
- **Critical role of education, outreach & dialogue:**
 - Raising awareness and understanding
 - Identifying impacts and exploring solutions
 - Building trust and credibility
 - Communication, communication, communication
- **Individual and institutional leadership was essential** – within PEAC partner institutions and within Pacific Island governments
- “Virtual center” approach has worked and is part of PEAC’s strength: *Partnership, Partnership, Partnership*
- **Success in 1997-1998 established credibility, track record and partnership with a core set of users**
- **Users interested in climate information on a variety of timescales; interactions and feedbacks important**
- **Encountered a number of scientific, technical and institutional constraints, including:**
 - Communications infrastructure
 - Forecast skill varies with season, place and parameter
 - Political and institutional boundaries – users and providers
 - Observations and data limited
 - Computational limitations
 - Limited understanding of consequences, vulnerability and options for risk management
 - Technical terminology and language considerations
 - “Getting the message right”
- **Importance of setting projections of future conditions in context:**
 - Problem to be addressed
 - Historical events, patterns and trends
 - Traditional knowledge and practices
 - Nature & consequences of any event depend on where you sit
- **Building trust & credibility a long-term endeavor:**
 - Eyeball-to-eyeball contact
 - Maintaining awareness between events
 - Accommodating relative successes & failures (e.g., 2001-2002 forecast)

Figure 2 – Chair’s Summary of PEAC Review Workshop Recommendations

- **Strengthen collaboration with users:**
 - Maintain ties to core users
 - Explore new sectors/user communities (health, coastal/marine resources, agriculture, forestry, land-use planning, economic development, tourism)
 - Review issues, problem definition and info. needs and evaluate products
 - Expand outreach and education efforts
 - Update distribution list
 - Enhance mechanisms for feedback
- **Strengthen and expand critical partnerships:**
 - Users
 - PEAC + Pacific Regional Integrated Science and Assessment Program (Pacific RISA)
 - National meteorological and hydrological services
 - WMO RA-V Regional Climate Center partners
 - Local-level expertise and capacity-building
 - Resource management & other mission agencies
 - Academia & scientific institutions
 - Regional organizations and programs (SOPAC, SPREP, PI-GCOS, climate adaptation projects,...)
 - Local boundary organizations and information brokers (intermediaries) – including educators, media, key ministries, etc.
 - Expand (formal & informal) education opportunities
- **Strengthen/enhance PEAC product line:**
 - Mechanisms for regular feedback and revision
 - Add verification and monthly updates of conditions
 - LOCAL nature & consequences of different strengths of ENSO events, neutral years, variability on other timescales
 - Explore new product lines including extreme rainfall/floods, sea level, hydrological information, typhoon outlooks & return periods, surf/swell/waves, etc.
 - Update rainfall atlas; national & local climatologies
 - Partnerships for locally-tailored products
 - Cost-benefit analyses (impacts & adaptation)
 - Basic information on climate & response options
 - Address data and communications issues
 - Explore new technology (e.g., data visualization tools)
- **Set PEAC in context of broader Pacific regional goals and opportunities:**
 - Climate adaptation and mainstreaming (enhancing resilience to variability)
 - Poverty reduction
 - Sustainable economic development
 - Millennium Development Goals
 - Natural resource management and biodiversity protection
 - Other national goals and priorities

At the conclusion of the PEAC Review Workshop, Jim Weyman, NWS Pacific Climate Services focal point, indicated that the findings and recommendations from the PEAC review would serve as a “roadmap for the future” of PEAC and many of the Workshop recommendations have already been incorporated into PEAC products and services (e.g., routine integration of sea level forecasts in PEAC quarterly newsletters). In addition, the insights from the PEAC review are being used to support the emergence of a Pacific Climate Information System (PaCIS).

Guiding Principles for a Pacific Climate Information System

The Workshop findings and recommendations as well as lessons learned from the PEAC Review project have been presented in a number of scientific and regional program venues including (but not limited to): regional, in-country workshops and meetings organized in the context of the Pacific Islands RISA program; Annual Meetings of the American Meteorological Society; the U.S. Climate Change Science Program (USCCSP) Workshop on Science in Support of Decision Making; workshops on climate vulnerability and adaptation sponsored by NOAA and other U.S. Climate Change Science Program (USCCSP) agencies; workshops on climate diagnostics, prediction and applications sponsored by NOAA; workshops on climate vulnerability and adaptation sponsored by Pacific regional organizations and institutions such as the Secretariat for the Pacific Regional Environment Programme (SPREP), the Asia-Pacific Network for Global Change Research (APN); the New Zealand National Institute of Water and Atmospheric Research; the Australia Bureau of Meteorology; and the Pacific Risk Management Ohana (PRiMO) among others.

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), the project Principal Investigator 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 have laid the foundation for the emergence of a Pacific Climate Information System (PaCIS) – a regional climate service for the Pacific that integrates observations, research, forecasting, information services, assessment and education/outreach activities in the context of a single, programmatic framework.

The Pacific Climate Information System

The Pacific Climate Information System (PaCIS) provides a programmatic framework to integrate ongoing and future climate observations, operational forecasting services and climate projections, research, assessment, data management and education that will address the needs of American Flag and U.S.-Affiliated Pacific Islands. PaCIS will also serve as a United State's contribution to the World Meteorological Organization's Regional Climate Centre for Oceania and as a step towards a regional climate service for the Pacific. Discussions of PaCIS and a Pacific Regional Climate Centre can trace their roots back to the 1997-1998 El Niño season and initial discussions of Pacific climate services at a workshop held in conjunction with the 1999 SPREP meeting of the Pacific Regional Meteorological Services Directors. Those early discussions identified a *regional Vision* for:

resilient and sustainable communities using climate information to manage risks and support practical decision-making in the context of climate variability and change.

That same vision has been embraced for U.S. PaCIS.

In order to further define the roles and capabilities of PaCIS, a Steering Committee has been selected incorporating PEAC, the Pacific RISA, PI-GCOS, U.S. National Weather Service Operations Service and Climate Services Division, and their partners as well as experts and users of climate science and applications in the region. Steering Committee membership includes representatives of institutions and programs working in the fields of climate observations, science, assessment and services in the Pacific as well as selected individuals with expertise in similar regional climate science and service programs in other regions.

The PaCIS Steering Committee will provide a forum for sharing knowledge and experience and will guide the development and implementation of this integrated, regional climate information program. During its inaugural meeting in August 2006, the PaCIS Steering Committee approved a PaCIS Action Plan that establishes the following *Mission Objectives*:

1. Clarify climate information needs to guide climate education, outreach, user information needs, observations, products, services, research and assessment;
2. Provide access to critical data, research and new climate information products and services;
3. Translate research and assessment results into useful and usable climate information;
4. Interpret global and regional climate forecasts and projections for local applications;
5. Enhance regional and local capabilities to manage risks and support sustainable development in the context of climate variability and change; and
6. Enhance collaboration among national, regional and international institutions and programs involved in climate information services.
7. To address the mission objectives, PaCIS will be implemented in the context of three program elements:
 - Education, Outreach and User Information Needs
 - Operational Climate Observations, Products and Services
 - Research and Assessment

Future planning for a number of U.S. climate programs in the Pacific including the Pacific ENSO

Applications Center (PEAC), the Pacific Islands Regional Integrated Science and Assessment (Pacific RISA) program and related climate activities in the region will be organized in the context of PaCIS. In addition to meeting the specific needs of U.S.-affiliated jurisdictions in the Pacific, PaCIS will also provide a venue to discuss the role of U.S. contributions to other climate-related activities in the Pacific including, for example, observing system programs in the region, such as the Pacific Islands Global Climate Observing System (PI-GCOS) and the Pacific Islands Global Ocean Observing System (PI-GOOS), as part of an integrated climate information system.

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ATTACHMENT A

PEAC Review Survey

Dear Colleague:

Aloha and thank you for taking the time to complete this Survey. The East-West Center is undertaking a review of the initial years of operation of the Pacific ENSO Applications Center (PEAC). PEAC represents a partnership among NOAA, the University of Hawaii, the University of Guam and the Pacific Basin Development Council. Since its inception in 1994, PEAC has provided forecasts of year-to-year climate variability¹ for the American Flag Pacific Islands (Hawaii, Guam, American Samoa and the Commonwealth of the Northern Mariana Islands) and the U.S-Affiliated Pacific Islands² (the Federated States of Micronesia, the Republic of the Marshall Islands and the Republic of Palau); additional information about PEAC can be found at the following website (<http://lumahai.soest.hawaii.edu/Enso/index.html>).

This Survey is being made available to past, present and potential users of PEAC products and services, including government officials, community leaders, businesses, climate scientists, national meteorological service forecasters, and non-governmental organizations throughout the Pacific. The information obtained through this Survey will be combined with the results of individual interviews, targeted discussions with key sectors and a regional workshop to address the following objectives:

- Assessment of the effectiveness of PEAC's approach to establishing and sustaining an interactive process of dialogue among scientists, forecasters and users of PEAC climate information products; and
- Identification of critical information gaps and future research needs associated with improving the development and application of climate forecast products for Pacific Island jurisdictions.

The findings and recommendations developed through the PEAC review project will help guide the future operations of PEAC and other elements of climate research, forecasting, assessment and information services to be undertaken by the NOAA and the other PEAC partners.

The Survey is completely voluntary and confidential; none of your responses will be attributed to you unless you provide explicit authorization to do so. In the event that we would like to directly quote something from your Survey response, we will contact you for approval prior to using your comments. Completing the Survey should take no more than an hour or so.

¹ For purposes of this Survey, climate variability is defined as relatively short-term variations in the natural climate system including, most notably, the El Niño-Southern Oscillation (ENSO), which bring changes in rainfall, temperature, humidity, tropical cyclones, sea level and other important characteristics of the Pacific climate system.

² The American Flag Pacific Islands include Hawaii, Guam, American Samoa and the Commonwealth of the Northern Mariana Islands and the U.S-Affiliated Pacific Islands include the Federated States of Micronesia, the Republic of the Marshall Islands and the Republic of Palau.

THE DEADLINE FOR SUBMISSION OF YOUR COMPLETED SURVEY IS MARCH 31, 2004. YOUR COMPLETED SURVEY CAN BE SUBMITTED BY MAIL, FAX OR ELECTRONICALLY TO:

PEAC Review Team
East-West Center
1601 East-West Road
Room 2062 John A. Burns Hall
Honolulu, HI 96848-1601
FAX: +1 (808) 944-7298
E-mail:peac@EastWestCenter.org

If you have any questions about the Survey or the PEAC Review Project, please do not hesitate to contact me via e-mail at (SheaE@EastWestCenter.org) or by phone in Honolulu, HI at +1 (808) 944-7253.

Documenting your experience with PEAC operations and products and providing your insights on the climate information needs of the region are critical to the success of this project. Thank you, again, for your valuable time and assistance!

Eileen L. Shea
Climate Project Coordinator
East-West Center

SECTION A – GENERAL BACKGROUND

Question A-1: Where do you currently work and what is your title?

Question A-2: What kind of responsibilities and tasks does your job entail?

Question A-3: What are the most important issues facing you and your home organization?

Question A-4: From the following list, please rank the following climate risks in terms of the challenges that they pose to you, your activities, the issues you have identified (in Question A-3), and the objectives of your organization (a ranking of 1 represents the highest priority and can be applied to more than one characteristic):

- _____ Extreme rainfall events
 - _____ Droughts
 - _____ Floods
 - _____ Tropical storms and cyclones
 - _____ Storm surge
 - _____ High winds
 - _____ Sea level variations
 - _____ Extreme temperatures; specify _____ High or _____ Low
 - _____ Other (please specify): _____
-
-
-
-
-

Question A-5: What climate information or services do you or your organization require to make informed decisions? (Please provide specific examples of decisions and required information services if possible)

Please mark the appropriate Box to indicate the amount of climate information you receive from each possible source.

Please mark the *primary* mode(s) of communication from each of these sources (you may check more than one box).

	A Lot	Some	A Little	Not Much	None	Phone	Fax	Internet	E-mail	Mail	Face-to-Face	Peacesat radio or VTC
Personal experience												
Traditional Leader(s)/Teacher(s)												
Local Expert(s)												
Local Weather Service Office												
NWS Forecast Office-Guam												
NWS Forecast Office-Honolulu												
NWS Climate Prediction Center												
Fiji Meteorological Service												
Pacific ENSO Applications Center (PEAC)												
Australia Bureau of Meteorology												
New Zealand-NIWA												
International Research Institute for climate prediction (IRI/Columbia University)												
Local Civil Defense, Disaster or Emergency Management Agency/Office												
Local FAA Office												
National/State Environment Agency												
National/State Water/Utilities Agency												
National/State Agriculture Agency												
National/State Resource Management Agency												
National/State Climate Change/PICCAP Office												
State/Local Climatologist												
University of Hawaii												
University of Guam												
College of CNMI												
College of FSM – Chuuk												
College of FSM – Kosrae												
College of FSM – Pohnpei (main campus)												
College of FSM – Yap												
College of Marshall Islands												
Palau Community College												
University of the South Pacific												
Other regional universities or scientific institutions (please specify)												
South Pacific Regional Environment Programme (SPREP)												
South Pacific Applied Geosciences Commission (SOPAC)												
Local/Regional NGO (pleases specify below)												
Media (newspaper, television, radio)												
Other (please specify below)												

- University
- Scientific/research institution
- Regional organization addressing issues related to weather and climate
- Other (please specify): _____

_____ B. Representative of a PEAC partner institution (i.e., a direct participant in the development and provision of PEAC products and services):

- NOAA
- University of Hawaii
- University of Guam
- Pacific Basin Development Council
- Other (please specify): _____

_____ C. Representative of a supporting research/scientific institution in the region (please specify): _____

_____ D. Other (please specify): _____

_____ E. No Current Relationship

Question B-4: Has this relationship changed over time? If so, how?

- No
- Yes (please describe): _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

Question B-5: We are interested in the extent to which PEAC has effectively communicated and encouraged/facilitated dialogue on issues related to the development and use of climate forecasts in the region. On a scale of 1 to 5 (low to high) please rank PEAC in terms of the following:

- Accessibility of PEAC products and services
- Accessibility of PEAC scientists and/or partner institutions
- Clarity/readability of PEAC newsletter and website information
- Availability of PEAC scientists/partner institutions to respond to specific questions on PEAC forecasts
- Availability to respond to general questions on climate variability and change
- Opportunities to convey product requirements specific to your information needs
- Opportunities to participate in the design of PEAC products and services

Please submit your completed survey to:

**PEAC Review Team
East-West Center
1601 East-West Road
Room 2062 John A. Burns Hall
Honolulu, HI 96848-1601
Fax: +1 (808) 944-7298
E-mail: peac@EastWestCenter.org**

Thank you, again, for contributing your valuable time and insights to the effort.

ATTACHMENT B

**Pacific ENSO Applications Center (PEAC) Regional Workshop:
A Look to the Future
June 1 – 3, 2004
East-West Center, Honolulu, Hawaii**

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ATTACHMENT C

Pacific ENSO Applications Center (PEAC) Regional Workshop: A Look to the Future

June 1-3, 2004
Imin International Conference Center
East-West Center
Honolulu, HI

FINAL AGENDA

TUESDAY, JUNE 1 (IMIN Conference Center, Second Floor--Asia Room)

- 12:00 noon **Registration** (Imin Center, second floor outside Asia Room)
- 1:00 p.m. **Oli Aloha**
(Kumu Hula Victoria Holt Takamine)
- 1:15 p.m. **Welcome and Opening Remarks**
- Letter to participants from Senator Daniel K. Inouye
 - Nancy Lewis, Director, Research Program, East-West Center
 - Chet Koblinsky, Director, NOAA Climate Office and Office of Global Programs
 - Jeff LaDouce, Director, National Weather Service Pacific Region
- 1:45 p.m. **Review of Workshop Objectives and Design**
(Eileen Shea, East-West Center)
- 2:00 p.m. **Brief History of the Pacific ENSO Applications Center**
(Eileen Shea, East-West Center)
- 2:30 p.m. **Personal Perspectives on PEAC's First Decade--The Original PEAC Team** (individual reflections on some key lessons learned)
- Michael P. Hamnett, University of Hawaii
 - Chip Guard, National Weather Service, Guam
 - Mark Lander, University of Guam
 - Tony Barnston, IRI
 - Luke He, NWS/NCEP/CPC
 - Alan Hilton, NOAA Corps
- 3:30 p.m. **BREAK**
- 3:45 p.m. **Personal Perspectives on PEAC's First Decade—Early Users**

(individual reflections on PEAC's contributions to managing climate risks in the region)

- Techur Rengulbai, Republic of Palau, Ministry of Resources & Development
- Clement Capelle, Disaster Management Office, Republic of the Marshall Islands
- Abe Malae, American Samoa Power Authority
- Joseph Konno, Chuuk EPA, Chuuk State, FSM

All participants invited to offer their own brief reflections on PEAC's first decade.

4:45 p.m.

PEAC in a Regional Climate Context

(informal reflections on the first decade and current collaborations from some PEAC partners in the Pacific)

- Pene Lefale, NIWA New Zealand
- Michael Coughlan, Australia Bureau of Meteorology
- Rajendra Prasad, Fiji Meteorological Service
- Taito Nakalevu, SPREP
- Atu Kaloumaira, SOPAC
- Other regional partners invited to offer their reflections

5:45 p.m.

Adjourn for the day.

Buses Depart for Waikiki Aquarium

6:00-8:00 p.m.

RECEPTION, Waikiki Aquarium

Cultural Presentation by Kumu Hula Victoria Holt Takamine and Halau Pua Ali'i Ilima

WEDNESDAY, JUNE 2 (IMIN Conference Center, Asia Room)

8:00 a.m.

Continental Breakfast

8:30 a.m.

Overview of PEAC Review Survey and Results
(Nicole Colasacco, NOAA Corps)

9:00 a.m. **Instructions for Working Groups**
(David Cash, Harvard University and Eileen Shea, East-West Center)

For the remainder of Wednesday and part of Thursday, 4 parallel Working Groups will discuss the strengths, weaknesses, opportunities and constraints of PEAC's first decade in the context of:

- ***Application of PEAC forecasts***, including identification of current and potential partnerships focused on using PEAC information to support decision making, exploration of early success stories in addressing regional issues in key sectors and identification of new sectoral opportunities;
- ***User engagement and participation***, including exploration of PEAC as a collaborative effort that effectively engages users and scientists in development, delivery, application and evaluation of PEAC products and services (i.e., issues of co-production of knowledge);
- ***Development of new applications, tools and services***, including discussion of scientific and technical issues related to developing new forecasting capabilities, the collaboration of forecast users and producers in developing new services, and identifying information gaps/needs to guide future products and applications
- ***Communications, education and outreach*** including issues related to the form and content of PEAC products & services

9:30 a.m. **Working Group Discussions on Application of PEAC Forecasts**

11:00 a.m. **BREAK**

11:30 a.m. **Plenary Presentation of Key Working Group Findings and Recommendations**
(approximately 10 minutes for each Working Group with some plenary discussion)

Working Group moderators will be asked to present short summaries of discussions highlighting:

- (3-4) key strengths of the current PEAC system;
- (3-4) key weaknesses or gaps; and
- (3-4) key recommendations for future PEAC operations.

12:30 p.m. **GROUP PHOTO**

LUNCH—IMIN, Garden Level

1:30 p.m. **Working Group Discussions of User Engagement and Participation**

3:00 p.m. **BREAK**

- 3:15 p.m. **Plenary Presentation of Key Findings and Recommendations on User Engagement and Participation**
- 4:15 p.m. **Working Group Discussions of New Applications and Services**
- 5:45 p.m. **Plenary Presentation of Key Findings & Recommendations on New Applications and Services**
- 6:45 p.m. **Working Dinner – IMIN, Garden Level**
- Presentation on May 6-8 Workshop on Decision Support Systems for Seasonal-to-Interannual Climate Forecasting (David Cash, Harvard University)**

THURSDAY, JUNE 3 (IMIN Conference Center, Asia Room)

- 8:00 a.m. **Continental Breakfast**
- 8:30 a.m. **Charge for the Day**
- 8:45 a.m. **Working Group Discussions of Communications, Education and Outreach**
- 10:15 a.m. **BREAK**
- 10:30 a.m. **Plenary Presentation of Key Findings and Recommendations on Communications, Education and Outreach**
- 11:30 a.m. **Plenary Discussion of outstanding and crosscutting issues**
- 12:00 noon **LUNCH – IMIN, Garden Level**
- 12:30 p.m. **Monthly Pacific ENSO Forecast Discussion Teleconference** (participation optional for most participants)
- 1:30 p.m. **PEAC Newsletter, Website and Research Plans**
Presentation and facilitate discussion of revised format for PEAC products and research plans (Nicole Colasacco, NOAA/NWS-PR and Rashed Chowdhury, University of Hawaii/SOEST)
- 3:00 p.m. **BREAK**
- 3:15 p.m. **PEAC Today – Emergence of Pacific Climate Services**
(10-15 minutes each)

- A U.S. National Weather Service Prospectice – James Weyman, National Weather Service
- WMO Regional Climate Centres – James Salinger, NIWA, New Zealand
- Conceptual Framework of a Pacific Climate Information System – Eileen Shea, East-West Center

4:00 p.m.

Presentation and Plenary Discussion of Key Lessons Learned and Recommendations

- Presentation – Eileen Shea, East-West Center
- Discussants – James Weyman, Roger Pielke, Jr., Cheryl Anderson

5:15 p.m.

Next Steps and Closing Remarks (Eileen Shea, East-West Center)

5:30 p.m.

WORKSHOP ADJOURNS

ATTACHMENT D

PEAC Review Workshop

June 1-3, 2004

Working Group Guidelines

Much of the discussion during the *Pacific ENSO Applications Center (PEAC) Regional Workshop: A Look to the Future* will take place in small-group discussions of four critical aspects of PEAC processes and products:

- ***Application of PEAC forecasts***, including identification of current and potential partnerships focused on using PEAC information to support decision-making, exploration of early success stories in addressing regional issues in key sectors and identification of new sectoral opportunities;
- ***User engagement and participation***, including exploration of PEAC as a collaborative effort that effectively engages users and scientists in development, delivery, application and evaluation of PEAC products and services (i.e., issues of co-production of knowledge);
- ***Communications, education and outreach*** including issues related to the form and content of PEAC products & services as well as an exploration of the mechanisms PEAC personnel have used to support education and outreach related to PEAC products and/or climate information in general; and
- ***Development of new applications, tools and services***, including discussion of scientific and technical issues related to developing new forecasting capabilities, the collaboration of forecast users and producers in developing new services, and identifying information gaps/needs to guide future products and applications.

Participants will be organized randomly into four working groups that will explore each of these four topics in parallel during approximately 90-minute sessions beginning at 9:30 on the morning of Wednesday, June 2. In other words, everyone will be talking about issues related to the application of PEAC forecast information during the first breakout session, user engagement and participation during the second breakout session, etc.

In order to capitalize on the time available, we hope that the working group discussions will focus initially on an identification of key strengths and weaknesses of our shared experience during PEAC's first decade in each of these theme areas. Following this initial discussion of the past decade, we hope that each working group will produce a set of recommendations for future operations that will address current gaps/challenges and capitalize on emerging opportunities in the Pacific. In each case, we hope that the working groups will focus both on the *products* that PEAC has produced (or could produce in the future) and the *processes* that PEAC has employed to develop and sustain an interactive, collaborative dialogue among the scientific providers of ENSO-based climate information and the users of the information in Pacific Island governments, businesses and communities.

Following each working group session, we will re-convene in plenary and ask the chair (or rapporteur) of each working group to share the highlights of their group's discussions in the context of:

- **3-4 key strengths;**
- **3-4 key weaknesses;** and
- **3-4 recommendations** for future PEAC operations.

It is our hope that these summary presentations will help identify areas of consensus regarding PEAC's first decade and provide a list of priority actions for the future. Detailed rapporteur notes will be provided to the Workshop Chair for inclusion in the final report on the PEAC review project. Each working group will be provided with a computer, an LCD projector and flip chart to support their deliberations and reporting.

There is, of course, some overlap between the four theme areas and it is our hope that we can use this overlap constructively to ensure that we have sufficient time to discuss PEAC products and processes in some detail during the one-and-a-half days dedicated to working group discussions. It is our expectation that the first working group discussion of PEAC forecast applications will provide an opportunity for members of the working groups to get to know one another and explore the areas where PEAC forecast information has been successfully applied during the past decade. This will, we hope, provide a foundation for subsequent discussions of PEAC's efforts to develop collaborative partnerships among scientists and users as well as help identify opportunities for developing new partnerships in other sectors and or user communities. We also hope that the initial working group discussions will help keep us focused on the need to start by understanding the information needs of decision-makers as a starting point for effective climate services.

Above all, we hope that the working group sessions will provide an opportunity for all participants to share their individual insights and provide their recommendations for the future of PEAC. While we anticipate that some of our experiences will be similar, we also expect that there may be some unique stories that will provide equally valuable insights into the strengths and weaknesses of PEAC operations and can provide guidance for the future. We encourage everyone to share their thoughts throughout the Workshop and hope that the working group discussions, in particular, will provide an opportunity for everyone to be heard. Mahalo nui loa (thank you very much) for sharing your perspectives and here's to a productive *and* enjoyable Workshop experience!

NOTE: DURING THE WORKSHOP, PARTICIPANTS DECIDED TO COMBINE CONSIDERATIONS OF DISCUSSION OF USER ENGAGEMENT AND PARTICIPATION WITH DISCUSSION OF COMMUNICATIONS, EDUCATION AND OUTREACH INTO A SINGLE WORKING GROUP DISCUSSION.